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## Cross-hole Seismic Reflection Surveying in Coal Measures

by

## Michael John Findlay

## A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy

# Department of Geological Sciences The University of Durham 1991

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i



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#### **Abstract**

This thesis is concerned with the development of the cross-hole seismic reflection surveying method with particular application to the shallow Coal Measures strata found in opencast coal mining prospects in the U.K.

A field acquisition technique developed for shallow boreholes utilising explosive sources and hydrophone receivers is described. Data have been acquired from several test sites in northern England.

Data-processing techniques including wavefield separation and waveshaping deconvolution have been developed for cross-hole data and the theories behind these techniques are discussed.

Methods of imaging cross-hole reflection data including the 'VSP-CDP' transformation and Generalised Kirchhoff migration are applied to computer-generated synthetic data and to real data in order to yield a depth section of the seismic reflectivity between the boreholes.

Finally, the data-processing and imaging techniques developed are applied to real data acquired at British Coal Opencast exploration sites in northern England between 1987 and 1990.

## **Table of Contents**

Chap	iter I	
Intro	duction	1
	1.1 Synopsis	1
	1.2 Opencast coal mining in the U.K	1
	1.3 Opencast coal exploration	2
	1.4 Seismic exploration for coal	4
Chap	ter II	
The	cross-hole seismic reflection method	6
	2.1 Borehole seismic techniques	6
	2.2 Cross-hole seismic techniques	
	2.3 Cross-hole seismic data acquisition	8
	2.3.1 The source	8
	2.3.2 The receivers	9
	2.3.3 Recording equipment	10
	2.3.4 Field equipment set-up	11
	2.4 Data acquisition problems	12
	2.4.1 Timing errors	12
	2.4.2 Noise	12
	2.4.3 Borehole blockages	13
	2.5 Uphole shots and verticality	14
	2.5.1 Uphole velocity estimates	14
	2.5.2 Borehole verticality	15
Chap	ter III	
Data	processing	16
	3.1 Introduction	16
	3.2 Editing	16
	3.2.1 Shot-matching deconvolution	17
	3.2.2 First break estimation and direct arrival suppression	18

3.3 Wavefield separation	19
3.3.1 The Nyquist frequencies and aliasing	21
3.3.2 Two-dimensional filter application	21
3.3.3 Filter design	22
3.3.4 Tube waves and spatial aliasing	23
3.3.5 Examples of wavefield separation in the f-k domain	25
3.4 Waveshaping deconvolution	27
3.5 Velocity field estimation	28
3.6 The reflection point mapping scheme or VSP-CDP transform	29
3.7 Velocity analysis using the VSP-CDP transform	32
Chapter IV	
Migration of cross-hole reflection data	37
4.1 Introduction	37
4.2 Finite-difference migration	38
4.3 Implementation of the finite-difference migration algorithm	39
4.3.1 The finite-difference approximation	40
4.3.2 Boundary conditions'	42
4.3.3 Grid dispersion	44
4.3.4 Modelling seismic data with EXTRAP	
4.3.5 Migrating seismic data with EXTRAPREV	
4.4 Kirchhoff migration	46
4.4.1 Diffraction stack migration	46
4.4.2 The Kirchhoff operator	47
4.4.3 The Generalised Kirchhoff operator	49
4.5 Comparison of finite-difference and Kirchhoff migration	50
4.5.1 Point diffractor model	50
4.5.2 Horizontal reflecting interface model	51
Chapter V	
Results from cross-hole surveys in Coal Measures strata	54
5.1 Introduction	
5.2 Tinsley Park	54

5.3 Lowther South, West Yorkshire	57
5.3.1 Survey B, illustrating the combination of up- and down- going	sections
••••••	58
5.3.2 Survey C; between boreholes II and III	60
5.3.3 Survey D; wider-spaced cross-hole reflection survey	61
5.3.4 Survey E; cross-hole survey through major fault zone	63
5.4 Lostrigg, Cumbria	66
5.4.1 Survey F; old mineworkings	66
Chapter VI A comparison of different migration operators for cross-hole se	
6.1 Introduction	
6.2 Migration operators	
6.2.1 Suitability of impulse response functions for cross-hole	
Chapter VII	
Conclusions and suggestions for future work	72
References	75
Appendix A Computer software	I
Appendix A.1 Data processing software	II
Appendix A.2 The reflection point loci program REFLOC	ın
Appendix A.3 The VSP-CDP transform program XHRMAP	IV
Appendix A.4 The raytracing program TRACER	V
Appendix A.5 The raytracing subroutine RAYTRA	VI
Appendix A.6 The finite-difference migration program EXTRAPREV	VII
Appendix A.7 The forward modelling program EXTRAP	VIII
Appendix A.8 The migration program KIRCHMIG	IX

## Chapter I

#### Introduction

#### 1.1 Synopsis

The purpose of this research work has been to develop the cross-hole reflection surveying method, and to consider its feasibility as an exploration technique for opencast coal prospects. The remainder of this chapter is concerned with opencast coal exploration in the U.K. in order to put the development of the cross-hole method into context. Chapter II deals with the acquisition of cross-hole seismic survey data and the problems associated with it. Chapter III is an overview of the data processing which is required for these surveys and chapter IV concentrates on the migration methods which may be used to image the data. Some trial surveys which were conducted at opencast prospects in the north of England are discussed in chapter V, and a comparison of different cross-hole migration operators is included in chapter VI. Conclusions of this work are drawn in chapter VII.

#### 1.2 Opencast coal mining in the U.K.

In the modern era, opencast coal mining in the U.K. began in 1942, when it was introduced as a wartime measure to extract shallow coal reserves from the top few metres of the ground. Modern mines are now much deeper; a typical working site may be 100m deep. Pits are much smaller than in other parts of the world, simply because of the high population density in the U.K. Site boundaries are restricted by



population centres and the communication networks between them as well as by natural boundaries.

Current estimates of shallow coal reserves in the U.K. suggest that there are around 300 million tonnes of coal which could be extracted by opencast mining. Although the total annual output (~15 Mtonnes) from opencast mines is less than 20% of the total U.K. production, opencast coal is more economical to produce and is often of an higher quality than deep-mined coal. Deep-mined coal often has opencast coal blended with it to improve its calorific value and bring it up to the required standard for a marketable product.

The responsibility for opencast coal developments lies with British Coal Opencast (BCO), which is a subsidiary of the British Coal Corporation. BCO provides a detailed specification of a prospect to civil engineering companies who tender for the contract to mine the site. BCO also uses the specification in applying for planning permission. As part of their contract, the civil engineering companies must restore the pit area when the mining operation has been concluded.

#### 1.3 Opencast coal exploration

Initial site assessments are based upon the currently available geological knowledge of the area. Additional information is also provided by the plans of old mineworkings (although these are usually too unreliable to help in site reserve estimates) as well as the data obtained from any nearby opencast sites. Once there is sufficient evidence to show that a proposed site may be profitable, the exploration stage begins.

BCO's present exploration strategy involves the drilling of a dense grid of shallow (typically with total depths less than 100m) boreholes. The boreholes have 14cm diameter steel casing from the surface down to rock head (typically 5-10 metres of casing), but below this depth they are left uncased. This drilling programme is a massive exploration effort with a total metreage of around 750,000m drilled each year. These are drilled using an air-flush system in which compressed air forces rock chippings from the drill bit to the surface, where they are logged by the driller. All the boreholes are subsequently geophysically logged by using natural gamma and density tools. The density log gives excellent responses to coal seams, whilst the natural gamma log identifies dirt bands and is used in correlations between boreholes. Approximately 20% of the boreholes are also cored. An ideal drilling strategy is initially to drill holes on a grid pattern with 120m spacing. This would then be reduced to 60m and then to 30m, or even less, in areas of particular interest where faulting or old mineworkings are believed to exist. However, permit difficulties and time limitations often dictate that the initial reconnaissance stage is omitted, and in some parts of the country only a single phase of drilling on, say, 50m centres is carried out. The interpreted logs from the boreholes are used to determine the overburden lithologies as well as the location and thicknesses of coal seams and the presence of fault zones which may lead to problems in the excavation of coal.

It is very important that BCO can provide as accurate an estimate as possible of the rippable coal reserves, since it will incur contractual penalties if the excavating civil engineering contractor finds less readily extractable coal in the site than was predicted, and also because any profits from excess coal reserves will chiefly benefit the contractor. The site must also be shown to be of primary economic importance to the appropriate planning authorities.

To date the drilling programme has proven to be an effective exploration strategy, but information coverage is disrupted where physical obstructions such as buildings and rivers are located. These gaps in the data might be filled by geophysical techniques which can provide information on the strata between the boreholes. It is barely possible to detect faults with throws of 2m or less from borehole levels, even if the boreholes were drilled only 2m apart. There is, therefore, great potential for a geophysical technique which can detect such small faults in critical areas such as site boundaries. In addition, suitable geophysical surveys combined with a 60m borehole spacing, might allow old workings and faults to be determined more accurately than would be possible by drilling boreholes with 30m separations. This could potentially eliminate the need for ~75% of the boreholes in these areas.

The pillar and stall type of old mineworkings are particularly prevalent in areas suitable for opencast mining because, naturally enough, the earliest old mineworkings were frequently located near outcrops. As many as five or six sets of old mineworkings may be present in different seams on the same site. Indeed, the greater part of the coal in an economically viable prospect may be in the form of pillars in the old mineworkings which were left behind to prevent collapse.

#### 1.4 Seismic exploration for coal

Surface seismic reflection surveys have been used as an exploration tool for deep mines for almost twenty years. In these surveys target depths are of the order of hundreds of metres, and poor imaging is obtained in the upper 100m of the sections (see e.g. Ziolkowski, 1979). The surface reflection method has been applied

specifically to opencast targets by Brabham (1986), but the results were poor with long wavelength (~20m) reflections being recorded, the higher frequencies having been absorbed by the weathered surface layers. A great problem for shallow seismic reflection surveys is interference from refracted waves and ground roll; this is very dependent on the shallow geology (Bredewout and Goulty, 1986).

In-seam seismic methods have also been used successfully in deep mines (Buchanan, 1983; Jackson, 1985). Deep mine hole-to-hole seam wave transmission experiments were carried out by Jackson et al. (1989), who observed arrivals with the dispersive character which one would expect for a low-velocity SH channel wave between holes where the seam was continuous. When old mineworkings or faulting exist between the boreholes, no such wave should be detected. The method has been applied to shallow Coal Measures strata (Goulty et al., 1990), but without success because of the strong attenuation of high-frequency shear waves in shallow strata. Vertical seismic profiling (VSP) methods have been applied to deeper coal seams by Suprajitno and Greenhalgh (1985) and Jackson et al. (1989) and to shallow Coal Measures strata by Kragh (1990).

It is hoped that cross-hole seismic reflection surveys may be used in conjunction with VSPs and borehole logs to provide a flexible, high-resolution tool for opencast coal exploration. In particular, they could fill in information where boreholes cannot be drilled and accurately determine the location of small faults and old mineworkings.

## **Chapter II**

#### The cross-hole seismic reflection method

#### 2.1 Borehole seismic techniques

The check shot survey is a long-established borehole seismic technique in the oil exploration industry which is used to calibrate velocity measurements obtained from borehole sonic logs. A natural progression from this was the vertical seismic profile (VSP). The VSP involves repeatedly firing rig-source shots while a geophone is located at successive depth levels in the borehole; see Balch et al. (1982) for a review. The seismic data recorded can then be processed to obtain a vertical profile of the seismic reflection response of the strata at the borehole. VSPs are useful for correlating conventional surface seismic reflection sections with well-log information.

Further developments in VSP data acquisition include offset VSPs, where the source is fired at a constant offset from the rig (see e.g. Dillon and Thomson, 1984) and walkaway VSPs, where the source is fired at several different offsets while the geophone position is kept constant (see e.g. Kohler and Koenig, 1986). These illuminate the geological structure over narrow cross-sections through the borehole in the azimuthal direction of the source locations. The most general case of such profiles utilises multiple geophone positions and source offsets in the same survey.

When the source is fired within the borehole and surface receivers are used the survey is known as a hole-to-surface seismic profile (Kragh, 1990), a simpler terminology for what has also become known as the inverse multi-offset VSP

(IMOVSP) (e.g. Jackson et al., 1989). These types of survey provide increased resolution of seismic reflectors compared with conventional surface seismic surveys because the acoustic signal only passes through the near-surface layer once, whereas two passes are needed for surface seismic reflection surveys. Thus the higher temporal frequencies in the signal are less attenuated by near-surface effects.

#### 2.2 Cross-hole seismic techniques

Cross-hole seismic methods involve firing shots in one borehole and recording the transmitted and scattered wavefields on receivers positioned in a neighbouring borehole. By positioning both sources and receivers in the sub-surface, the frequency content of the data is higher than that of VSPs. The first applications of this recording geometry were in velocity surveys where the travel times of direct arrivals are used by tomographic inversion algorithms to generate a tomogram or slice of the velocity field between the boreholes (see e.g. Worthington, 1984; Dines and Lytle, 1979). The uses of this technique are principally in locating local velocity anomalies caused by intrusions and voids (e.g. Cottin et al., 1986; Bishop and Styles, 1990), and also in monitoring the changes in a velocity anomaly with time which may occur during fluid-injection enhanced oil recovery projects (Macrides et al., 1988 and Justice et al., 1989). Kragh (1990) applied the technique in trying to locate shallow old mineworkings in Coal Measures strata by looking for velocity anomalies in the collapsed zones immediately above the old mineworkings, but concluded that any such velocity anomalies were too small to be detectable by this method.

The basic type of tomographic survey uses only the direct arrival traveltime data. Obviously additional information is also present in the later scattered arrivals. Techniques to utilise scattered arrivals have been developed by Devaney (1984) and Pratt and Worthington (1988), amongst others. The diffraction tomography method may be applied to cross-hole data to provide velocity and attenuation tomograms. An alternative to this approach is to consider a cross-hole reflection survey as being composed of several offset VSPs where the sources and receivers are all below ground level. Data processing of the survey is then similar to, but more complicated than, processing a set of offset VSPs. This processing route has previously been applied to synthetic data by Hu et al. (1988) and to ultrasonic scale-model data by Zhu and McMechan (1988) and Balch et al. (1990). This is the processing method which has been adopted in this work.

#### 2.3 Cross-hole seismic data acquisition

As in any type of seismic survey, the choice and deployment of acquisition equipment should be considered carefully. Of particular importance are the types of source and receiver and the recording device used.

#### 2.3.1 The source

An explosive source was used in all the trial surveys of Chapter V. The explosive charge used consisted of an electrical (no.8 type) detonator which was sometimes boosted by 25g of dynamite. The dynamite was used to improve the

signal-to-noise ratio in surveys where high background noise levels were observed, but it was generally avoided in order to minimise the risk of damage to the borehole walls. There was no noticeable change in the frequency content of data recorded using a dynamite source compared with that of data recorded using a detonator alone, suggesting that the charge scaling law proposed by Ziolkowski et al. (1980) does not hold for small-sized charges fired in boreholes.

The charge is positioned at the end of a 4cm diameter hollow steel tube which is 40cm long. The purpose of the tubing is to provide to provide sufficient weight to allow the source to be lowered and raised easily in the borehole and also to prevent the explosion from damaging the firing or triggering leads with which the source is connected to the surface. This source was found to give an adequate frequency range for the purposes of the trial surveys and also gave good shot repeatability.

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#### 2.3.2 The receivers

It was decided that, for reasons of practicality and speed, a string of receivers would be needed. The simplicity of utilising a ready-built hydrophone string greatly outweighed the complexity of constructing a string of (three-component) geophones. Hydrophones in a vertical fluid-filled borehole may be expected to detect SV body waves as well as P waves, but not SH waves (Schoenberg, 1986). However, the practical difficulties of accurately recording rock particle motion by a borehole geophone were recently demonstrated by Beattie (1990). She found that the geophone was much more sensitive to tube waves; a surprising result but explained by the effect of the pressure in the fluid due to the tube waves acting on the top and bottom of the geophone housing.

Two 12-channel hydrophone strings were used; the first (used in survey A of chapter V) had hydrophone spaced at 4m intervals and the second (used in the remainder of the trial surveys) had a 2m hydrophone spacing. The hydrophones were streamlined by enclosing each one in heat-shrink plastic to prevent snagging on the borehole wall. A weight is fastened to the bottom end of the string to facilitate lowering in the borehole. The 4m-spacing string was supported by a steel cable fed past each hydrophone and attached to the weight at the bottom. In the 2m-spacing prototype a nylon rope was used instead in order to reduce the overall weight of the string and make it easier to handle.

#### 2.3.3 Recording equipment

Two recording devices were used in the field trials. The first was an EG&G Geometrics Nimbus 12-channel 10 bit enhancement seismograph with a dynamic range of 66dB. This was used in survey A of chapter V. In the remainder of the surveys an EG&G Geometrics ES-2401 24-channel enhancement seismograph was used. This equipment was a significant improvement on the earlier model with a much greater dynamic range and the additional benefit of storing data in SEG-DOS format on floppy disks instead of the tape reels (SEG-D format) used by the Nimbus. The advantage of 24-channel recording allowed the simultaneous acquisition of crosshole and hole-to-surface surveys, with 12 channels allocated to the downhole hydrophones and the other 12 to a surface geophone spread. This led to a greatly improved rate of data acquisition, and reduced the risk of losing a survey due to explosive damage instigating collapses in the borehole wall.

#### 2.3.4 Field equipment set-up

The typical equipment arrangement used in the field trials of chapter V is illustrated schematically in figure 2.1. The string of hydrophones is lowered into borehole B and the source is positioned in hole A. Shots are repeated at the same depth levels for different positions of the hydrophone string in order to extend the coverage of the receiver array. One hydrophone position is kept in common between the repeated shots to allow amplitude scaling and repeated shot deconvolution to be carried out (see section 3.2.1). In the trial surveys, the hydrophone string remained fixed while shots were fired successively at depth intervals of 2m (to make the coverage of reflectors between the boreholes as uniform as possible). The hydrophone string was then moved to a new position and the shot sequence was repeated.

A sampling interval of 200µs was used in all the trials and a data length of 1024 samples (204.8 ms) was recorded.

The deepest shot and receiver locations were usually limited by collapses in the boreholes, rather than the total depth actually drilled, and the shallowest shot and receiver positions were restricted by the level of the water table in each borehole. A hydrophone will simply not respond if it is not submerged, and there is insufficient coupling of the source energy to the surrounding rock unless the shot is also submerged. Shots fired 1-2m below the water table resulted in a noticeably lower frequency content in the recorded data; the dominant frequencies being approximately half those of the deeper shots. This was presumably due to an insufficient confining hydrostatic pressure to restrict the expansion of the exploding gas bubble.

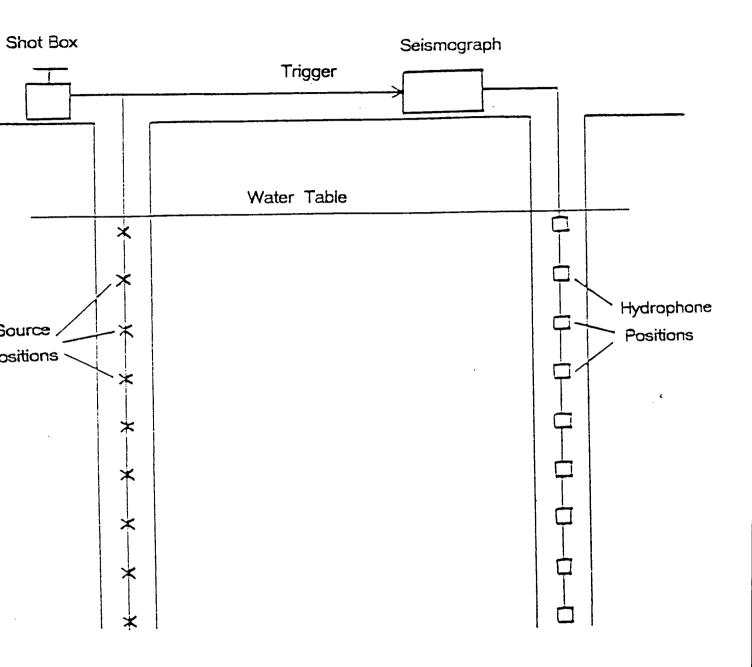


Figure 2.1 Typical cross-hole survey field set-up.

#### 2.4 Data acquisition problems

Three distinct types of problem were encountered during data acquisition: timing errors, noise and borehole blockages.

#### 2.4.1 Timing errors

Initial trials with the acquisition system used a Huntex shot box to fire the detonator and simultaneously send a trigger signal to the seismograph, but this was found to be insufficiently accurate, resulting in random timing errors of up to 1 ms in the recorded data. As an alternative to this, some wire was wrapped around the detonator and connected to a trigger lead above the steel tube of the source tool. The trigger lead ran up the borehole and was fed into the trigger input of the seismograph via a differentiating capacitor. The firing pulse was provided by a 12V car battery. When the detonator exploded, the wire around the detonator was broken causing a resistive change at the trigger input. This method was found to give very accurate timing breaks. Timing errors could be checked by inspecting the first break time of the common hydrophone channel between repeated shots. Occasionally random timing errors would still occur, and these were attributed to electrical pick-up between the firing and triggering lines.

#### **2.4.2** Noise

There were two different categories of noise: shot-generated noise and background noise. The shot-generated noise consisted of tube-wave arrivals (equivalent to surface waves in conventional seismic surveys) which are low-velocity

events travelling along the borehole wall. These are discussed in section 3.3.4. No suitable acquisition technique could be used to suppress these arrivals.

Background noise was both man-made and natural, including drilling-rig vibrations (because acquisition took place on active exploration sites), and factory-generated noise at one site. Water dripping into the boreholes from above the water table caused noise events on shallow receivers and low-frequency (~10 Hz) pipe resonances were detected in some surveys. Pipe resonances could be removed by the use of high-pass filters, but the presence of drilling crews frequently led to long delays between successive shots, until a lull in drilling operations took place.

#### 2.4.3 Borehole blockages

Borehole blockages were the most serious problem encountered in data acquisition, and led to several trial surveys being abandoned. After drilling was finished, the borehole would gradually fill with mud and debris which fell from the borehole walls. This obviously reduced the maximum source and receiver depths as time passed. It was therefore essential for surface casing to be left in the boreholes so that the soft near-surface drift material would not simply fall down the boreholes. Ideally, surveys would also be carried out as soon as possible after the boreholes were drilled and logged.

Unfortunately, where old mineworkings and faulting occur in the boreholes (i.e. those areas of particular interest), the borehole walls are particularly susceptible to collapse. It was frequently the case that a borehole would be blocked just above the level of old mineworkings. Surveys in available boreholes where not attempted

when the borehole walls were thought to be particularly unstable for fear of losing the hydrophone string.

#### 2.5 Uphole shots and verticality

Two further sets of measurements were required to complete each survey: velocity readings within the boreholes and verticality readings. Unfortunately, in some cases these additional data were unobtainable due to borehole collapses.

#### 2.5.1 Uphole velocity estimates

Interval velocity estimates are made in each borehole by firing a shot 2m below the hydrophone string. In this way approximate values of the vertical velocity field can be obtained. A sampling interval of  $100\mu s$  is used and worst errors,  $\Delta v$ , in the interval velocities, v, can be estimated using the following equation (Stewart, 1984):

$$\Delta v = 2v \frac{\delta t}{\Delta t} \tag{2.1}$$

where  $\Delta t$  is the travel time between two receiver positions, and  $\delta t$  is the timing error. To avoid the risk of losing the hydrophone string, it was sometimes necessary to estimate the interval velocities by recording the traveltimes to a surface geophone from several shot positions, but this resulted in less accurate first break picks and thus greater errors in the interval velocity field estimates.

#### 2.5.2 Borehole verticality

The deviation of the borehole from the vertical and the azimuth of this deviation were measured by using a pendulum-type inclinometer. This tool could be run down the borehole within its own casing in two perpendicular directions, but had a depth limit of 60m. The dip readings were converted to borehole displacements using the program of Howson and Sides (1986). On the whole, borehole deviations were slight, particularly at shallow depths, and were rarely more than 3.0 metres at the bottom source and receiver depths. Neighbouring boreholes usually deviated in a similar manner.

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## **Chapter III**

## **Data processing**

#### 3.1 Introduction

The close resemblance of cross-hole seismic reflection common shot gathers to offset vertical seismic profiles (OVSPs) provides an obvious route for processing these surveys. Essentially, each common shot gather may be thought of as an individual OVSP, but with the additional complication of having some receiver positions at shallower depths than the level of the source. A typical data processing scheme for cross-hole data is shown in figure 3.1. The processing consists of several distinct stages: editing, wavefield separation, deconvolution, velocity field estimation and imaging. These are discussed below.

#### 3.2 Editing

Following data acquisition, the field data are transferred from DOS-format floppy disks to the University of Durham Amdahl 470/V8 mainframe computer. Data from combined hole-to-surface and cross-hole surveys (see section 2.3.3) are then separated using utility software, and the cross-hole data are then sorted into common shot gathers.

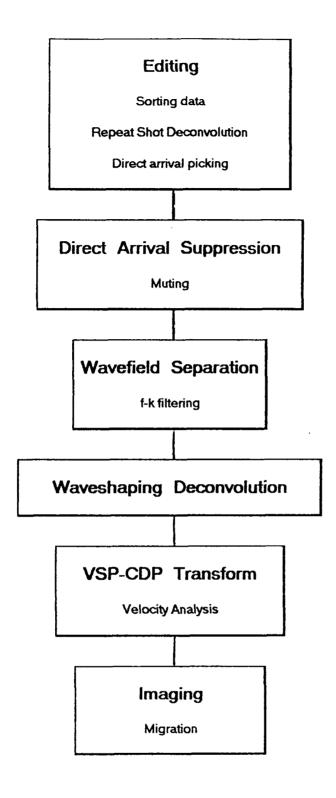


Figure 3.1 Outline of cross-hole reflection data-processing scheme.

#### 3.2.1 Shot-matching deconvolution

Usually each common shot gather comprises two (or more) positions of the hydrophone string with at least one hydrophone position kept in common between adjacent string positions for the repeated shots. This is used as a precautionary measure to ensure that there are no time break errors in the survey and also to check for the repeatability of the source waveform. In cases where the common shot traces do not correspond, a waveshaping Wiener filter may be designed and applied to one set of hydrophone positions so that a match will occur on the common trace. An example of such a deconvolution is shown in figures 3.2-3.5.

Figure 3.2 shows the raw recorded data for a particular common shot gather. In this case, data were recorded by firing a shot whilst the hydrophones were at depths (12-34 m) and then moving the hydrophones so that they lay at depths (34-56m) and firing a second shot at the same depth. Thus channels 12 and 13 correspond to the common channel for this common shot gather. There is a noticeable mismatch in the character of these traces and so a deconvolution operator was designed along the following lines. Firstly, a suitable time window (including the first arrivals and any dominant reflections) was chosen for the two traces and the segments of data within the window were tapered. A least-error-energy Wiener waveshaping filter was then calculated which, when convolved with the window from trace 13, would result in an output which approximated the window from trace 12. Figure 3.3 illustrates the windowed data, the deconvolution operator, and the filter output as time series. The respective amplitude spectra are plotted in figure 3.4. Figure 3.5 is a plot of the common shot gather following the application of the same waveshaping filter to traces 13-24.

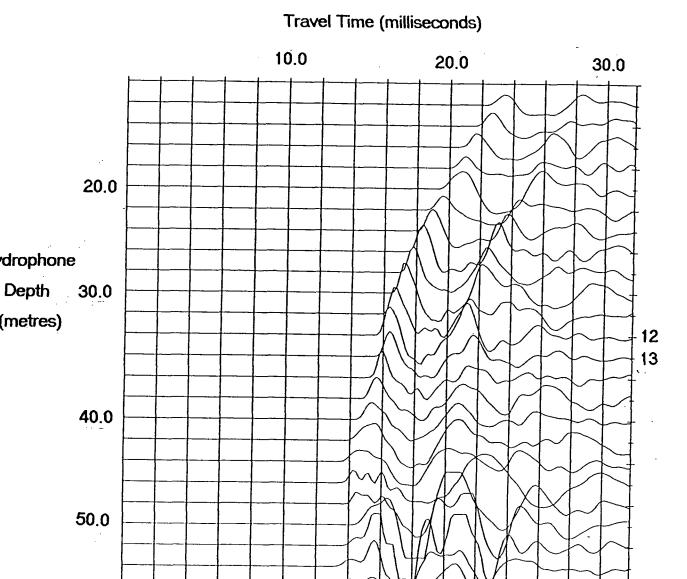
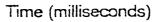


Figure 3.2 Unprocessed common shot gather. Channels 12 and 13 are repeat shot common receivers.



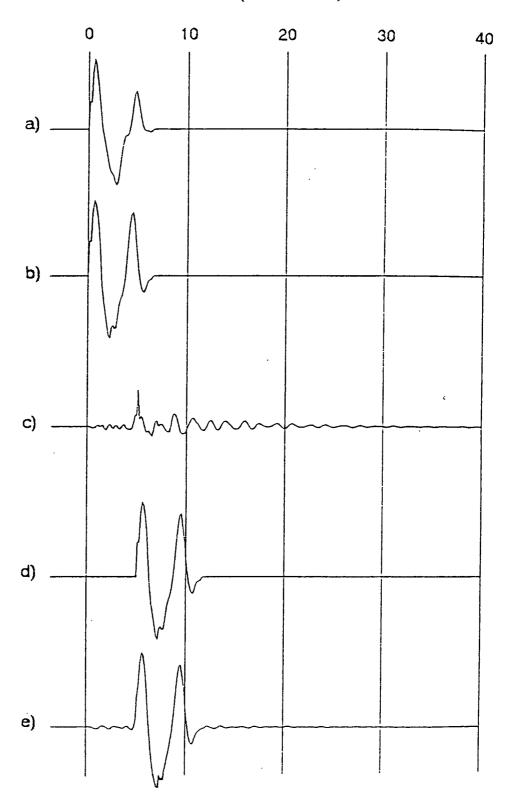


Figure 3.3 Repeat shot deconvolution: a) input signal, b) desired output signal, c) filter, d)lagged desired output signal, e) convolution of input signal and filter.

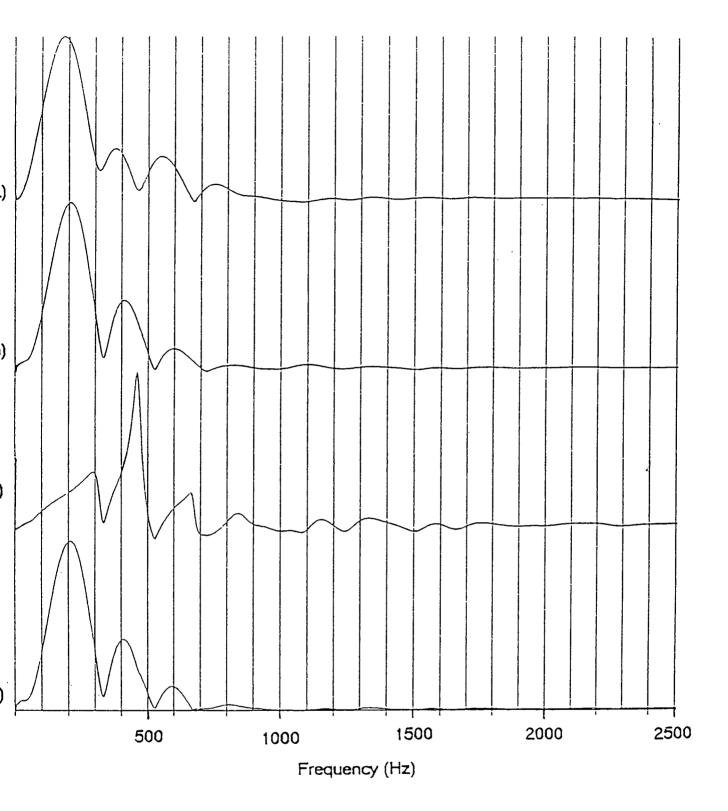


Figure 3.4 Repeat shot deconvolution - amplitude spectra: a) input signal, b) desired output, c) filter, d) filtered input.

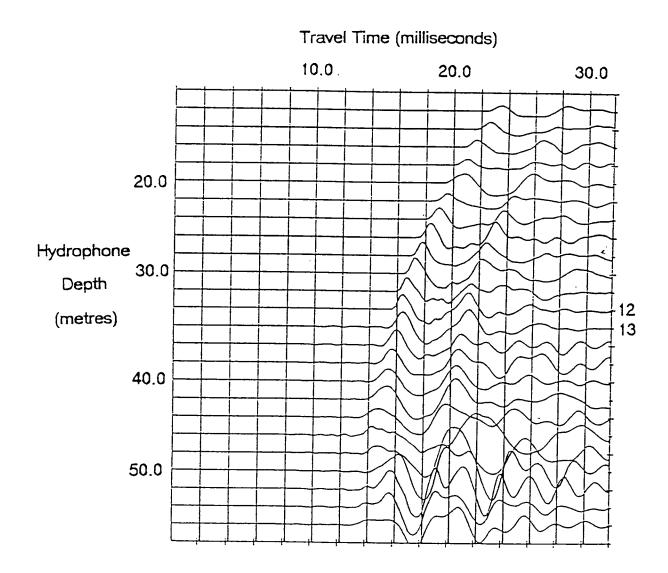


Figure 3.5 Common shot gather after repeat shot deconvolution.

After this preliminary deconvolution, an amplitude scaling factor is applied to equalise the shot energies for the two hydrophone positions. This is taken to be the ratio of the rms amplitudes of the common receiver traces.

#### 3.2.2 First break estimation and direct arrival suppression

In order to mute out the large-amplitude direct arrivals, it is first necessary to estimate the direct arrival times at each hydrophone position. An automatic first-break picking program was found to give good results for cross-hole data provided the signal-to-noise ratio was sufficiently high (as is usually the case with cross-hole data). First breaks are picked on a statistical basis, by simply locating the time sample where the recorded signal amplitude rises sufficiently above the rms amplitude of the background noise. In addition, it was found to be necessary to check all first-break times manually to avoid the inclusion of "head wave" arrival picks.

Once direct arrival times have been picked from the data, it is a simple matter to mute the direct arrival energy by specifying a window for a cosine taper on each trace. Some reflected energy is undoubtedly lost by removing the direct arrivals in this way. Unfortunately this means that reflector coverage will be lost near the receiver borehole, but this method was found to be the most suitable for the field datasets discussed in chapter V.

An alternative scheme for direct arrival removal has been proposed by Pratt and Goulty (1991) who applied it to ultrasonic model data. This removes the direct arrival waveform of a particular trace by aligning the first breaks of those traces which correspond to nearest neighbour sources and receivers. These trace are then averaged to provide an estimate of the direct arrival waveform which may then be

subtracted from the original trace to yield the scattered wavefield. This method was found to be unsuitable for the cross-hole datasets discussed later, because the direct arrival waveform was not sufficiently consistent between adjacent traces. This is probably due to peg-leg multiples which will be present in data acquired from the real earth with its small-scale layering, as opposed to that acquired from an ultrasonic modelling system where the model consists of relatively few homogeneous layers.

Direct arrival muting may be carried out either before or after wavefield separation. Inclusion of the direct arrivals in the wavefield separation can lead to ringing problems when frequency-wavenumber filters are applied to the data (see section 3.3), but on traces where the direct arrivals are downgoing and the interesting reflections are upgoing, it is preferable to mute after separation in order to preserve as much of the scattered wavefield as possible. This is the final stage of the editing procedure, and the processing sequence then continues with the application of wavefield separation filters.

#### 3.3 Wavefield separation

The scattered wavefield recorded for each common shot gather may be classified as consisting of upgoing and downgoing components. These refer to waves which travel upwards or downwards, respectively, across the receiver array. The upgoing and downgoing scattered energies must be imaged independently because of the net cancellation effect which would result in combining their respective reflectivity amplitudes.

Clearly, for a particular reflecting interface, the signals which are recorded from shots above the interface on receivers above the interface (i.e. upgoing reflection events) will be of opposite polarity to those which are recorded from shots below the interface on receivers also below the interface (i.e. downgoing reflected events). Since the apparent velocities of these upgoing and downgoing events are of opposite sign  $(\frac{dz}{dt} > 0$  for downgoing events;  $\frac{dz}{dt} < 0$  for upgoing events) these events are readily separable by means of velocity filters.

For zero-offset VSP surveys, separation may be carried out by median filters which rely upon the linear moveout of reflection events (Hardage, 1983). When the source is offset from the receiver array, however, this moveout is non-linear and so it is necessary to apply filters which can selectively pass or reject arrivals with a range of apparent velocities. One such filter type is the pie-slice filter (Embree et al., 1963), which is applied to data which have undergone a two-dimensional Fourier transform into the frequency-wavenumber (f-k) domain.

The two-dimensional Fourier transform is implemented on digitally recorded data by means of the Fast Fourier Transform or FFT (Cooley and Tukey, 1965). This algorithm requires that the data consist of  $2^n$  samples (n being an integer) and assumes that the data have a periodicity equal to this sample size. To carry out a two-dimensional transform on a common shot gather the algorithm may be applied first in the time direction on all traces, and then in the spatial (depth or z) direction at all frequencies, although the sequence of these operations is immaterial.

In dealing with digitally sampled data, there are some important factors to be considered which do not occur with analogue data. In particular, in discrete Fourier space, there may be problems due to the data being undersampled and thus not uniquely defined.

#### 3.3.1 The Nyquist frequencies and aliasing

If the recorded data have a time sampling interval  $\Delta t$  and the receivers are regularly spaced at intervals of  $\Delta z$ , then the temporal and spatial Nyquist frequencies are respectively defined as:

$$f_{\text{NYQ}} = \frac{1}{2\Delta t} ; k_{\text{NYQ}} = \frac{1}{2\Delta z}$$
 (3.1)

Only if all (f,k) components in the recorded data lie within the range governed by the positive and negative Nyquist values will the data be completely determined by the recorded samples. If (f,k) components outside the Nyquist range are present then they will be aliased when they are recorded. This means that they will wrap around in the discrete Fourier space because of the periodic nature of the transform and contaminate the unaliased (f,k) components. March and Bailey (1983) give an informative account of the f-k transform.

#### 3.3.2 Two-dimensional filter application

Filter application in the f-k domain involves complex number multiplications of each component in f-k space with the corresponding component of the filter. This operation is equivalent to a convolution in the z-t domain of the original data with the impulse response of the filter.

One characteristic of the Fourier transform is that discontinuities or steep slopes which are present in a function in one domain lead to the Gibb's phenomenon, also known as ringing, in the transformed data. With cross-hole seismic data it is common to find that the data taper smoothly towards zero amplitude in the temporal direction but, because of the restriction imposed by the finite recording aperture of the receiver array, there are sharp discontinuities at the edges of the data in the spatial direction. Normally these would result in ringing in the wavenumber domain. It is thus necessary to apply a taper across the edge traces in the spatial direction, and a simple cosine taper over four traces is found to be adequate for this purpose.

Another problem with the discrete Fourier transform is that the data, although recorded over a finite range of times and depths, are assumed to be periodic outside the recorded ranges. Hence, a multiplication in the f-k domain is equivalent to a cyclic convolution, and not a transient convolution. Convolution in the time domain results in an output which has a length equal to the length of the data plus the length of the filter. When the filter is applied in the f-k domain, the extra output length will become wrapped around "noise" on the outer traces after the reverse transform is applied. This filter leakage can be avoided if the data are padded out with blank traces before applying the FFT. The total number of traces is made up to the next power of two, since the FFT algorithm requires that the number of samples to be processed is a power of two.

#### 3.3.3 Filter design

In the case of pie-slice filters which are applied to common shot gathers of cross-hole seismic data, it is usually necessary to design the f-k filter with steep slopes in order to separate the upgoing and downgoing events, whilst rejecting as little of the appropriate P-wave reflection energy as possible. In order to accomplish this, while at the same time keeping the ringing effects induced by the steep slopes to a

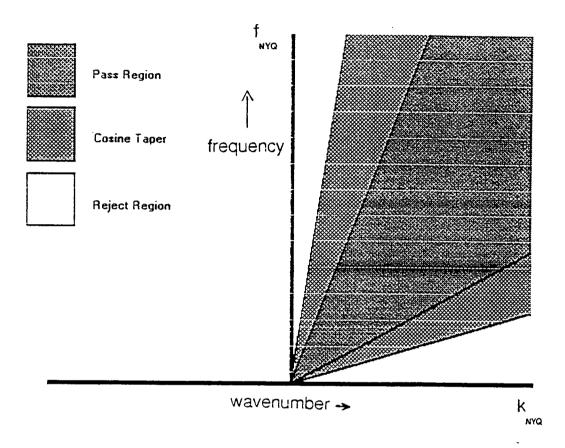


Figure 3.6 Two-dimensional f-k filter implementation

minimum, the edges of the velocity filters are selected so that they lie along low amplitude channels in the data; an approach advocated by Christie et al. (1983) and similar to the contour-slice filtering proposed by Suprajitno and Greenhalgh (1985). Filter edges are tapered by a smooth cosine taper which runs perpendicular to the bisector of two lines in f-k space which determine the tapering region (figure 3.6).

Other considerations of filter design include the rejection of events other than P-wave reflections. Although the hydrophone receivers used in the cross-hole surveys discussed later are pressure sensitive devices, they will also record SV energy when they are located in a borehole (Schoenberg, 1986). The apparent velocity of SV arrivals ranges from infinity (wavefronts parallel to the borehole axis) down to the SV wave velocity in the rock medium (raypaths parallel to the borehole axis). Thus direct wave SV arrivals are difficult to filter out but SV arrivals with apparent velocities less than the P-wave velocity in the rock may be readily removed. Generally, it would only be mode-converted P—>SV reflections which would arrive within the time window of interest in the surveys reported here.

### 3.3.4 Tube waves and spatial aliasing

Another type of coherent noise event, which is more significant in borehole seismic data, is the tube wave. The tube waves, which have been observed in the boreholes discussed in chapter V, typically have a larger amplitude and lower frequency than body waves and can be thought of as a type of surface wave (the Stoneley wave) which travels along the interface between the borehole wall and the borehole fluid with an elliptical particle motion. These waves sometimes emanate from the top (or water table) and bottom of the receiver borehole, and frequently

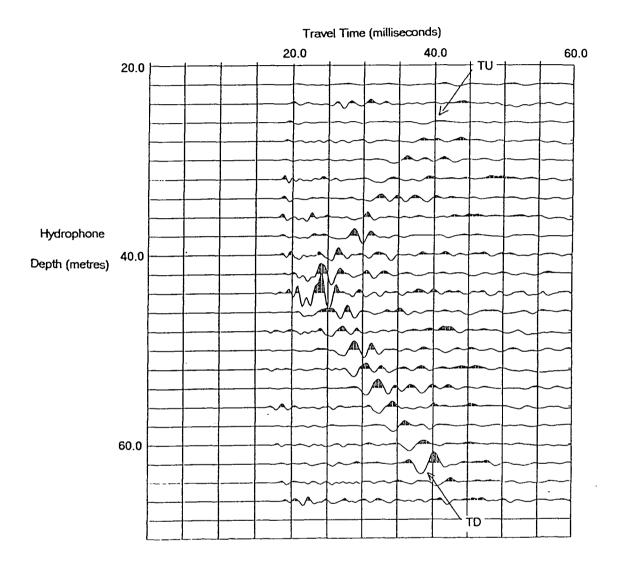


Figure 3.7 Tube waves example: upgoing and downgoing tube wave events are indicated by TU and TD respectively.

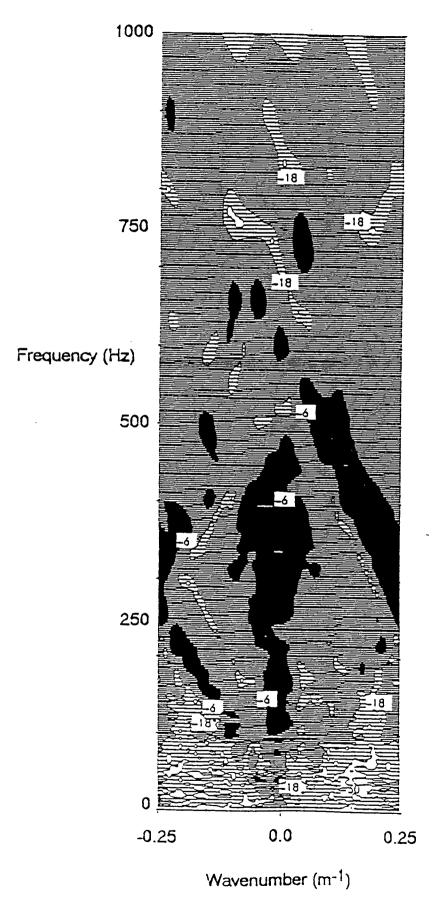


Figure 3.8 Tube wave amplitude spectrum. Contour levels are at 6, 18 and 30 dB below peak amplitude.

originate at seam level depths in shallow Coal Measures strata. One such tube wave is shown in figure 3.7 with its f-k spectrum in figure 3.8.

Examination of the moveout per trace of the tube wave arrival in figure 3.7 reveals that this is greater than half the dominant period of the arrival and so it is spatially aliased. An event with an apparent velocity  $V_{\rm APP}$  will be spatially aliased for temporal frequencies greater than  $f_{\rm ALIAS} = V_{\rm APP} / k_{\rm NYQ}$ . A spatially aliased event wraps round in the f-k domain (see figure 3.8) due to the periodicity of the discrete Fourier transform. Therefore, in order to remove spatially aliased noise from the data, it is necessary to apply a rejection filter which itself will wrap around in the f-k domain. Unfortunately, this type of filter will also remove reflected P-wave energy from the quadrant in f-k space into which it wraps round, thus reducing the information content of the data. In most cases where this was done it did not have a severe effect on the data.

An alternative method of removing low velocity spatially aliased noise is to apply a linear moveout to the data before applying the two dimensional FFT and thereby alter the moveouts of all events so that the spatially aliased events are no longer aliased and can be removed with ease in *f-k* space. The artificial moveout is then removed following a transformation back to the *z-t* domain. This method can lead to events, which were not previously aliased, becoming aliased, and so the method is highly data-dependent and must be applied with care. In most cross-hole surveys where tube waves occurred they were both upgoing and downgoing which meant that this method could not be applied (de-aliasing of one tube wave type would mean even more severe aliasing of the other).

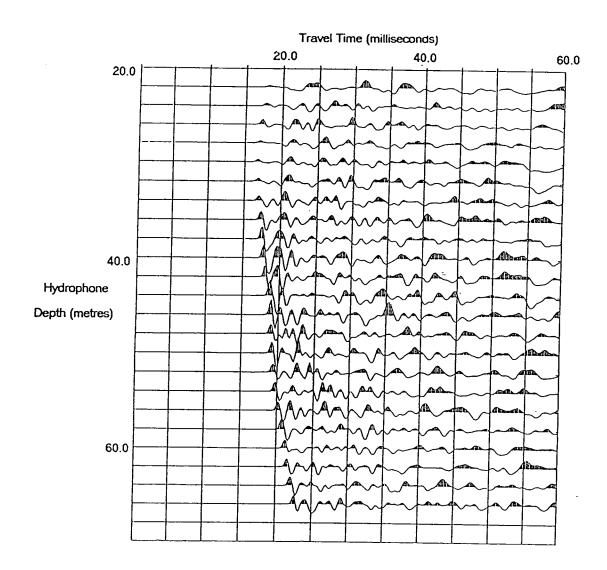


Figure 3.9 A common shot gather from survey A of chapter V.

The data processing software (Appendix A.1) allows for several different filter design options, including the wrap around type of filter and trapezoidal-shaped filters as well as pie slice filters. All filters can be specified as pass or reject types.

### 3.3.5 Examples of wavefield separation in the f-k domain

A common shot gather from one particular survey (survey A in Chapter V) is illustrated in figure 3.9. In this case the shot was positioned at a depth of 30m and the hydrophones were positioned at 2m intervals over a depth range of 22-66m. The receiver borehole was at an offset of 56m from the source. The data consist of both upgoing and downgoing reflections with direct arrivals also being present.

The data were transformed into f-k space to yield the amplitude spectrum of figure 3.10. This spectrum is plotted on a dB scale with the 6dB contour representing component amplitudes which are half the maximum amplitude. The principal features of this spectrum include: large direct arrival amplitudes around the k=0 axis and to the left of it; upgoing scattered arrivals to the right of this axis; and downgoing arrivals to the left of this axis. A pie slice filter designed to pass only the upgoing energy is specified by the lines OA and OB. This filter will pass all upgoing arrivals which travel with an apparent velocity of between 2000 m/s and 8000 m/s across the receiver array. Following application of the filter, the data were transformed back into z-t space (figure 3.11). The filter has successfully removed downgoing energy and enhanced the appearance of the upgoing reflected energy. Some of the direct arrival energy (on the upper traces) is also upgoing and so remains after the filter has been applied, but this may be removed by the application of a mute.

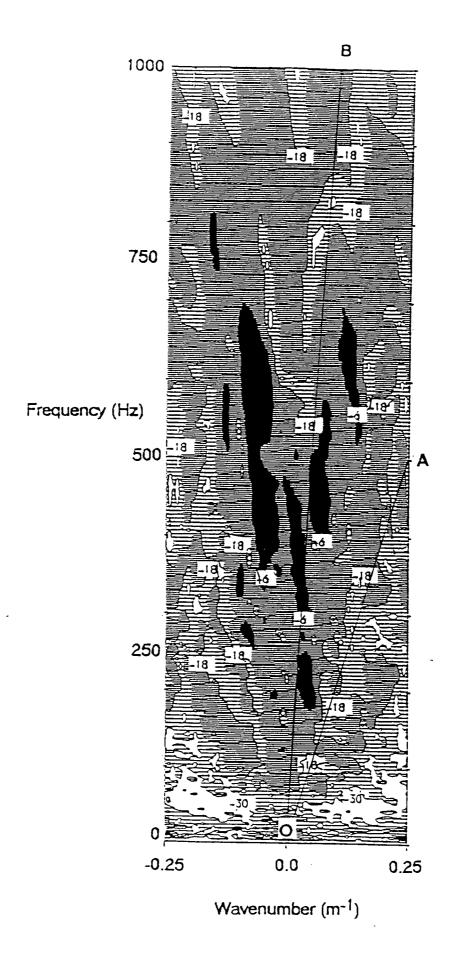


Figure 3.10 f-k amplitude spectrum of the common shot gather shown in figure 3.9. Edges of a filter to extract the upgoing wavefield are indicated by the lines OA and OB.

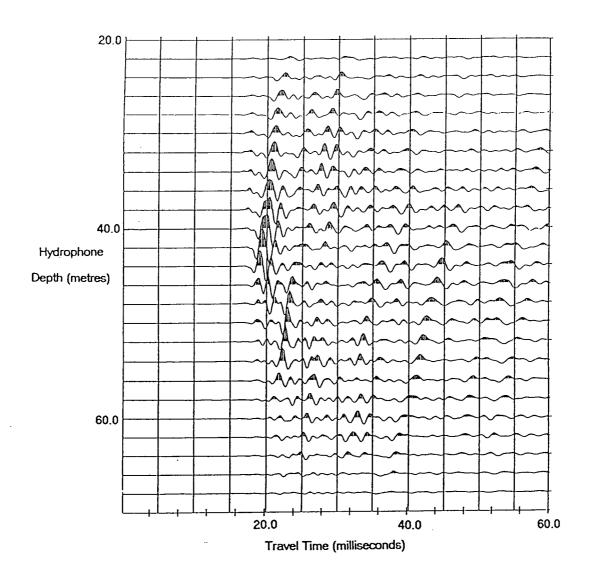


Figure 3.11 Upgoing wavefield after the application of a wavefield separation filter to the data of figure 3.9.

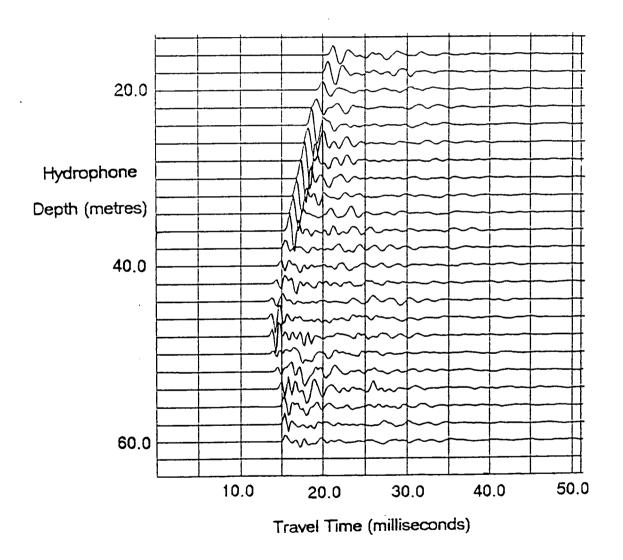


Figure 3.12 Common shot gather from survey B of chapter V.

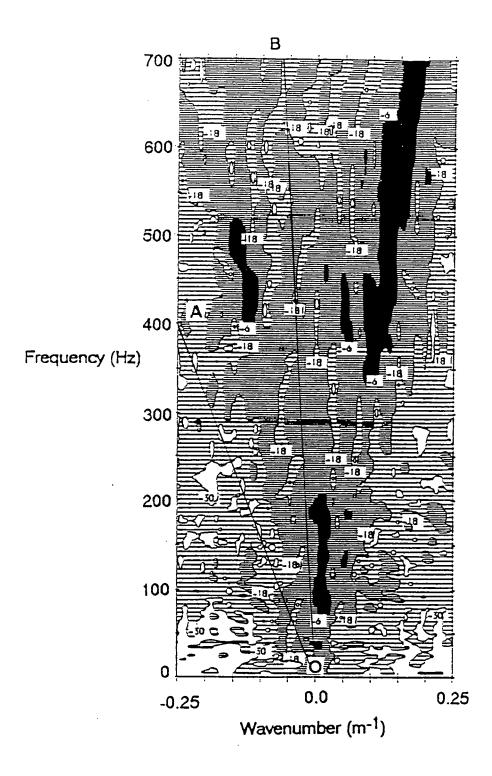


Figure 3.13 f-k amplitude spectrum of the common shot gather shown in figure 3.12. Edges of a filter to extract the downgoing wavefield are indicated by the lines OA and OB.

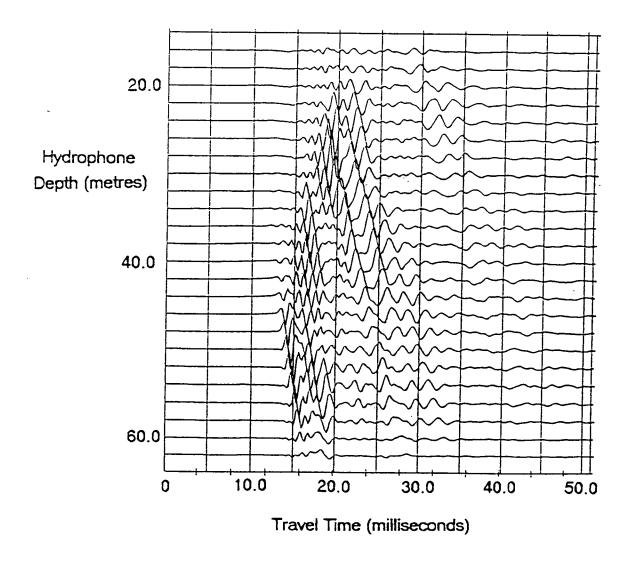


Figure 3.14 Downgoing wavefield after the application of a wavefield separation filter to the data of figure 3.12.

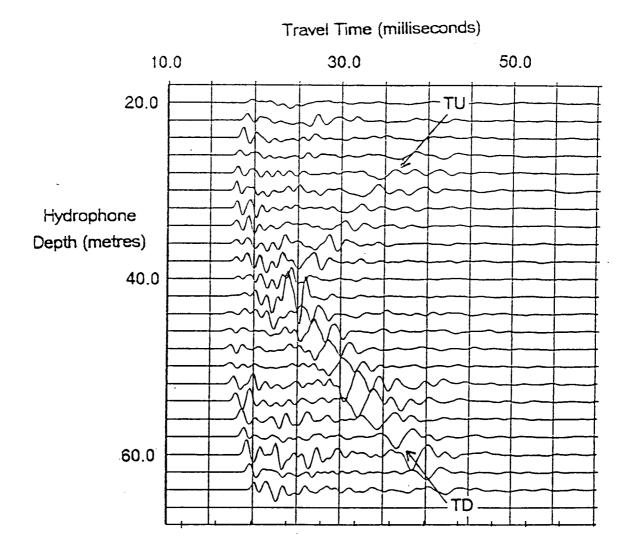


Figure 3.15 A common shot gather with tube waves indicated by TU (upgoing tube wave) and TD (downgoing tube wave).

Figure 3.12 is another common shot gather acquired on survey B of chapter V. In this case the shot depth is 48m and the receiver borehole offset is 40.9m, with 23 hydrophone positions covering a depth range of 16-60m. The two-dimensional amplitude spectrum is shown in figure 3.13. Again a filter has been defined by the lines OA and OB, in this case to pass velocities of between 1600 and 10000 m/s in the downgoing wavefield. Figure 3.14 shows the filtered common shot gather in z-t space. The downgoing reflected arrivals are now apparent, and the remaining direct arrival energy can again be muted out.

An example of a low-frequency high-amplitude tube wave with an apparent velocity of 1100 m/s is presented in figure 3.15. The events (both upgoing and downgoing) originate from a depth of 44m which corresponds to a coal seam in the receiver borehole. The shot was fired at the seam level depth. Presumably energy from P-wave first arrivals has been focused as "diving rays" by the low velocity of the coal relative to its surrounding bedrock. This would result in a large amplitude arrival at the receiver borehole which has in some way triggered off a tube wave, perhaps because the receiver borehole is caved at the seam level. The wave is obviously spatially aliased (i.e. undersampled by the receiver array) with the moveout per trace being greater than half the dominant period of the wave.

When the data are transformed into the f-k domain the amplitude spectrum (figure 3.16a) also shows the aliasing effect. The dominant downgoing tube wave wraps around in the k-direction from  $-k_{\rm NYQ}$  to  $+k_{\rm NYQ}$ . In order to remove the tube wave noise from the data, it is necessary to apply a reject filter with parallel edges so that as much of the P-wave arrival energy is preserved as possible. The filter used is indicated by the lines AB, CD, EF and GH. On returning to z-t space (see figure 3.16b), we can see that the downward-travelling aliased event has been suppressed,

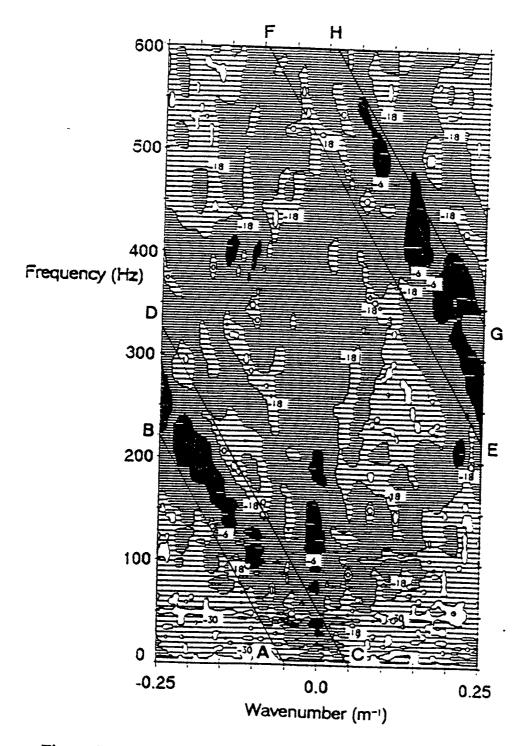
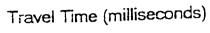


Figure 3.16a f-k amplitude spectrum of the data shown in figure 3.15. Filter edges for the removal of the downgoing tube wave are marked by AB, CD, EF, GH.



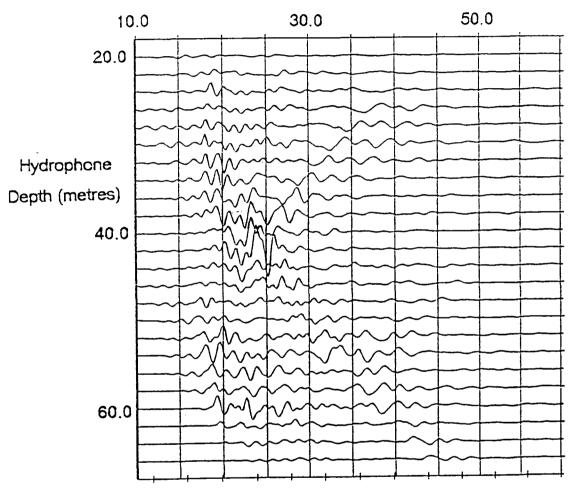


Figure 3.16b Common shot gather after the application of a reject filter to remove the downgoing tube wave.

although this has been at the expense of some of the reflected arrival information in the data. Ringing has also been introduced into the traces because of the sharp filter edges required to remove the tube wave.

### 3.4 Waveshaping deconvolution

In order to enhance the higher frequencies present in the data before they are imaged, a band pass filter may be applied which can suppress the low frequency (in this case below 200 Hz) components. In addition, there are advantages in changing the phase of the source wavelet in the data. The recorded seismograms may be thought of as convolutions of a real (causal) source function with the reflectivity response of the earth. As such, the onset of each arrival corresponds to the traveltime along the reflected raypath. It is preferable to produce a section in which the central peak of the arrival waveform corresponds to this traveltime. Such a waveform may be thought of as a band-limited spike with zero phase.

A least-squares energy Wiener waveshaping filter (see e.g. Robinson and Treitel, 1985) may be calculated to shape an estimate of the source wavelet into a zero-phase wavelet with a modified amplitude spectrum. This filter may then be convolved with the data to yield a zero-phase section. For the purposes of this deconvolution, the upgoing and downgoing wavefields in each common shot gather are processed separately because of possible directivity effects in the source signature. An estimate of the source waveform is obtained by assuming that the source function is a minimum phase wavelet and then applying a spectral factorisation (Claerbout, 1976) to a window of each trace in the common shot gather. The estimate of the

# Travel Time (milliseconds)

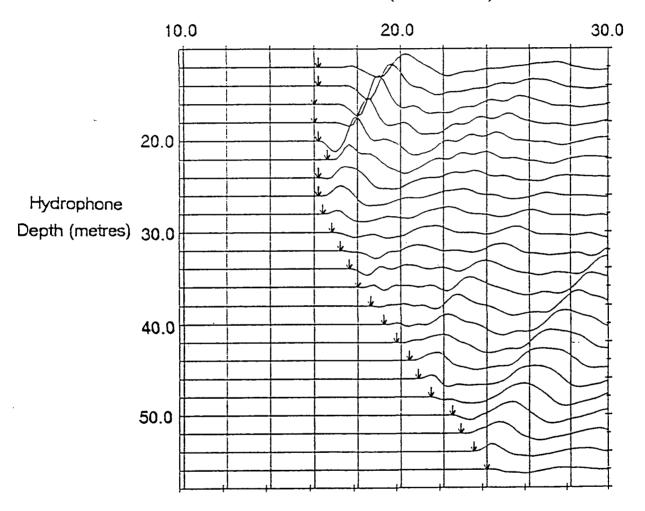


Figure 3.17 Waveshaping deconvolution: Upgoing wavefield common shot gather. Arrows indicate direct arrival picks.

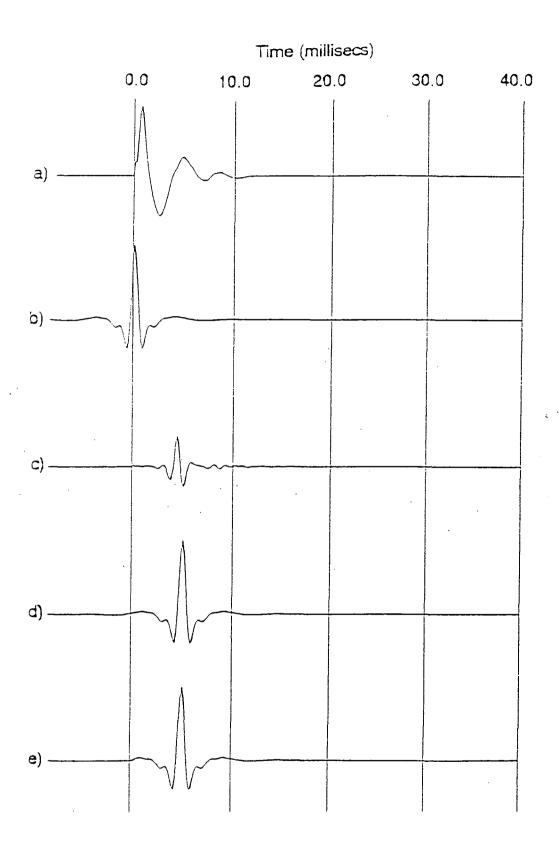


Figure 3.18a Waveshaping deconvolution: a) input wavelet, b) desired output zero-phase wavelet, c) waveshaping filter, d) lagged desired output, e) convolution of input wavelet and filter.

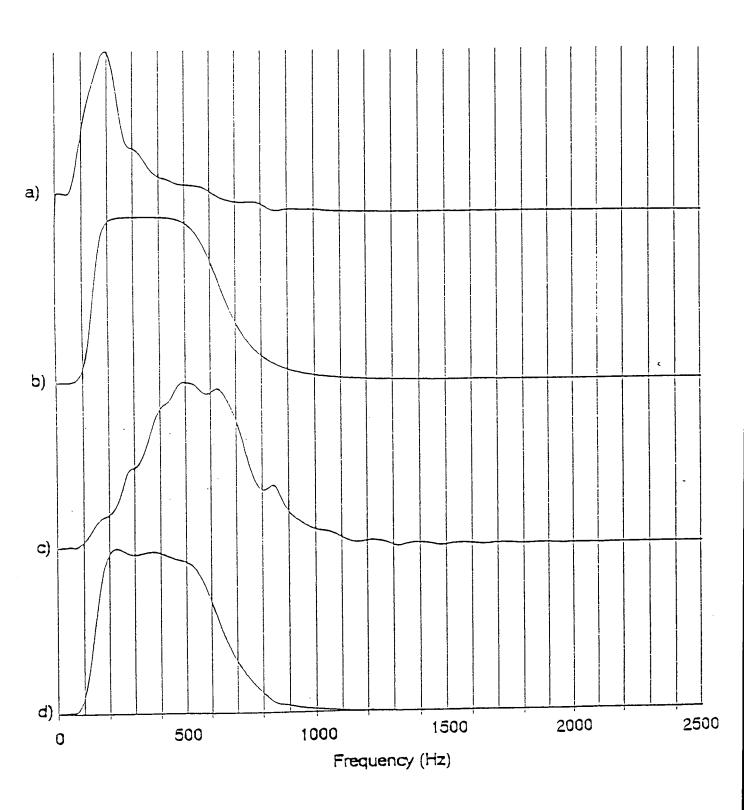


Figure 3.18b Waveshaping deconvolution amplitude spectra: a) input, b) desired output, c) filter, d) filtered input.

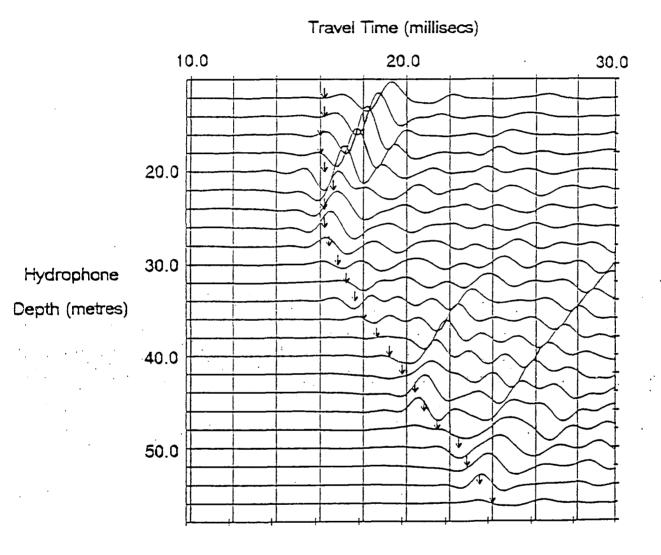


Figure 3.19 Common shot gather of figure 3.17 following waveshaping deconvolution.

waveform is then assumed to be an average of the estimates from each trace. Figures 3.17-3.19 illustrate the application of this method to the upgoing wavefield in a common shot gather.

Figure 3.17 is a plot of the upgoing wavefield after direct arrival suppression. Figure 3.18a consists of four waveforms. The first is the estimate of the source function obtained in the manner described above. The second is the desired output, a zero-phase Butterworth wavelet, and the third is the calculated filter coefficients. The bottom trace is a convolution of the filter with the input wavelet. The respective amplitude spectra of these traces are plotted in figure 3.18b. Figure 3.19 is the same common shot gather after the application of the designed waveshaping filter to all the traces. A comparison with figure 3.17 shows that the lower frequencies have been suppressed, and that zero crossings in figure 3.17 now correspond to peaks in figure 3.19.

### 3.5 Velocity field estimation

The direct arrival times, which are picked in the editing stage, can be used as the input to a Simultaneous Iterative Reconstruction Tomography (SIRT) velocity inversion program, written by Dyer (1988) and developed by Wye (1986), Findlay (1987) and Kragh (1990). Other P-wave velocity estimates can be obtained from uphole shots and by inspection of the near horizontal raypath traveltimes.

The results of tomographic inversion of the direct arrival times were disappointing with significant artifacts appearing in the final image at the corners. The pitfalls of using a tomographic inversion method on the cross-hole survey

geometries which are available from shallow opencast exploration boreholes in the U.K. are discussed by Kragh (1990). Essentially, poor discrimination between headwave and direct arrival types and the lack of vertical raypaths provided by crosshole surveys results in poor imaging conditions. Figure 3.20 is typical of the types of tomographic inversion obtained from cross-hole surveys in shallow Coal Measures strata. It was found to be more useful to estimate the inter-hole velocity fields by using uphole shots and by inspection of the near-horizontal raypath travel times. Velocity models were assumed to have no lateral velocity variations between the boreholes (other than some overall dip) because of the evenly bedded nature of the strata, which is typical of Coal Measures sequences, and also because no data were available to justify including lateral variations.

### 3.6 The reflection point mapping scheme or VSP-CDP transform

In the general case of the cross-hole survey method, sources and receivers are located at different depths. Therefore, the image points of reflected arrivals in a time section (common shot gather) do not correspond to the simple common depth point (CDP) case used in surface seismic imaging (see figure 3.21). Instead of the vertical CDP locus, the locus of possible image points follows a curved path defined by the source and receiver positions and the velocity field between the boreholes. This locus has been applied by Dillon and Thomson (1984) to offset VSP data. It has been termed the 'VSP-CDP transform' as it provides a processing route which converts the data from VSP coordinates (depth of borehole receiver, or source, and traveltime) into the familiar coordinates of surface seismic sections (lateral position and depth or

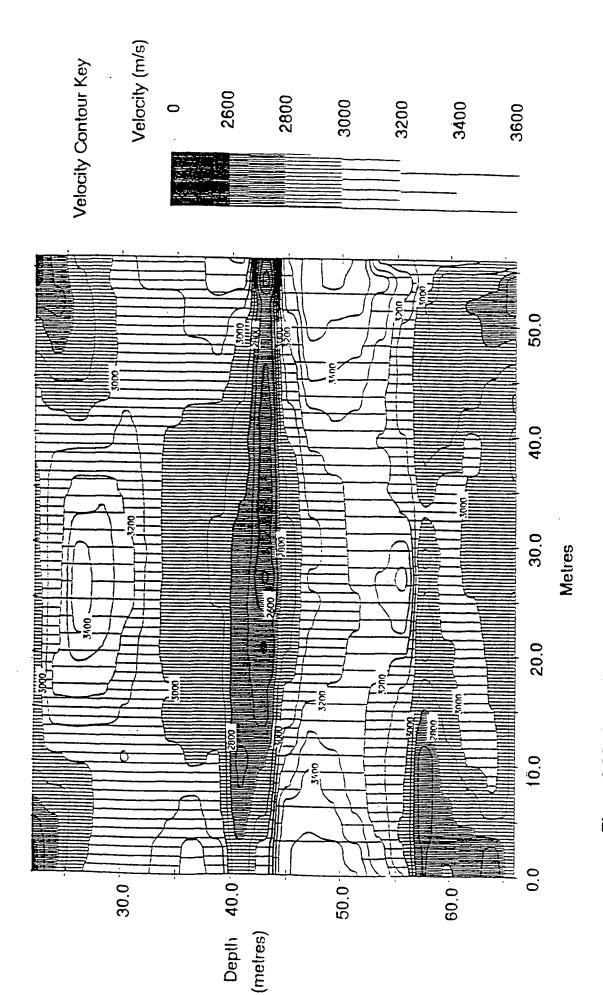
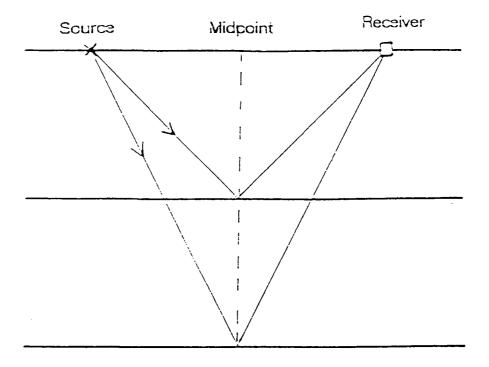


Figure 3.20 A sample tomographic velocity inversion (from Kragh, 1990).



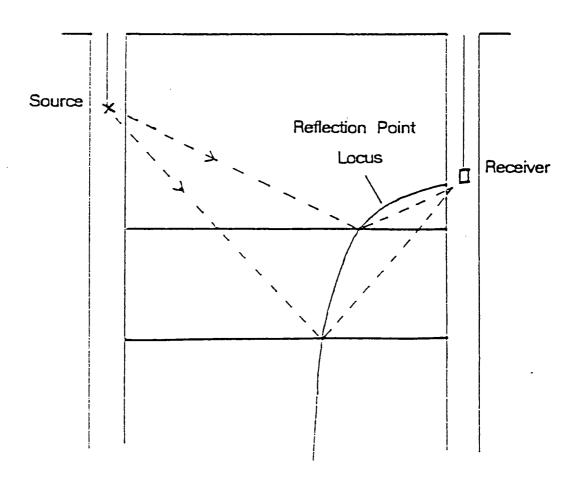


Figure 3.21 A comparison of the common midpoint of surface seismics and the reflection point locus of the cross-hole reflection method.

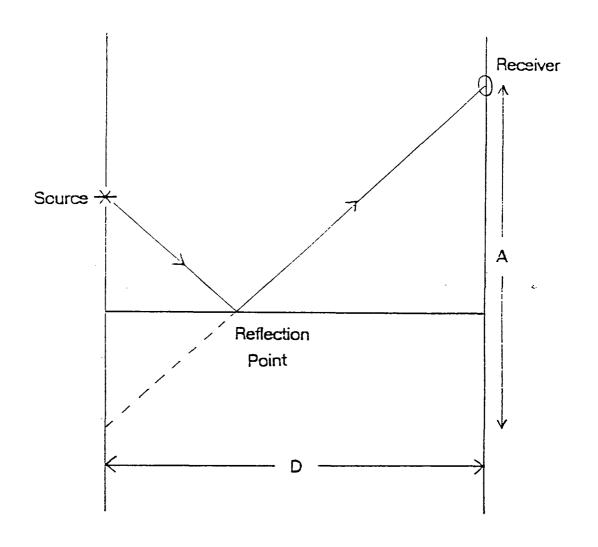


Figure 3.22 Reflection point geometry assuming a uniform velocity field.

vertical traveltime). The method involves considering each source and receiver pair independently. It is a single-channel process, not a true migration method, and therefore will not collapse Fresnel zones. The locus may be calculated by raytracing reflection raypaths between the source and the receiver over a range of take-off angles. This simultaneously provides the reflected ray traveltime,  $T_{\rm r}$  for each point calculated on the locus. If a constant, isotropic velocity field and vertical boreholes are assumed (figure 3.22), then this traveltime is given by

$$VT_{r} = \sqrt{A^2 + D^2}$$
 (3.2)

where V is the constant velocity,

D is the borehole separation,

and A is the total vertical distance travelled by the raypath.

The next processing stage is to distribute the appropriate trace for this source-receiver combination along the locus, by putting the signal amplitude recorded at a particular time  $T_{\rm rec}$  at the point on the locus which has the corresponding reflection time  $T_{\rm r}=T_{\rm rec}$ . Interpolation is carried out to ensure that the data are not undersampled in the imaging space. The mapping can then be applied to all the traces in a common shot gather, and to all the common shot gathers in a survey.

Two programs are used to apply the VSP-CDP transform. REFLOC (Appendix A.2) calculates the reflection point loci from the given parameters of the source and receiver locations and the velocity model. The program allows velocity models which consist of plane parallel layers to be specified. It has been further modified by Kragh (1990) so that the layers may exhibit the elliptical approximation to transversely isotropic media. Raytracing is carried out by shooting a ray from the source towards the receiver borehole, and shooting a ray with the same ray parameter

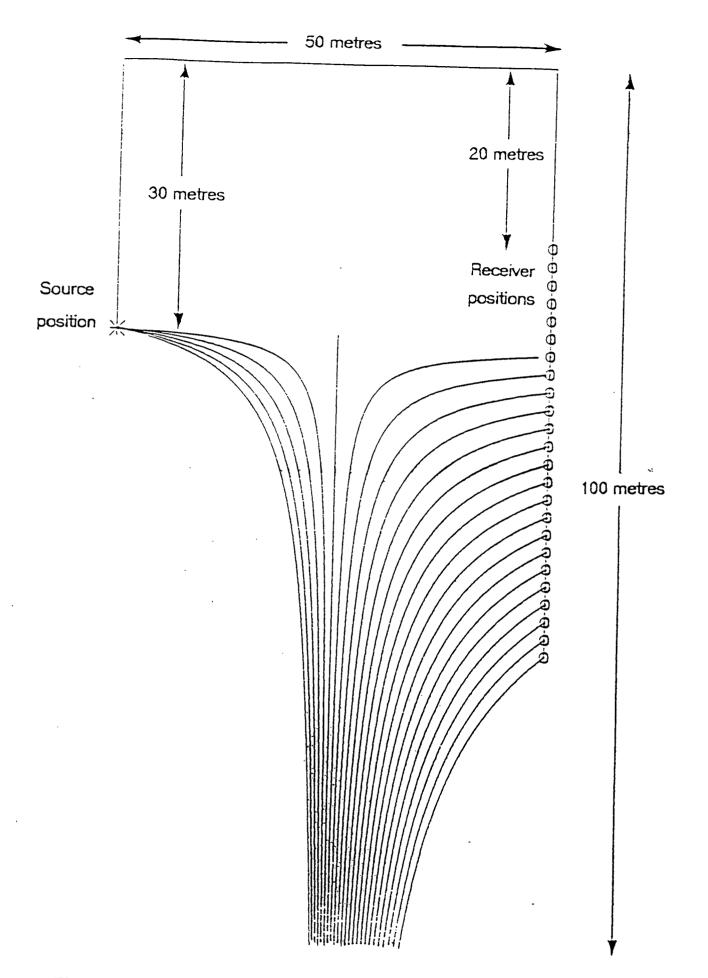


Figure 3.23 Reflection point loci for a common-shot gather assuming a uniform velocity field with recording at 24 receiver positions. The source is located in the left borehole at a depth of 30m and there are 24 receivers at 2m depth intervals ranging from 20m to 66m in the right borehole.

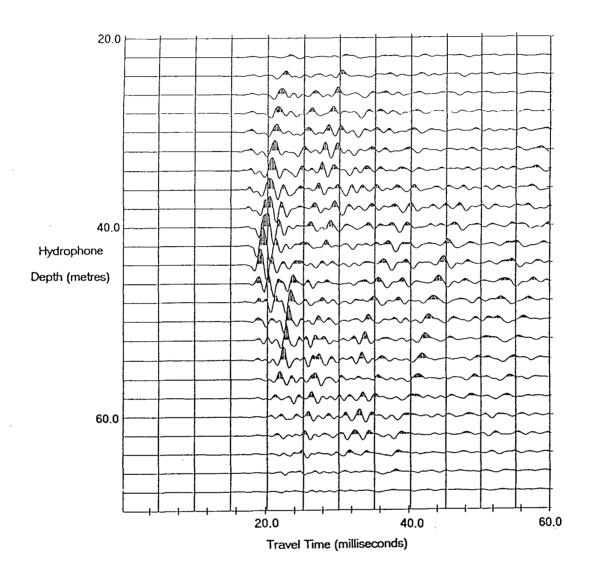


Figure 3.24 The upgoing wavefield of a common shot gather from survey A of chapter V.

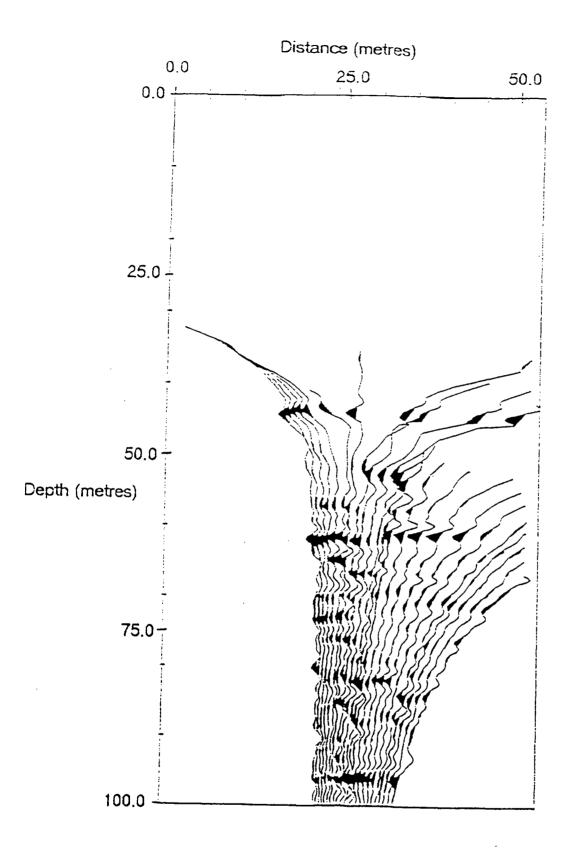


Figure 3.25 Upgoing wavefield of figure 3.24 mapped into a depth section using the VSP-CDP transformation.

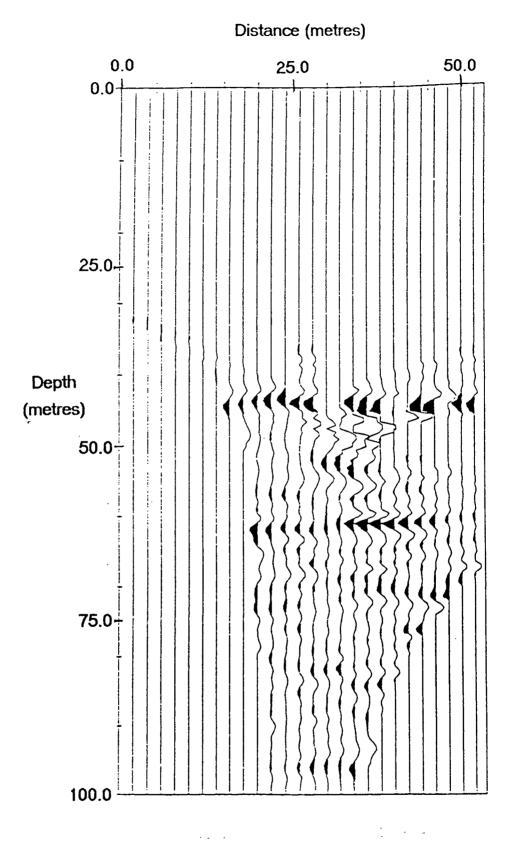


Figure 3.26 Depth section of figure 3.25 following binning on to a discrete grid.

(i.e.  $\sin\theta / V$  where  $\theta$  is the angle between the ray and the vertical, always taken as positive) from the receiver towards the source borehole. The point where these rays intersect will lie on the reflection point locus.

The program XHRMAP (Appendix A.3) is a menu-driven program which distributes the reflection data on to the loci and samples the mapped section on to a regular grid. The sampling is done by spreading each amplitude on each locus into its four nearest grid points with a weighting factor proportional to  $(1-x_i)$  where  $x_i$  is the normalised distance of the locus point from grid point i. With the data for all the common shot gathers binned on to a regular grid, the separate sections may be stacked together, with a normalisation factor which depends on the number traces contributing at a grid point. Other program options include the ability to mute out data contributions which correspond to near-horizontal raypaths, where a relatively small error in the velocity field would lead to a significant positioning error in the locus, and the option of previewing CDP gathers (i.e. the contributions of each shot to the stack at a particular offset).

Examples of real data undergoing the VSP-CDP transform are illustrated in figures 3.23-3.26. The data form part of survey A in chapter V. Figure 3.23 illustrates the field arrangement. The source was located at a depth of 30m and 23 receivers were positioned at 2m intervals between 22m and 66m depth at an offset of 56m. The upgoing wavefield of the common shot gather is shown in figure 3.24. This has been mapped on to reflection point loci in figure 3.25 and then resampled on to a regular grid in figure 3.26.

The reflection point mapping technique also gives an indication of the type of subsurface coverage we might expect from a cross-hole reflection survey. Figure 3.27 is a plot of all the (upgoing) reflection loci for a survey in which the boreholes

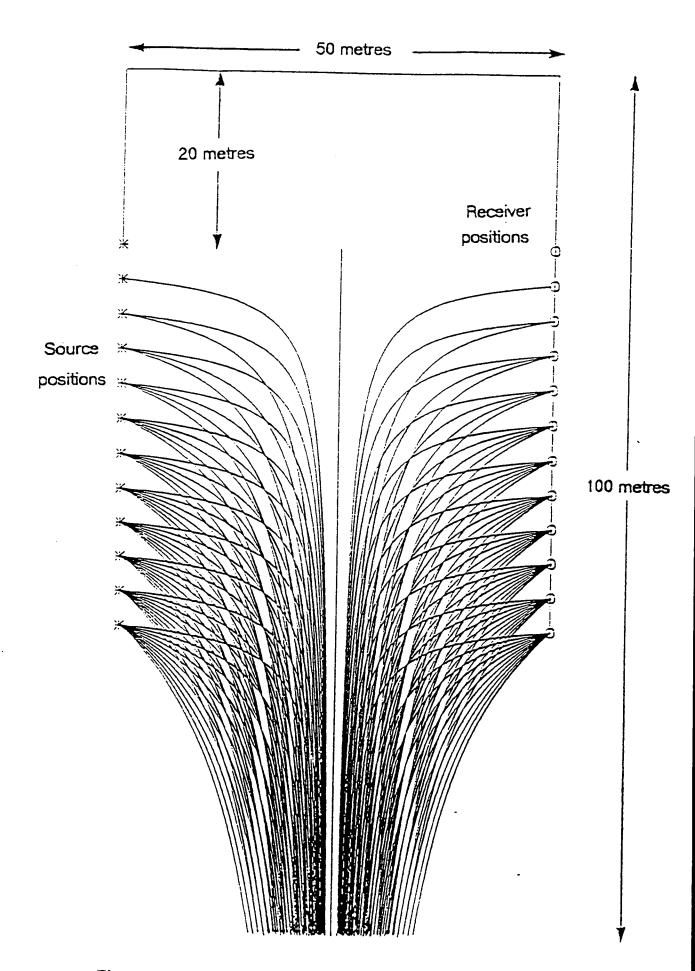


Figure 3.27 Reflection point coverage for an acquisition geometry with sources located in the left borehole and receivers in the right borehole. A uniform velocity field has been assumed. Source and receiver positions are illustrated at 4m spacings for clarity.

separation is 50m, and 13 sources and receivers are positioned at 4m intervals in the boreholes. This emphasises the funnel-shaped nature of the reflection point coverage obtained from cross-hole surveys, with no coverage at all immediately below the bottom source and the bottom receiver. The low density of reflection points near the boreholes means that the number of contributions to the stack is lower there and consequently the image quality will be poorer. Furthermore, muting direct arrivals will remove the corresponding earliest segment of each reflection point locus.

## 3.7 Velocity analysis using the VSP-CDP transform

Prior to stacking, the reflection point mapping technique may also be used as a velocity analysis tool by inspecting CDP gathers (i.e. stack contributions from each source position for a particular offset). It is not feasible to carry out a precise velocity analysis on real data in a single pass, due to the inability to perform a layer-stripping analysis when the source and receiver arrays are parallel to the direction of major velocity variations. Nevertheless, an estimate of velocity field corrections may be made by examining the moveout of reflections in CDP-space.

Let us assume that the velocity field V is constant between the boreholes. For any particular source and receiver combination (see figure 3.22), the reflection point travel time is given by equation (3.2)

i.e. 
$$V^2 T_r^2 = A^2 + D^2$$
 (3.2)

Let  $Z_{\rm S}$  be the vertical separation of the source and the reflector,

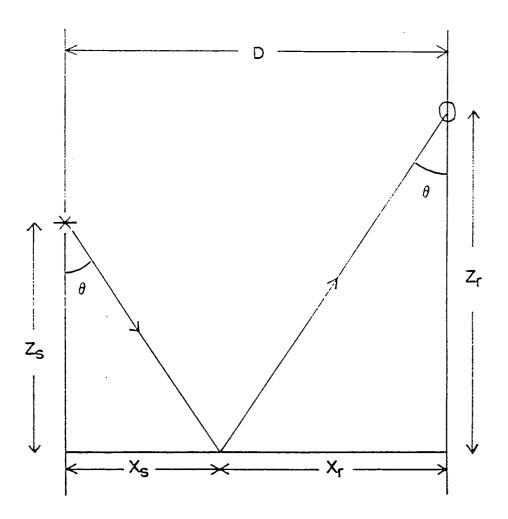


Figure 3.28 The parameters used in velocity analysis calculations.

 $Z_{\rm r}$  be the vertical separation of the receiver and the reflector,

 $X_{s}$  be the offset of the reflection point from the source,

and  $\theta$  be the angle which the raypath makes to the vertical.

Therefore,

$$\frac{X_{\rm S}}{Z_{\rm S}} = \frac{D}{A} = \tan \theta \tag{3.3}$$

To estimate the vertical positioning error  $\Delta z$  which would be caused by an error  $\Delta v$  in the velocity field, equation (3.2) may be differentiated with respect to V, with  $T_{\rm r}$  and D held constant.

$$VT_{\mathbf{r}}^{2} = A \frac{\mathrm{d}A}{\mathrm{d}V}$$

but from (3.2)

$$VT_{\rm r}^2 = \frac{A^2 + D^2}{V}$$

therefore

$$A\frac{\mathrm{d}A}{\mathrm{d}V} = \frac{A^2 + D^2}{V} \tag{3.4}$$

Now  $\Delta A = 2 \Delta z$ , so we may rewrite the above expression as an approximation for small, but finite,  $\Delta v$ 

$$\Delta z \approx \frac{1}{2} \frac{A^2 + D^2}{A} \frac{\Delta v}{V_0} \tag{3.5}$$

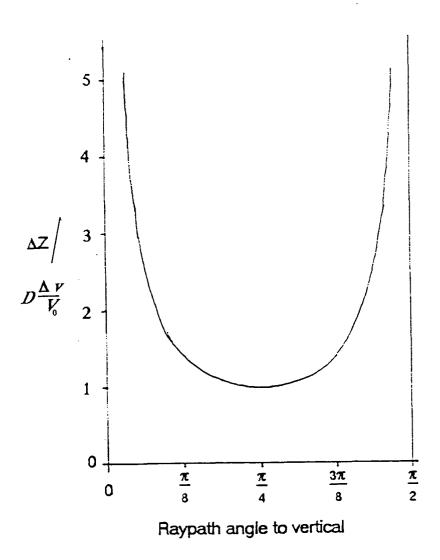


Figure 3.29 The vertical positioning error  $(\Delta z)$  as a function of the ray angle to the vertical.

Substituting for A from (3.3)

$$\Delta z = \frac{1}{2}D \left( \tan\theta + \cot\theta \right) \frac{\Delta v}{V_0} = \frac{D}{\sin 2\theta} \frac{\Delta v}{V_0}$$
 (3.6)

Thus, the vertical positioning error  $\Delta z$  is positive for  $\Delta v > 0$  and negative for  $\Delta v < 0$  and the dependence on raypath angle is shown in figure 3.29. For a given velocity error, the positioning error is a minimum when the raypath makes an angle of 45° to the vertical and increases as this angle deviates from 45°. If the velocity values are too large then one would expect to see the reflector depth increase as the source depth approaches that of the reflector; if the velocity values are too small the reflector depth will decrease as the source approaches the reflector depth. This therefore provides a trial-and-error method of improving the velocity field estimate by firstly applying the VSP-CDP transform, inspecting the CDP gathers, modifying the velocity field and then re-applying the VSP-CDP transform with the new velocity field.

Great care is needed in this process, because the shots and receivers are at different depths. The raypaths for contributions to the stack at a particular image point will thus be subject to different corrections when the layer velocities are modified. A change in a particular layer velocity will (in the case of upgoing reflections) affect only those CDP contributions from shots and receivers which are above or within the layer.

It is also useful to appreciate the lateral positioning error  $\Delta x$  which arises from a velocity field error.

From equation (3.3)

$$X_{\rm S} = Z_{\rm S} \tan \theta = Z_{\rm S} \frac{D}{A}$$

Differentiating with respect to V,

$$\frac{\mathrm{d}X_{\mathrm{S}}}{\mathrm{d}V} = \frac{D}{A} \frac{\mathrm{d}Z_{\mathrm{S}}}{\mathrm{d}V} - Z s \frac{D}{A^2} \frac{\mathrm{d}A}{\mathrm{d}V}$$
 (3.7)

Applying  $2dZ_s = dA$  and  $Z_s = \frac{AX_s}{D}$ 

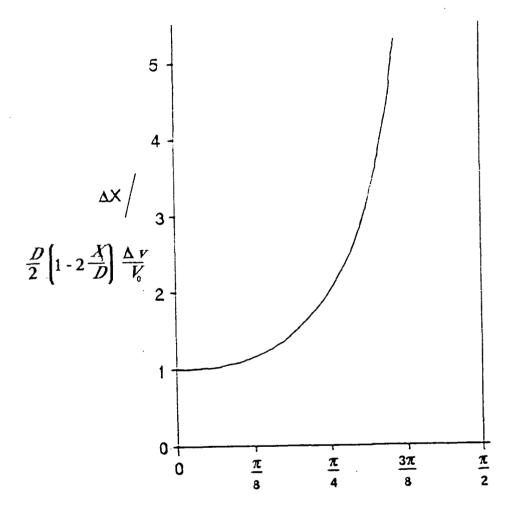
$$\frac{\mathrm{d}X_{\mathrm{S}}}{\mathrm{d}V} = \frac{1}{A} \left[ \frac{D}{2} - X_{\mathrm{S}} \right] \frac{\mathrm{d}A}{\mathrm{d}V}$$

$$:= \left(\frac{D}{2} - X_{S}\right) \frac{A^{2} + D^{2}}{A^{2}V}$$
 using (3.4).

For small, but finite  $\Delta v$  we may write this as the following approximation using (3.3).

$$\Delta x \cong \frac{D}{2} \left[ 1 - 2 \frac{X_{\rm S}}{D} \right] \frac{\Delta v}{v_{\rm o}} \sec^2 \theta$$
 (3.8)

Thus  $\Delta x$  is zero at  $X_s = \frac{1}{2}D$  (i.e. no lateral moveout at the midpoint of the boreholes) and increases to  $\frac{1}{2}\frac{D}{V}\sec^2\theta$  (see figure 3.30) at the boreholes. One would thus expect that the image quality will be much better towards the centre of a cross-



Raypath angle to vertical

Figure 3.30 The lateral positioning error  $(\Delta x)$  as a function of raypath angle to the vertical.

hole reflection survey than it is nearer the boreholes, because of the increased number of stack contributions as well as the lower sensitivity of these areas to lateral positioning errors.

Once a sufficiently accurate velocity model has been obtained through the combination of experimental measurements and velocity analysis via the VSP-CDP transform, the imaging of the data can be carried out by applying migration techniques. These are discussed in chapter IV.

## Chapter IV

# Migration of cross-hole reflection data

#### 4.1 Introduction

The migration of seismic data is the means whereby reflection events are relocated to their true subsurface positions and diffraction events are collapsed towards a point. Surface seismic data are generally migrated post-stack. The stacked data are assumed to be the equivalent of a zero-offset (i.e. coincident sources and receivers) section. Data will not be migrated correctly when normal moveout corrections result in a section which is not truly zero-offset, such as when conflicting reflector dips are present at the same traveltime. To get around NMO problems prestack migration may be used, but this is an expensive processing procedure because the data-volume is many times greater before stacking than it is after stacking. With cross-hole seismic surveys the data-volume is relatively small and so pre-stack migration methods can be more readily applied.

Two different two-dimensional migration schemes have been implemented in this work: a finite-difference method and a Kirchhoff integral method. Both algorithms were implemented specifically for cross-hole recording geometries, but with subsurface sources and receivers being the most general case, the programs will also migrate VSP and surface seismic profile data.

#### 4.2 Finite-difference migration

A finite-difference modelling scheme for OVSP data has been developed in the (x,z,t) domain by McMechan (1985). Migration schemes based on this method have been applied to real OVSP data by Chang and McMechan (1986) and to synthetic and scale-model cross-hole data by Hu et al. (1988). In these cases the data were migrated pre-stack in common shot gathers and an acoustic migration scheme was used. Sun and McMechan (1986) have applied an elastic finite-difference algorithm to image synthetic OVSPs and Zhu and McMechan (1988) have migrated both acoustic synthetic and scale-model cross-hole data after stacking by assuming that the sources and receivers could be combined and treated as vertical planes lying perpendicular to the plane of the boreholes.

The algorithm applied here takes the upgoing or downgoing reflection energy from each common shot gather and drives a two-dimensional wavefield on a regular grid by using the traces as boundary conditions to solve the two-dimensional acoustic wave equation. By repeatedly stepping backwards in time, the wavefield P(x,z,t) between the boreholes can be found for all image points at all relevant times. The relevant time at each image point is selected according to the imaging condition as defined by Claerbout (1971). Reflectors exist at points in the subsurface where the first arrival of the source-emitted wave is time-coincident with a scattered wave. Thus the time sample of interest at a particular image point  $(x_1, z_1)$  corresponds to the excitation time  $T_S$  of the point by a direct arrival wave emitted from the source position. The excitation time may be obtained by raytracing through a velocity model between the source position and the image point. When the wavefield is backpropagated in time, it is a simple matter to extract the appropriate amplitude of the wavefield  $P(x_1,z_1,T_S)$  and to store it in an array which represents the imaged data.

This technique is known as reverse-time finite-difference migration with the excitation-time imaging condition.

#### 4.3 Implementation of the finite-difference migration algorithm

The migration method involves two separate stages. Firstly rays are traced from the source to each imaging point in order to obtain the excitation time of the image points. The excitation times are then used as input parameters to the finite-difference migration program which back-propagates the recorded wavefield.

Two raytracing algorithms have been used. The first is the program TRACER (listed in Appendix A.4) which uses the ray-equation method of Lee and Stewart (1981) and which allows lateral velocity variations to be taken into account. This method was found to be too computationally expensive and so a faster two-point iterative algorithm was also developed (subroutine RAYTRA in Appendix A.5). RAYTRA ignores lateral velocity variations, but does allow transversely isotropic media to be modelled by means of an elliptical velocity approximation (Levin, 1978). The RAYTRA program was used in preference to TRACER because of its speed, particularly because lateral velocity variations between boreholes in a cross-hole survey could not be determined with sufficient confidence to justify using a laterally variant velocity structure.

The excitation time for image reconstruction is obtained by raytracing from the source location to each point in the image space. The traveltimes along the appropriate raypaths are stored in a data file for future reference by the imaging algorithm. The reverse-time wavefield extrapolation program EXTRAPREV is listed in Appendix A.6. A similar program EXTRAP is listed in Appendix A.7. EXTRAP is a forward modelling program which allows wavefields to be propagated from a source point with a given time-dependent signature and allows the wavefield at particular receiver positions to be recorded, thus generating synthetic seismograms.

The EXTRAP programs use an algorithm which carries out a second order finite-difference formulation of the acoustic wave equation. This is a two-dimensional (2-D) modelling algorithm which allows sources and receivers to be positioned at any subsurface (or surface) location in a 2-D velocity field. The finite-difference algorithm corresponds to that of McMechan (1985) which was written for offset VSPs, but with the additional provision of a variety of absorbing boundary conditions as discussed by Renaut and Petersen (1989). The programs allow the user to specify a laterally variant isotropic velocity field sampled on a rectangular grid and then the pressure response of the medium to a change in pressure with time (such as from a point source or from boundary conditions provided by a receiver array) is obtained by solving the acoustic wave equation in the time domain.

## 4.3.1 The finite-difference approximation

The 2-D acoustic wave equation is (Claerbout, 1976)

$$\frac{\eth^2 P}{\eth x^2} + \frac{\eth^2 P}{\eth z^2} = V^2(x, z) \frac{\eth^2 P}{\eth t^2}$$
(4.1)

where P is the acoustic response and V is the velocity of acoustic waves in the medium. The solution of equation (4.1) is achieved by a second order finite-difference approximation with discretisation in time and space. A fourth order

approximation (Alford et al., 1974) was tried but resulted in no noticeable improvement in imaging results. Three wavefields are involved at any particular time step  $t_i$ . These are

 $P(x,z,t_1)$  the wavefield at time  $t_1$ ;

 $P(x,z,t_{i-1})$  the wavefield at time  $t_{i-1}$ , the previous step; and

 $P(x,z,t_{i-2})$  the wavefield at time  $t_{i-2}$ .

The acoustic response at any particular grid point  $(x_k, z_j)$  may be defined as  $P(x_k, z_j, t_i)$  where  $(x_k, z_j)$  is the intersection of the j<sup>th</sup> horizontal grid line with the k<sup>th</sup> vertical grid line.

The finite difference approximations to partial differentiations with respect to x are given by

$$\frac{\delta P}{\delta x} \cong \frac{P_{k+1} - P_k}{\Delta x} \tag{4.2}$$

$$\frac{\eth^2 P}{\eth x^2} \cong \frac{P_{k+1} - 2P_k + P_{k-1}}{\Delta x^2} \tag{4.3}$$

where  $\Delta x$  is the grid spacing in the x-direction. Thus equation (4.1) may be approximated by equations like (4.3) and rearranged to give a value of  $P(x_k, z_j, t_i)$  which depends solely on the values of  $P(x_k, z_i)$  calculated at times  $t_{i-1}$  and  $t_{i-2}$ .

$$P(x_{k}, z_{j}, t_{i}) = 2(1-2A^{2}) P(x_{k}, z_{j}, t_{i-1}) - P(x_{k}, z_{j}, t_{i-2}) +$$

$$A^{2} [P(x_{k+1}, z_{j}, t_{i-1}) + P(x_{k-1}, z_{j}, t_{i-1}) + P(x_{k}, z_{j+1}, t_{i-1}) +$$

$$P(x_{k}, z_{i-1}, t_{i-1})]$$
(4.4)

where  $A = V(x_k, z_j)\Delta t/h$ ,  $\Delta t$  is the time step ( $\Delta t = t_i - t_{i-1}$ ) and h is the distance between both horizontal and vertical grid lines. This algorithm has been shown to be stable (Mitchell, 1969) provided that the following condition is met.

$$\Delta t < \frac{h}{\sqrt{2}V} \tag{4.5}$$

#### 4.3.2 Boundary conditions

A computational problem occurs at the edges of the finite-difference grid. If values of zero are used to define the acoustic response at the edges of the grid then a free surface boundary condition (zero pressure) has been created and outgoing wavefields will be reflected back into the grid. Methods of avoiding this problem include enlarging the grid size, a computationally expensive choice, or applying absorbing boundary conditions (Clayton and Engquist, 1977) at the edges of the grid. Absorbing boundary conditions are essentially a finite-difference approximation to the one-way or paraxial wave equation (Claerbout, 1976). A dispersion relation which

restricts the range of propagating rays to a cone around the z-axis is (Clayton and Engquist, 1977)

$$\frac{Vk_z}{\omega} = 1 - \frac{1}{2} \left( \frac{Vk_x}{\omega} \right)^2 + O\left[ \left| \frac{Vk_x}{\omega} \right|^4 \right]$$

which translates to the following differential form.

$$\frac{\eth^2 P}{\eth z \eth t} + \frac{1}{V} \frac{\eth^2 P}{\eth t^2} - \frac{V}{2} \frac{\eth^2 P}{\eth x^2} = 0 \tag{4.6}$$

The above equation is an approximation which would allow a wave to propagate in the positive z direction only. Renaut and Petersen (1989) have derived several different finite-difference approximations similar to (4.6) as follows:

$$\frac{\eth^2 P}{\eth z \eth t} + \frac{p_0}{V} \frac{\eth^2 P}{\eth t^2} + V p_1 \frac{\eth^2 P}{\eth x^2} = 0 \tag{4.7}$$

where  $p_0$  and  $p_1$  are defined according to Table 4.1.

Approximation	Pade	$L^{2}$	Chebychev-Pade
$p_{e}$	1.000	21π/64	10/3π
$p_1$	-0.5	-15π/64	-8/3π

**Table 4.1 Finite difference approximations** 

The program EXTRAP permits selective use of these boundary conditions and also allows the option of free-surface boundaries. The  $p_0$  and  $p_1$  parameters may be chosen as appropriate to the survey geometry. Generally, the  $L^2$  approximation, which yields a least squares reflected amplitude over all incident angles, seemed to provide the best absorption for cross-hole data where waves may be striking the boundary at a wide range of incident angles.

## 4.3.3 Grid dispersion

One problem associated with the finite-difference approximation is that of grid dispersion (Alford et al., 1974). This manifests itself in the dispersion of the source waveform as it propagates through the discrete-model medium, with lower frequencies travelling faster than higher frequencies, the pulse becomes delayed, broadened and develops a ringing tail. The effect arises because of the discrete approximation to the differential wave equation by equation (4.4). Grid dispersion effects can be reduced by decreasing the grid spacing parameter h but, as well as increasing the data volume, this necessitates a reduction in the size of the time step  $\Delta t$  in order that the stability equation (4.5) remains satisfied. Reduction of the grid

spacing by a factor of two thus results in a four-fold increase in the data volume and an eight-fold increase in the computational time. Alford et al. (1974) have shown that dispersive effects are not significant for wavelengths greater than about 10 times the grid spacing, and this provides a useful benchmark in determining the optimal values of  $\Delta t$  and h to use for a given source function.

## 4.3.4 Modelling seismic data with EXTRAP

Two cross-hole synthetic datasets were constructed using the EXTRAP finite-difference algorithm in order to test the Kirchhoff and reverse-time wavefield extrapolation finite-difference migration methods. These models are fully discussed in section 4.5. The required input parameters are:

Source function specification

Grid size

Temporal sampling interval

Source location

Receiver locations

Two-dimensional velocity model of medium

Program output allows the pressure response of the medium to be viewed at any given time, as well as the generation of synthetic seismograms. These implementations of the finite-difference algorithm are for the acoustic (scalar) wave equation. It is hoped that future development work may be carried out to enhance this modelling method in order to include anisotropy and elastic wave propagation.

#### 4.3.5 Migrating seismic data with EXTRAPREV

EXTRAPREV functions in a similar manner to EXTRAP, but instead of providing a source function to the algorithm, the data recorded at the receiver positions is time-reversed and then input to the finite-difference wavefield at all receiver grid points simultaneously at the appropriate time samples. The drawback of this approach is that it is necessary to match the receiver spacing to the grid size and so a certain amount of spatial interpolation is necessary to achieve this (since a relatively small grid spacing may be necessary in order to avoid grid dispersion effects). Reduction of the grid spacing may also force an interpolation in time in order that the stability requirement (4.5) is met. This results in a substantial increase in computing time. Examples of this migration on synthetic model data are discussed in section 4.5.

#### 4.4 Kirchhoff migration

A Kirchhoff migration technique was also developed. This is an extension of the diffraction stack migration approach which is readily understood from geometrical considerations.

## 4.4.1 Diffraction stack migration

The diffraction stack migration method was one of the first migration types to be applied to seismic data. It follows simple ray and wavefront theory. In the case of

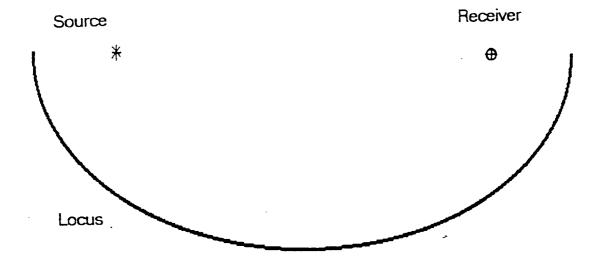


Figure 4.1 Locus of possible reflector locations for an impulsive arrival at time T for a particular source and receiver combination.

zero-offset (or post-stack) surface seismic data, diffraction stack migration is implemented by summing along hyperbolic trajectories and placing the results at the apices of the hyperbolas. For cross-hole data, however, the summation operator is more complicated.

Consider a particular source-receiver combination with a single impulsive arrival recorded at time  $T_{\rm S}$  and assume that the velocity of the medium is uniform and isotropic. The locus of possible reflection points for a particular traveltime must be the ellipse in image space as shown in figure 4.1 with the source and the receiver at the focal points. Migration may be accomplished by distributing the recorded amplitudes along the appropriate ellipses for each trace in a common shot gather. Constructive imaging takes place where ellipses intersect at a diffracting point.

Alternatively, each imaging point may be considered in turn. Raytracing from the source position to the point and from the receiver position to the point provides a total traveltime for scattering from the image point with the particular source-receiver combination. The amplitude corresponding to this traveltime is then summed into the imaging array together with similar contributions from other source-receiver pairings. This is the migration procedure utilised in this work.

#### 4.4.2 The Kirchhoff operator

Kirchhoff wave equation migration is an extension of the diffraction stack imaging concept based upon Kirchhoff's integral (see French, 1975 and Schneider, 1978).

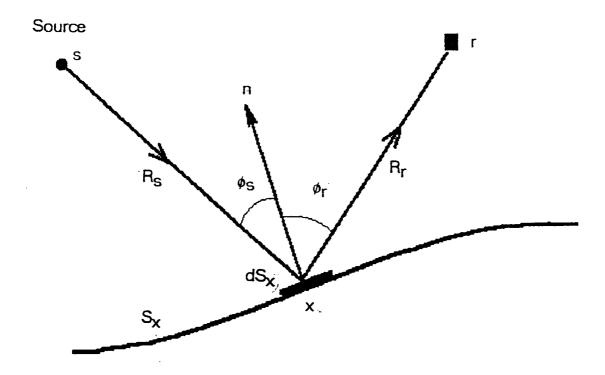


Figure 4.2 Scattering angles and raypath lengths for equation 4.8.

If we consider a wave incident on a scattering interface, then the wavefield  $U(\underline{\mathbf{r}},\underline{\mathbf{s}},t)$  recorded at  $\underline{\mathbf{r}}$  as a result of an impulsive source at  $\underline{\mathbf{s}}$  being scattered from the interface  $S_X$  is given by (Dillon, 1990 equation (1)):

$$U(\underline{\mathbf{r}},\underline{\mathbf{s}},t) = \int dS_{\mathbf{X}} \frac{C(\underline{\mathbf{x}},\phi_{\mathbf{S}})}{4\pi V} \frac{\cos(\phi_{\mathbf{S}}) + \cos(\phi_{\mathbf{r}})}{R_{\mathbf{S}}R_{\mathbf{r}}} \delta' \left[ t - \frac{R_{\mathbf{S}} + R_{\mathbf{r}}}{V} \right]$$
(4.8)

The scattering angles  $\phi_S$  and  $\phi_T$  and raypath lengths  $R_S$  and  $R_T$  are illustrated in figure 4.2. The reflectivity  $C(\underline{x},\phi_S)$  is angle-dependent. Equation (4.8) is the three-dimensional response recorded at a receiver. If one assumes that the geological structure is invariant perpendicular to the plane of the survey, then by integrating along one direction, the equivalent  $2\frac{1}{2}D$  formula is obtained. Dillon (1990) has derived a  $2\frac{1}{2}D$  migration integral which yields the reflectivity  $C(\underline{x})$ .

$$C(\underline{\mathbf{x}}) = \frac{1}{\pi} \int d\mathbf{L}_{\mathbf{r}} \sqrt{\frac{R_{\mathbf{S}}(R_{\mathbf{S}} + R_{\mathbf{r}})}{2VR_{\mathbf{r}}}} \cos(\theta_{\mathbf{r}}) M\left[\underline{\mathbf{r}}, \frac{R_{\mathbf{S}} + R_{\mathbf{r}}}{V}\right]$$
(4.9)

where  $M(\underline{\mathbf{r}},T)$  is the source wavefield  $U(\underline{\mathbf{r}},T)$  following the application of a Newman half-differential filter. This filter has a spectrum with a  $\frac{\pi}{4}$  phase shift and a high frequency amplitude boost of  $f^n$  and is implemented in the frequency domain. Equation (4.9) may be approximated by a summation over the receiver array  $L_{\mathbf{r}}$ .

$$C(\underline{\mathbf{x}}) = \sum_{\mathbf{L_r}} \Delta \mathbf{L_r} \sqrt{\frac{R_s}{R_r}} \cos(\theta_r) \sqrt{R_s + R_r} M\left[\underline{\mathbf{r}}, \frac{R_s + R_r}{V}\right]$$
(4.10)

Equation (4.10) is similar to a diffraction stack with the amplitude and phase corrections of the Newman filter and a wavefront spreading correction term being incorporated. Clearly this expression is inadequate for cross-hole geometries where we should obtain similar reflectivity responses across the survey. In equation (4.10) the reflectivity will be larger where  $R_{\rm S} > R_{\rm T}$  (i.e. nearer the receiver borehole) and an expression which is symmetrical with respect to an exchange of source and receiver arrays would be preferable.

## 4.4.3 The Generalised Kirchhoff operator

Dillon (1990) derived a Generalised Kirchhoff (GK) migration integral which is reciprocal with respect to sources and receivers and which is closely related to the Generalised Radon Transform (GRT) migration integral proposed by Miller et al. (1987). The 2-D form of the GK summation operator is given by

$$C(\underline{\mathbf{x}}) = \sum_{L_{\mathbf{T}}L_{\mathbf{S}}} \left[ \Delta L_{\mathbf{r}} \sqrt{\frac{R_{\mathbf{S}}}{R_{\mathbf{r}}}} \cos(\theta_{\mathbf{r}}) + \Delta L_{\mathbf{S}} \sqrt{\frac{R_{\mathbf{r}}}{R_{\mathbf{S}}}} \cos(\theta_{\mathbf{S}}) \right] \mathbf{x}$$

$$\sqrt{R_{\mathbf{S}} + R_{\mathbf{r}}} M \left[ \underline{\mathbf{r}}, \frac{R_{\mathbf{S}} + R_{\mathbf{r}}}{V} \right]$$
(4.11)

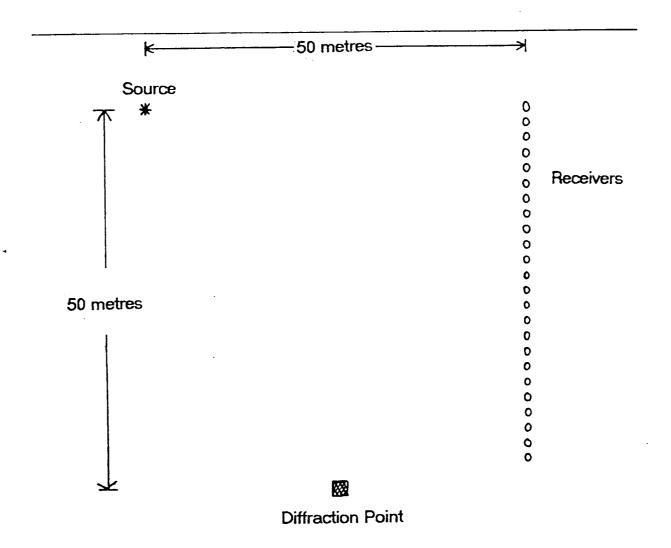


Figure 4.3 Model used to acquire synthetic dataset of point scatterer.

There is an additional small error term to the above equation which is proportional to  $(\cos(\phi_S)-\cos(\phi_T))$  (Dillon, 1990),  $\phi_S$  and  $\phi_T$  being the scattering angles defined in figure 4.2.

The program KIRCHMIG in appendix A.8 was written to carry out diffraction stack, Kirchhoff summation and Generalised Kirchhoff summation of cross-hole data with a variety of options being variable. Amongst these is the migration aperture by which the summation locus (equivalent to a hyperbola in surface seismic migration) is spatially restricted to realistic geological dips. A very small aperture is equivalent to specular reflections and corresponds to the reflection point mapping technique (Dillon, 1988, Van der Poel and Cassell, 1989). Comparisons of the impulse responses of different migration operators are included in chapter VI.

## 4.5 Comparison of finite-difference and Kirchhoff migration

Synthetic datasets were created by forward modelling using the EXTRAP finite-difference method. Models of point diffractors and planar reflectors were used to study the effectiveness of the two migration techniques. In these models, no allowance for density variations was made; the only variable parameter being the structure of the velocity field.

## 4.5.1 Point diffractor model

The following model (see figure 4.3) was used to simulate a point diffractor. A velocity of 2500 m/s was used. The grid size h was 0.5 m, and a time step  $\Delta t$  of 0.1

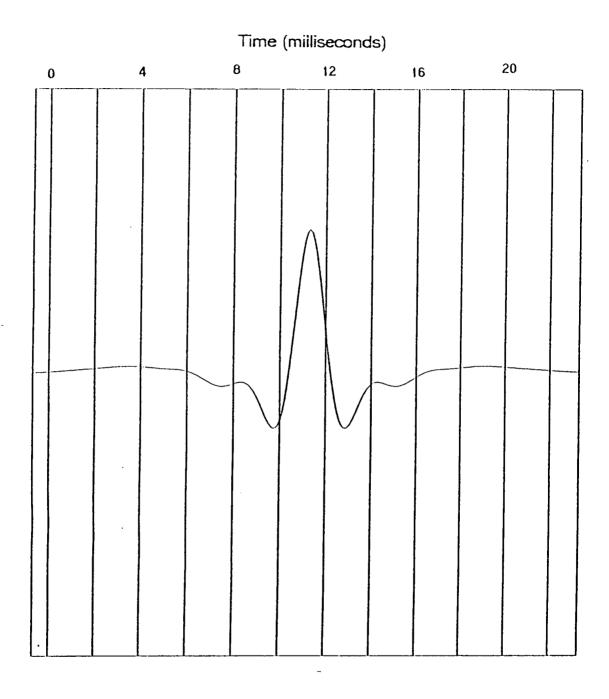


Figure 4.4 Source wavelet used in synthetic seismogram modelling.

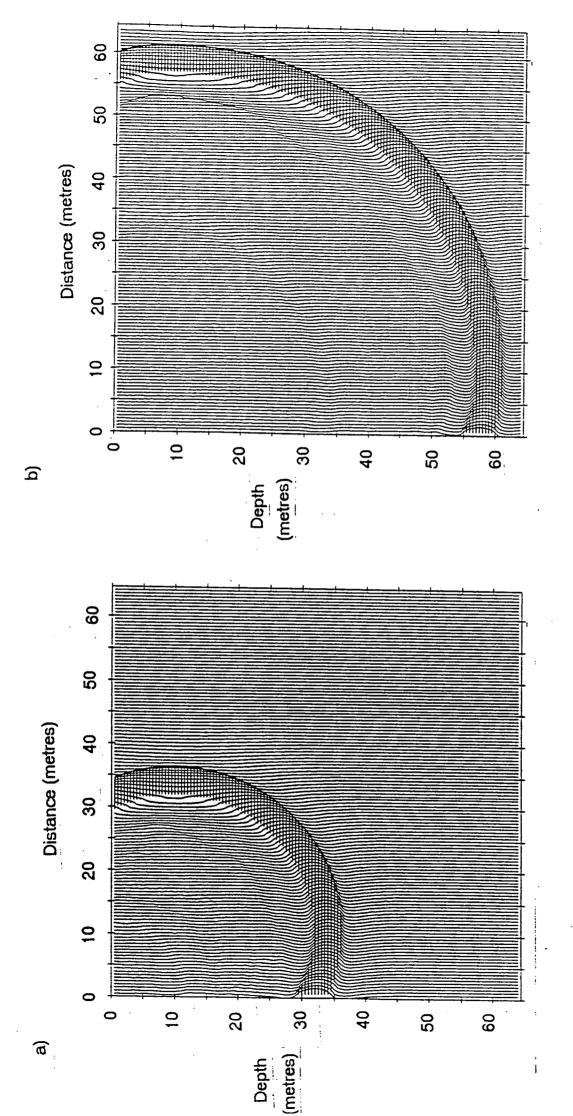
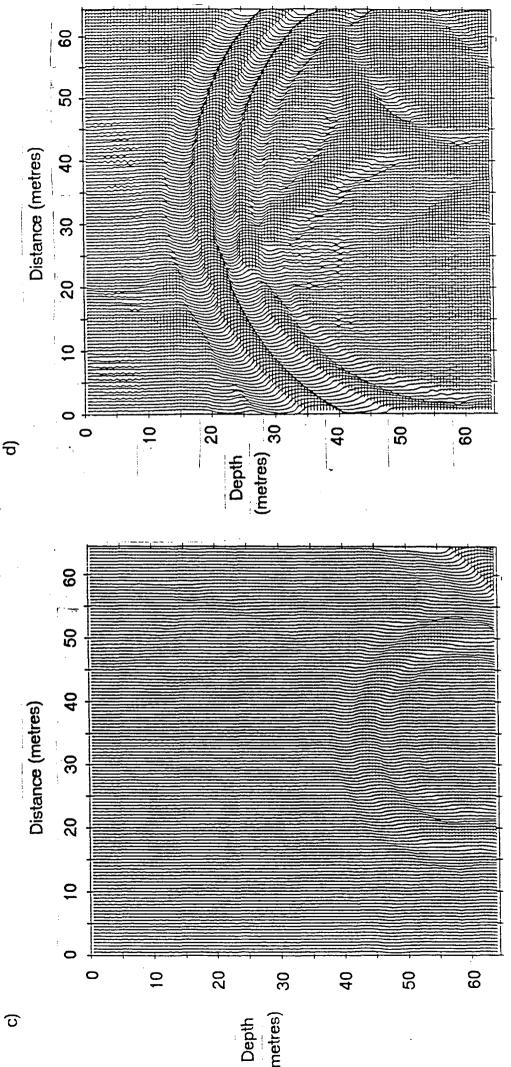


Figure 4.5 Evolution of the wavefield with time: a) 10ms, b) 20ms, c) 30ms, d) 40ms. The original source position was at (10,10).



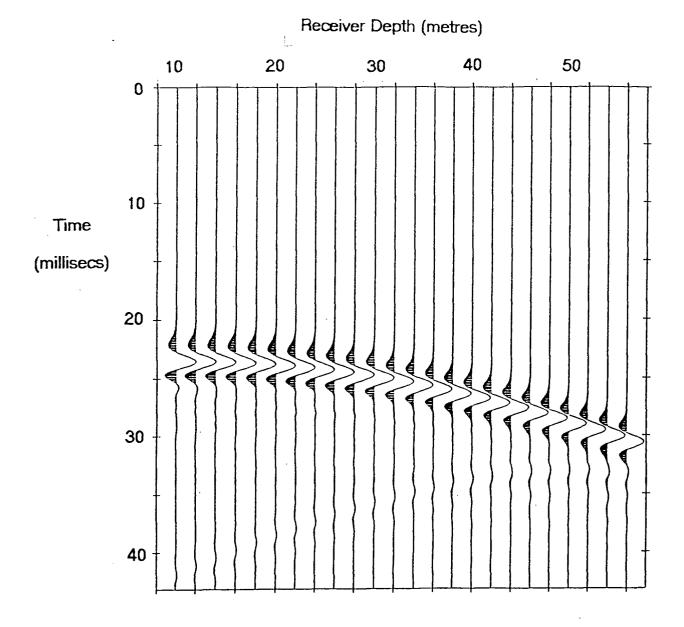


Figure 4.6 Synthetic seismogram produced for diffraction event.

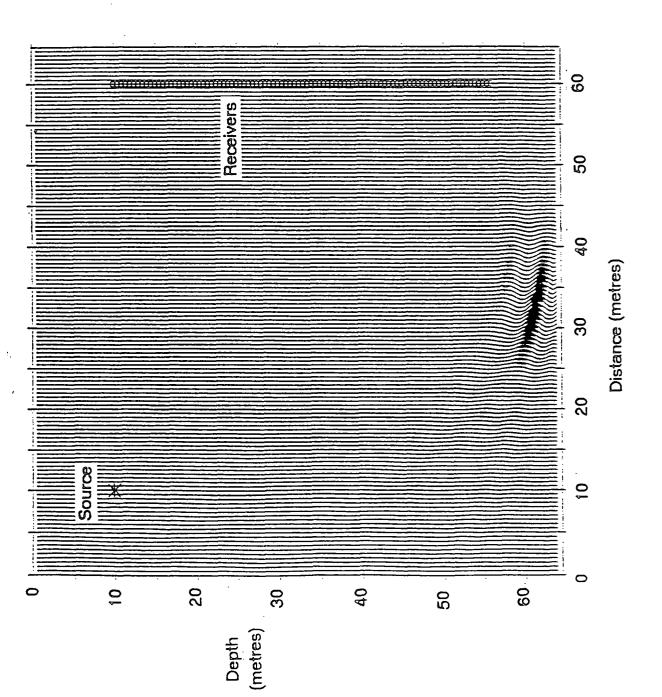


Figure 4.7 Finite-difference migrated image of the diffraction event.

Thus the stability relation of equation (4.5) was satisfied. Butterworth zero-phase source wavelet was used (figure 4.4) with a bandwidth of 150-500 Hz. The bandwidth was chosen to minimise the problem of grid dispersion which would occur for wavelengths greater than 10h=5m. A square diffractor of size 2m x 2m and velocity 1000m/s was positioned at the coordinates (35,60). The source was positioned at coordinates (10,10) and 24 receivers were positioned at 2m intervals, ranging in depth from 10m to 56m, at an offset of 50m from the source. The zero time of the data was set to coincide with the central peak of the source wavelet. The model was run using the L<sup>2</sup> absorbing boundary conditions discussed in §4.3.2. These were applied to all sides (i.e. no free surface reflections were allowed at the top of the model). Figure 4.5 illustrates the progression of the source pulse through the medium at times of 10, 20, 30 and 40 ms. Signal amplitudes have been scaled by taking the square root and retaining the polarity of the signal to enhance the diffracted energy in the diagrams. The circle of energy diffracted from the diffractor point location can be seen clearly in figures 4.5c and d. Data were calculated up to a time of 40 ms. The data "recorded" at the receiver positions are illustrated in figure 4.6. These data were then processed to remove the direct arrival. Since the data have been created by a 2-D modelling algorithm, no amplitude recovery is necessary in the preprocessing stage. The data were migrated by the finite-difference method resulting in the image of figure 4.7. This image is quite disappointing, with significant "smiles" around the diffraction point. The tilt of the migration smearing in this case is characteristic of the geometry of this survey.

Generalised Kirchhoff migration of the same data results in the image shown in figure 4.8. In this case, a full aperture (i.e. allowing all possible structural dips)

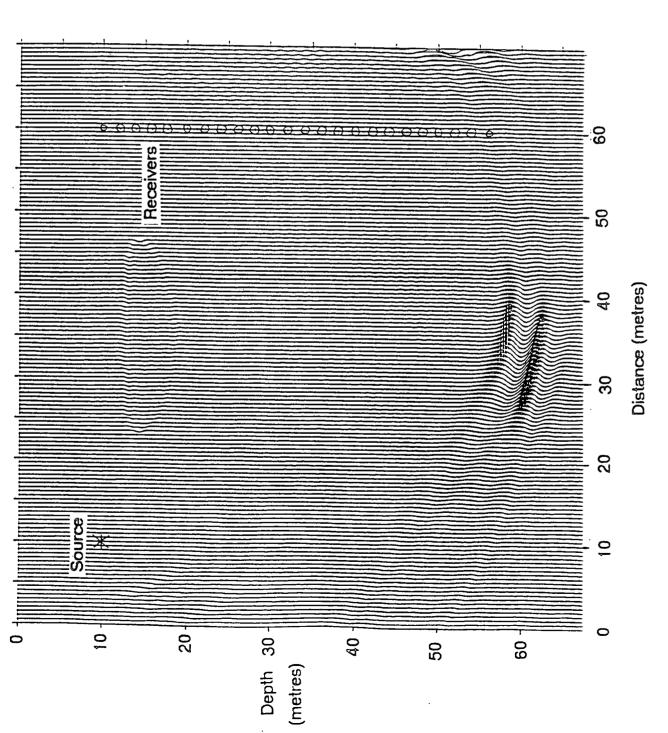


Figure 4.8 Generalised Kirchhoff migrate image of the diffraction event.

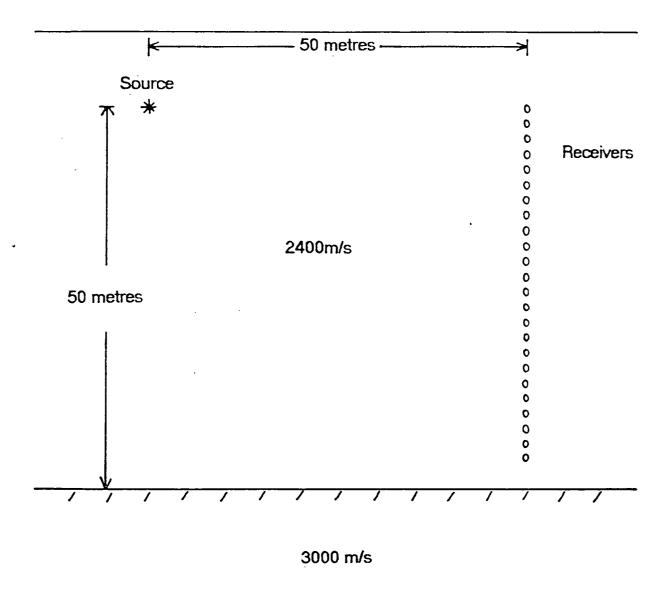


Figure 4.9 Model used to generate synthetic data for cross-hole reflection

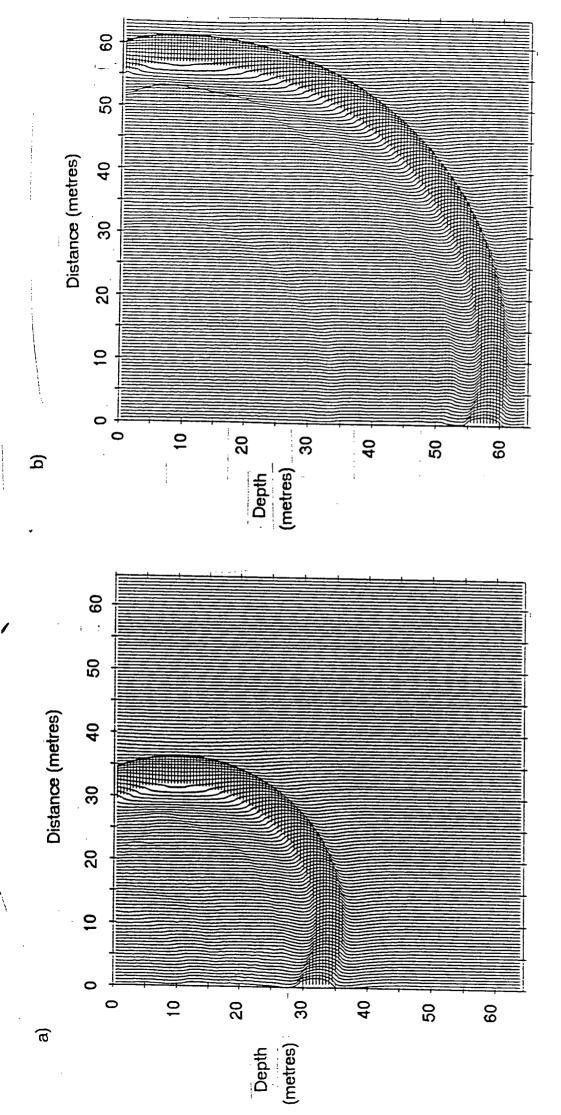
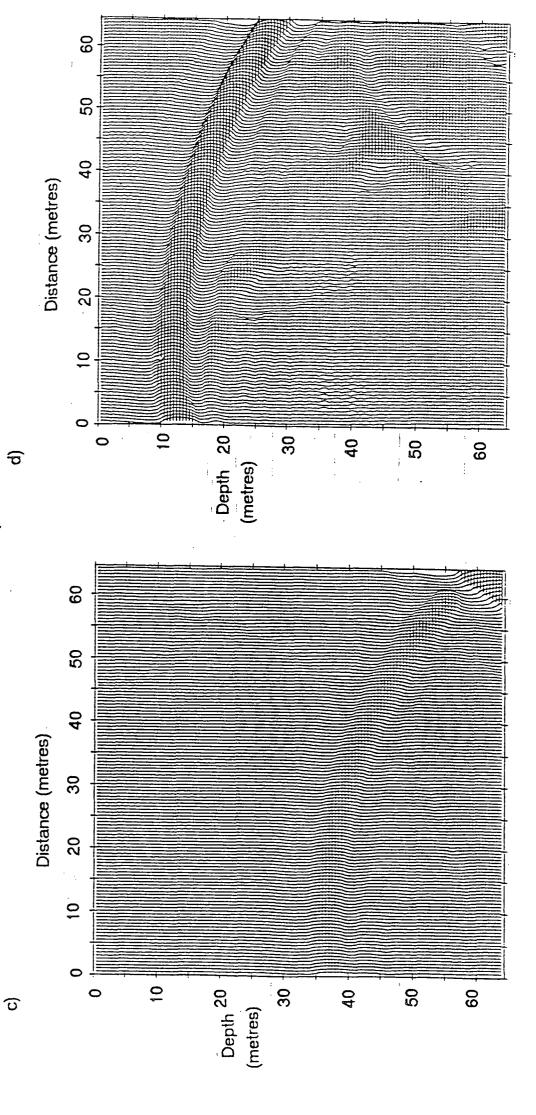


Figure 4.10 Evolution of the wavefield with time: a)10ms, b) 20ms, c) 30ms, d) 40ms. The original source position was at (10,10).



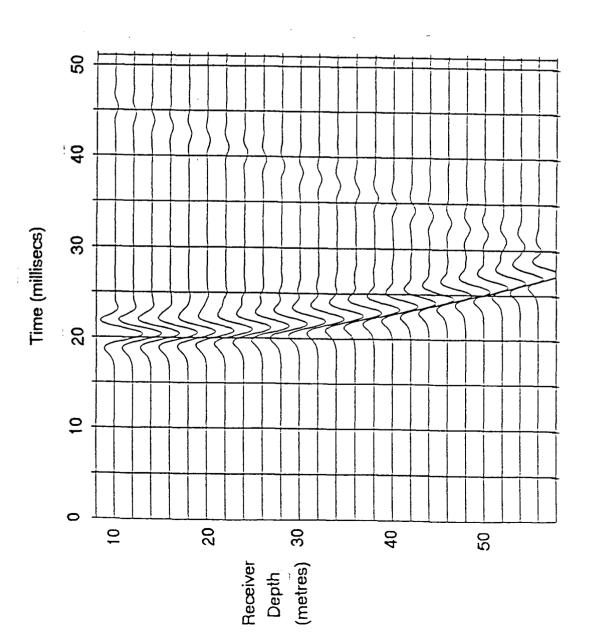


Figure 4.11 Synthetic seismogram produced for reflection event.

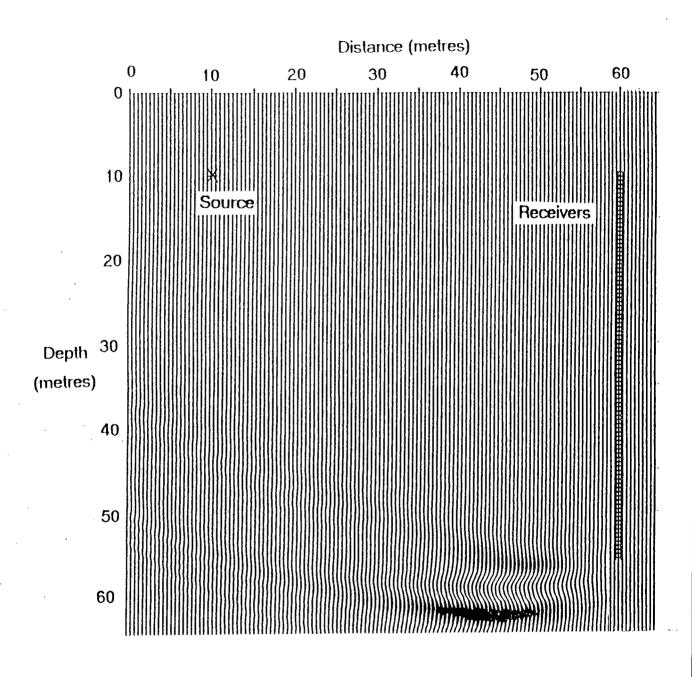


Figure 4.12 Finite-difference migrated image of the reflection event.

was used and the Newman filter was also applied. Again, smiling of the data is apparent and the image is similar to that in figure 4.7.

## 4.5.2 Horizontal reflecting interface model

Another synthetic dataset was modelled using the EXTRAP program. This time the reflectivity of a horizontal reflector was considered. A two-layer model was used (figure 4.9). The top layer of velocity 2400m/s was 50m thick and the bottom layer was assigned a velocity of 3000m/s. The source (again a Butterworth wavelet with a bandwidth of 150-500 Hz) was positioned at coordinates (10,20) and a vertical line of receivers were positioned at 2m intervals at depths from 10m to 56m at an offset of 50m from the source position. L<sup>2</sup> absorbing boundary conditions were applied on all sides of the model. The propagation of the source pulse has been plotted at times of 10, 20, 30 and 40 ms in figure 4.10, and the resultant seismogram following the application of an amplitude recovery ramp, linearly dependent on time, is shown in figure 4.11. The direct arrival and the primary reflected arrival are clearly visible.

Finite difference migration of the data following direct arrival suppression resulted in the image of figure 4.12. Substantial trailing "smiles" are apparent beyond the area of illumination of the reflecting interface. Generalised Kirchhoff migration of the same synthetic data with a full imaging aperture (i.e. allowing all possible reflector dips to be imaged) led to a very similar image (figure 4.13). Subsequently, the migration aperture was reduced to allow geological dips of less than 22.5° and the data re-migrated (figure 4.14). This image is sharper defining the zone of illumination more clearly. The Generalised Kirchhoff approach is preferable to the

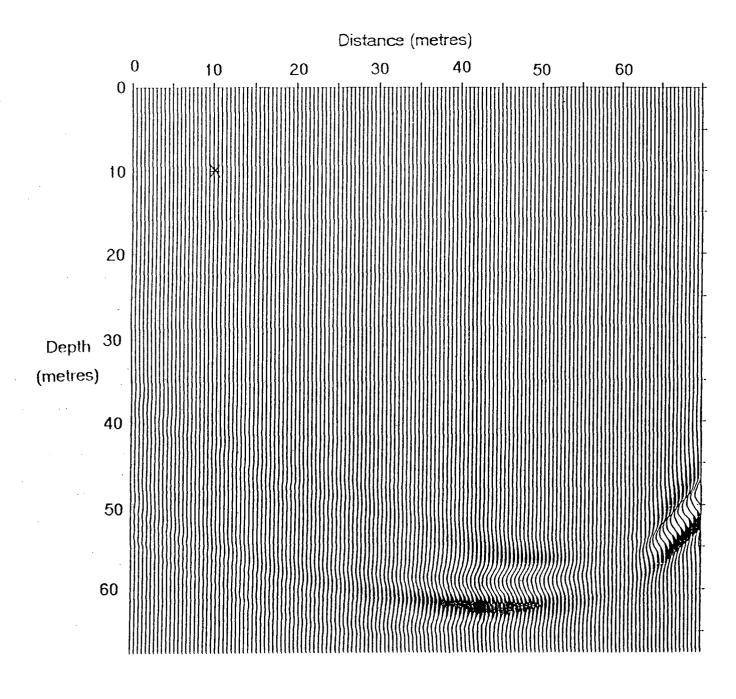


Figure 4.13 Generalised Kirchhoff (full aperture) migrated image of the reflection event.

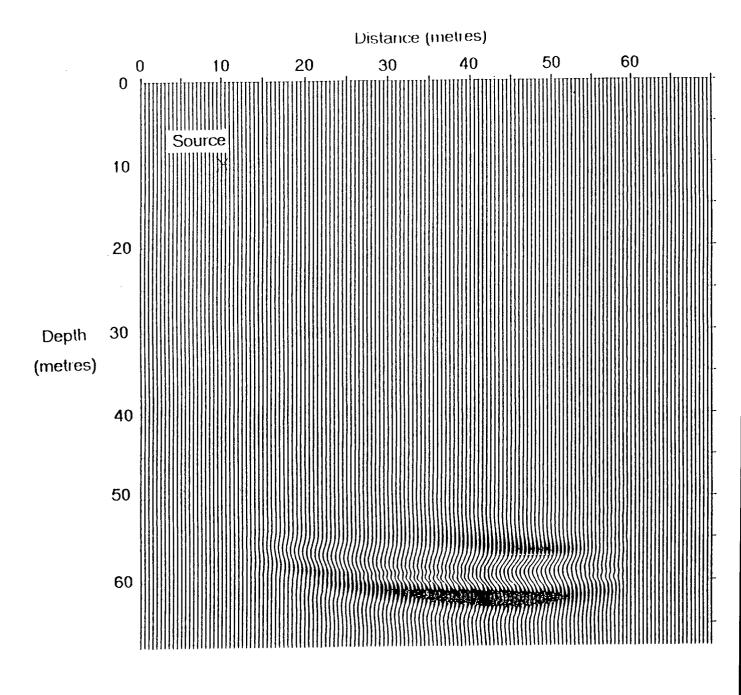


Figure 4.14 Generalised Kirchhoff (22.5° dip aperture) migrated image of the reflection event.

finite-difference approach in this case, because it is faster and also because of the extra control of image quality available during the migration process by the use of an imaging aperture.

# Chapter V

# Results from cross-hole surveys

#### in Coal Measures strata

#### 5.1 Introduction

Trial cross-hole surveys were carried out at three British Coal Opencast exploration sites in the North of England. These were Tinsley Park in South Yorkshire, Lowther South in West Yorkshire and Lostrigg in Cumbria.

#### 5.2 Tinsley Park

Test survey A was carried out at Tinsley Park in 1988 in order to assess the feasibility of the acquisition technique. Preliminary tests had been carried out with sources and receivers positioned at depth intervals of 4m corresponding to those used in earlier cross-hole tomographic work (Findlay, 1987 and Kragh, 1990), but this resulted in spatial aliasing of the data, prohibiting the use of wavefield separation techniques. The survey presented in this section utilised 2m source and receiver intervals.

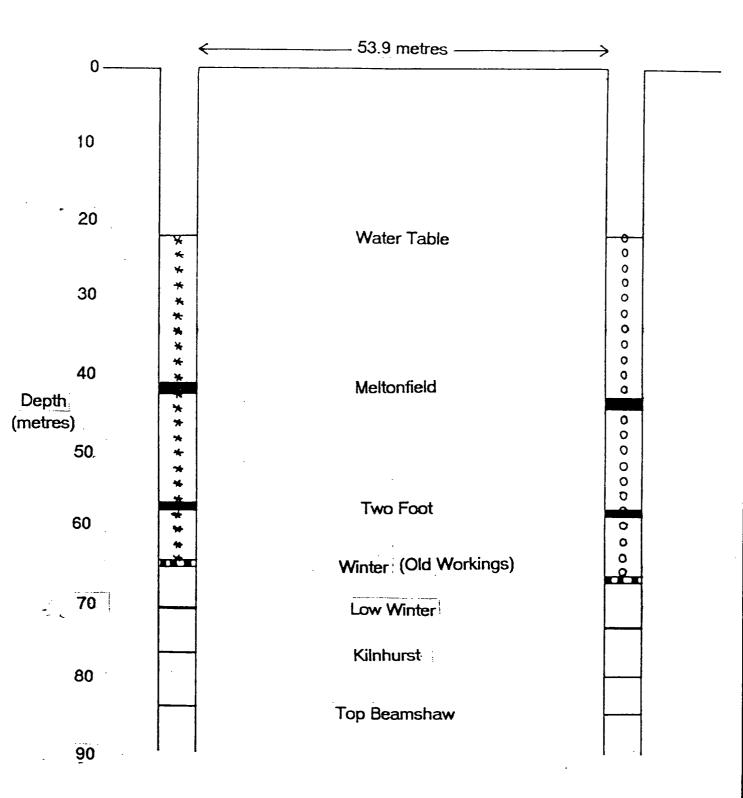


Figure 5.1 Logged coal seams and source and receiver positions for the boreholes used in survey A.

Figure 5.1 shows the interpreted stratigraphic logs and shot and receiver locations for survey A. The water table was at a depth of 22m and the boreholes were blocked at depths of 65m (source hole) and 66m (receiver hole). Repeated shots were fired at depths ranging from 22m to 64m and the hydrophone depths ranged from 22m to 66m. Seismic detonators were used as sources. The principal coal seams logged are listed in Table 5.1.

Seam	Depth to base (metres)	Thickness (metres)
Meltonfield	41.85	1.55
Two Foot	57.00	0.90
Winter	64.70	0.80
Low Winter	70.30	0.15
Kilnhurst	76.20	0.20
Top Beamshaw	83.35	0.45

Table 5.1 Principal coal seams in stratigraphic logs from survey A at Tinsley Park

Of these seams, the Winter seam is known to have been worked with virtually total extraction and the remaining seams are believed to be solid near these boreholes.

The data from this survey were processed and imaged by means of the VSP-CDP transform. A simple velocity field (see table 5.2), derived from a combination of cross-hole tomography and uphole shots, was used to map the data in to a depth section.

Depth range	Interval Velocity
(metres)	(metres/sec)
0-21	2100
21-25	2850
25-40	2950
40-43	2300
43-55	3250
55-57	2450
57-64	, 2800
64-66	2400
>66	3000

Table 5.2 VSP-CDP velocity field used for survey A

In the data processing stage the zero-phase waveshaping deconvolution was omitted and so reflection depths will correspond to the first break of a wavelet rather than to a peak or a trough. The depth section for the upgoing wavefield is presented in figure 5.2. An AGC of length 25m has been applied vertically down the section to compensate for variations in signal amplitude. The horizontal trace separation is 2m and the vertical sampling interval is 0.25m. Normal SEG polarity of reflection amplitudes (i.e. white amplitudes are compressive and black amplitudes are dilatational) has been used in this display and all subsequent sections. Clear reflections are observed from the two shallowest and thickest seams (the Meltonfield

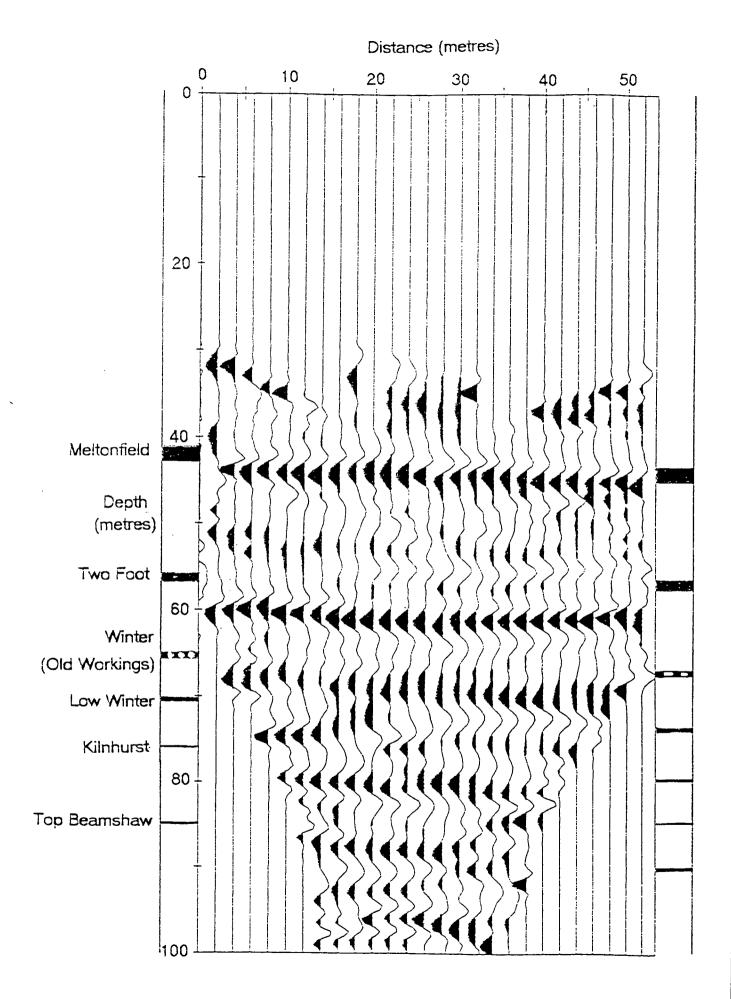


Figure 5.2 Depth section produced by VSP-CDP transform of upgoing reflections for survey A.

and the Two Foot). The reflection event seen at a depth of around 65 metres from the worked Winter seam is disrupted probably as a result of collapses in the roof of the seam and the irregular nature of the room and pillar mineworkings. Signal penetration was poor below this seam and no shots or receivers were located below the seam depth because of borehole blockages. As a result the quality of the image below the Winter seam is poor. The seams are also thinner in this area and one would expect that the reflection response from these seams would be weaker as well. The vertical resolution in the data is indicated by the wavelength of the reflections from the seams. In this case, the wavelengths are around 4m and one would therefore expect to be able to resolve reflector discontinuities caused by faulting or old mineworkings on a scale of 2m or even better. The strength of the reflections from targeted coal seams in this initial survey was very encouraging for the development of this technique.

#### 5.3 Lowther South, West Yorkshire

Four cross-hole surveys were acquired at the Lowther South exploration site in West Yorkshire in the autumn of 1989. The first three surveys were acquired using three collinear boreholes (I, II and III) near to, but not within, a major fault zone known as the Methley-Saville fault. The line of the boreholes was selected to be perpendicular to the strike of the fault. The fourth survey was acquired between two boreholes (IV and V) located within the fault zone and lying approximately collinear

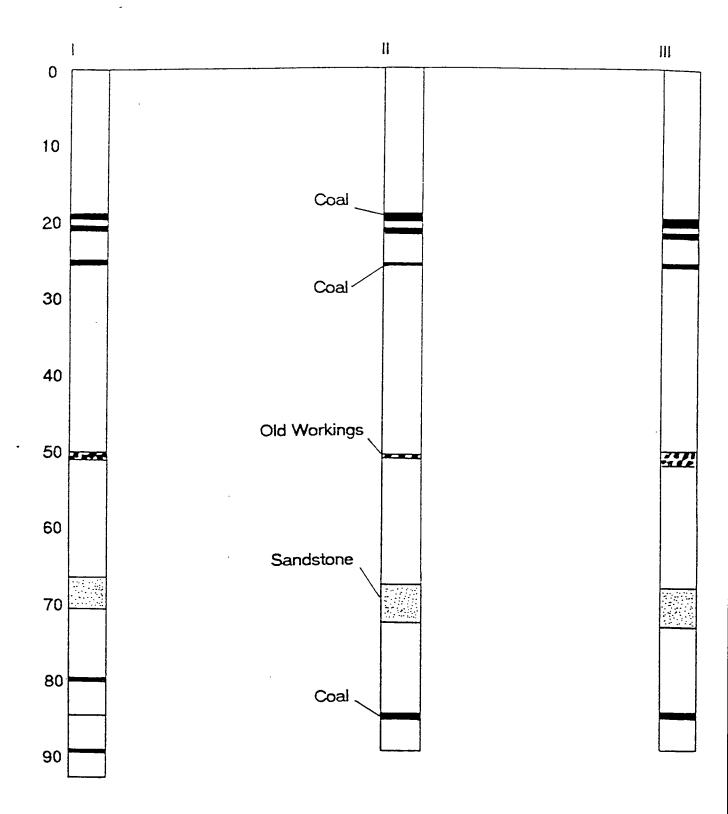


Figure 5.3 Interpreted stratigraphic log for the collinear boreholes I, II and III at Lowther South, West Yorkshire. Principal seams and their thicknesses are depicted.

to the first three boreholes. The interpreted stratigraphic logs for the three collinear boreholes are shown in figure 5.3. The principal seams are listed in Table 5.3.

Seam	Depth to base (metres)	Thickness (metres)
Kents Thick	21.4	1.3
1AY	25.5	0.2
Barnsley Top Softs	51.0	1.1
Dunsil	80.2/84.5*	0.7
*Seam is shallower in	borehole I than in boreholes II	and III

Table 5.3 Principal seams in boreholes I,II and III

The logs indicate that the strata lie horizontally between these boreholes with the exception of a small fault which must cut the Dunsil seam between boreholes I and II. The seams are solid apart from the Barnsley Top Softs which is known to have been extensively worked in the area. The water table intersected these boreholes at a depth of 8m and the boreholes were blocked at depths of 62m, 57m and 52m, respectively.

#### 5.3.1 Survey B, illustrating the combination of up- and down- going sections

Shots were fired from 27 depth levels at 2m intervals ranging from 10m to 62m in borehole I and the data were recorded at 23 hydrophone depth levels at 2m intervals ranging from 16m to 60m in borehole II (see figure 5.4). The borehole

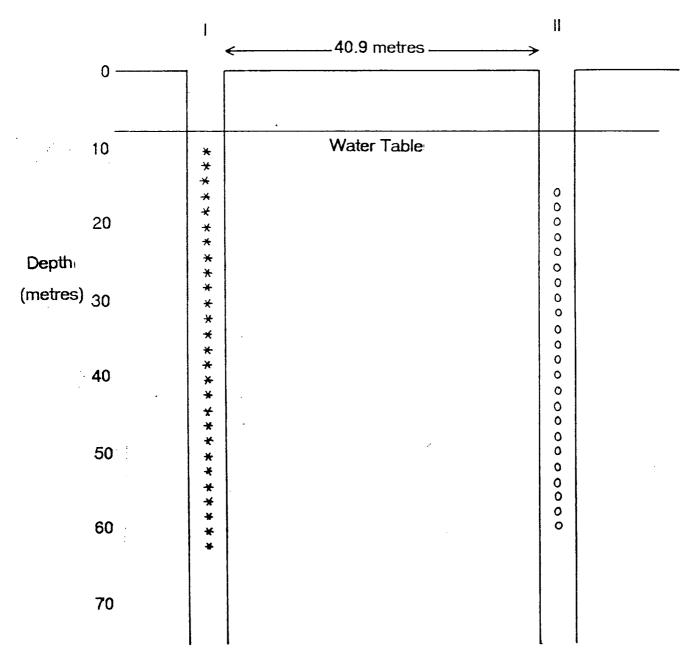


Figure 5.4 Shot and receiver positions for survey B.

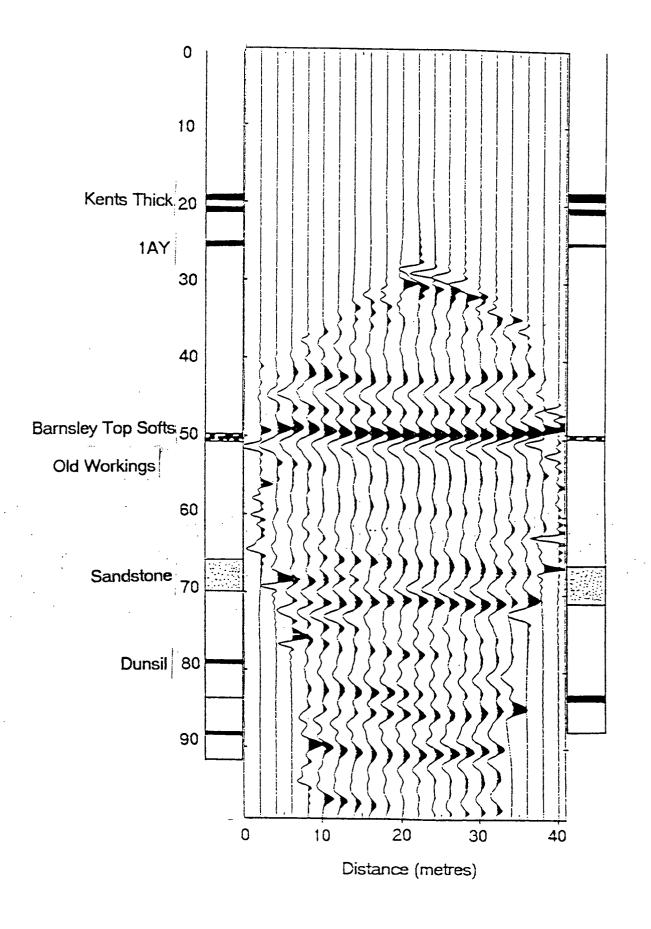


Figure 5.5a Upgoing Generalised Kirchhoff migrated section (22.5 dip aperture) for survey B.

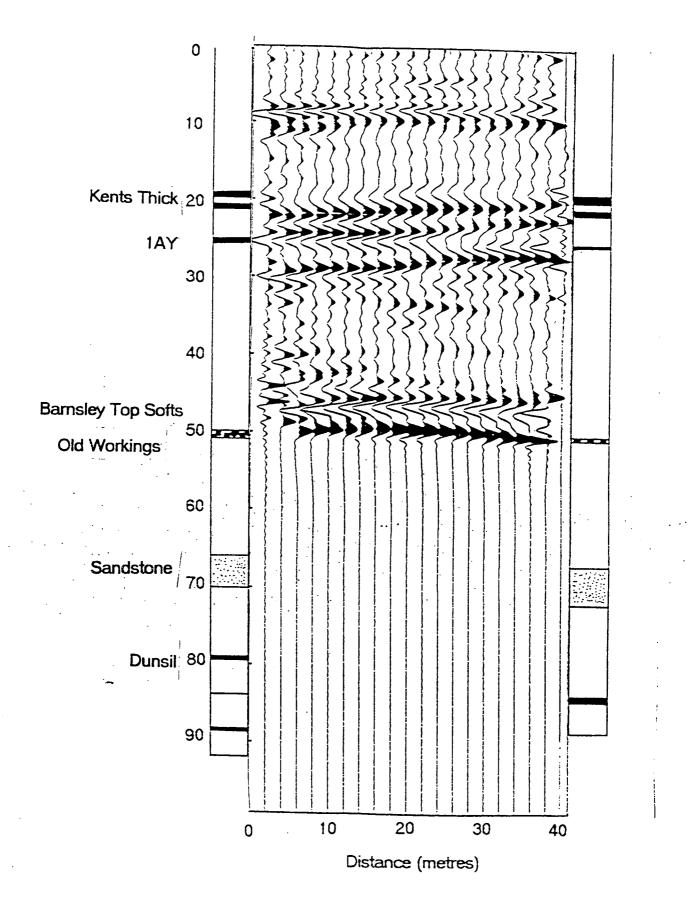


Figure 5.5b Downgoing Generalised Kirchhoff migrated section (22.5 dip aperture) for survey B.

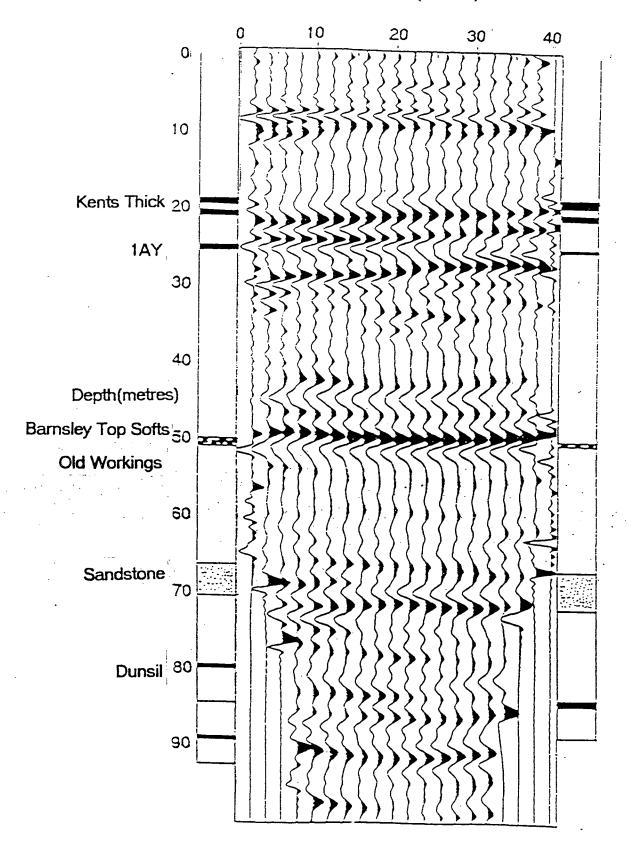


Figure 5.5c Combined upgoing and downgoing Generalised Kirchhoff migrated section for survey B. Sections are merged between 40m and 50m depth using cosine tapers.

separation was 40.9m at the surface. Both boreholes were blocked at a depth of around 62m. The data were processed as described in chapter III and imaged by means of the G-K migration algorithm. A migration dip aperture of +/- 22.5° was used. The migration velocity field is described in table 5.4.

Depth range	Migration interval
(metres)	velocity (metres/sec)
0-10	1200
10-22	2250
22-54	, 2600
54-100	2700

Table 5.4 Migration velocity field used for survey B

The depth sections are presented in figure 5.5. Figure 5.5a is the depth section imaged from the upgoing reflections and figure 5.5b is the depth section imaged from the downgoing reflections. Figure 5.5c is the depth section of the combined up- and down- going sections produced by melding the two sections together over a depth range of 40-50m. An AGC of length 25 metres has been applied vertically to balance up the amplitudes at all depths. Several clear reflectors are apparent corresponding to the coal seams at depths of 8m, 20m, 25m and 50m. The seams at 20m and 25m have a flat, continuous character as might be inferred from the stratigraphic logs. The Barnsley Top Softs seam at 50m depth has been worked right across the section, but still shows a strong, coherent reflection. The presence of a fault intersecting borehole

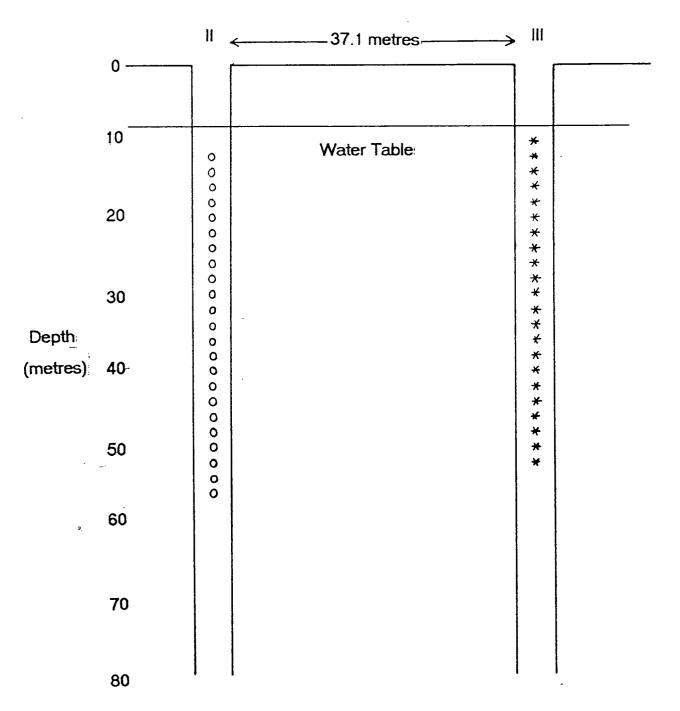


Figure 5.6 Shot and receiver locations for survey C.

B at a depth of between 50m and 80m might be expected from interpretation of the borehole logs. Unfortunately, the fault is not apparent on the cross-hole survey either because it is located too close to the borehole where reflector coverage is very poor, or else because of the lack of penetration of the signal through the old mineworkings at 50m depth. The Dunsil seam (log depth 85m) may have been imaged closer to 90m due to errors in the velocity field below the bottom source and receiver depths. Image quality is poor in those regions of the image where specular reflection raypath coverage is of a low density. These regions are in the vicinity of the boreholes and in the areas near the boreholes above the top source and receiver positions and below the bottom source and receiver positions.

#### 5.3.2 Survey C; between boreholes II and III

In this survey a total of 22 shot positions were used in borehole III at 2m depth intervals ranging from a depth of 10m to a depth of 51.9m (see figure 5.6). Electrical detonators were used as an explosive source. Hydrophone locations were at 2m depth intervals ranging from a depth of 12m to a depth of 56m in borehole II. The borehole separation was 37.1m at the surface. The data were processed as described in chapter III and imaged by means of the G-K migration algorithm with a migration dip aperture of +/-22.5° The isotropic velocity model used to migrate the data is described in table 5.5.

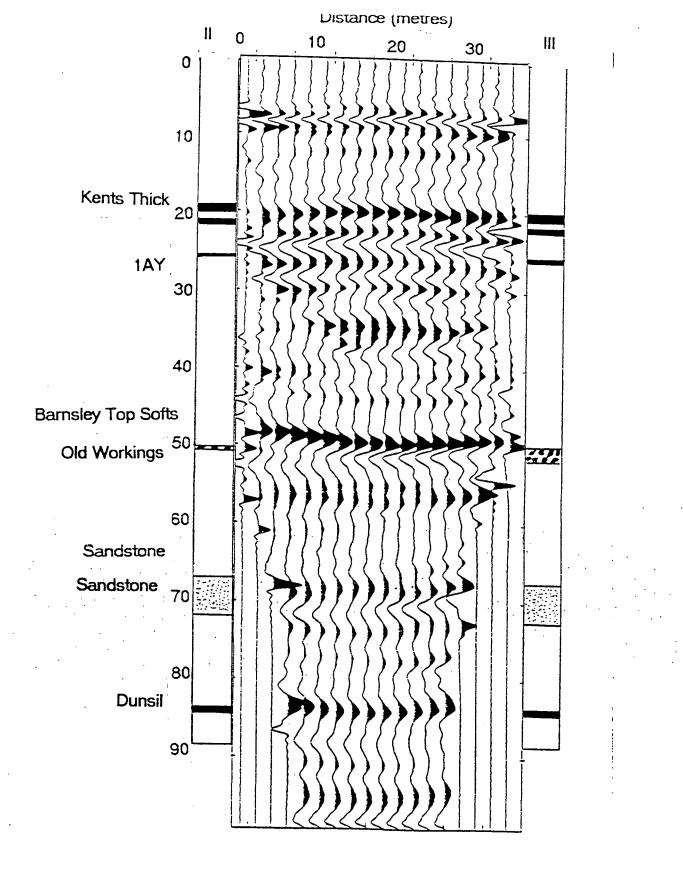


Figure 5.7 Depth section produced by combining Generalised Kirchhoff migrated sections of the upgoing and downgoing reflections for survey C.

Depth range	Migration interval
(metres)	velocity (metres/sec)
0-10	1200
10-22	2400
22-40	2600
40-100	2700
	·

Table 5.5 Migration velocity field used for survey C

The depth migrated section produced by combining the sections produced from the upgoing and downgoing wavefields from this survey are shown in figure 5.7. Again an AGC of length 25 metres has been applied in the vertical direction. The section is very similar to that produced for survey B (figure 5.5c) with clear reflections from the principal coal seams. The seams appear to be of a flat and continuous nature.

#### 5.3.3 Survey D; wider-spaced cross-hole reflection survey

A further survey was acquired between boreholes I and III (at a separation of 78.0m) for comparison purposes with surveys B and C and also in the expectation of imaging the strata near borehole II, where the image quality is very poor for surveys B and C. When the fieldwork was carried out it was found that borehole I had collapsed still further since survey B and was blocked at a depth of 52m. The borehole collapse was probably aggravated by the detonation of the source charges for survey B in this borehole. A larger charge size (25g of dynamite) was used to improve the signal-to-noise ratio because of the greater borehole spacing in this

survey. The data were processed as discussed in chapter III and the imaging was once more carried out by means of the Generalised Kirchhoff method with a dip aperture of +/-22.5°. The interval velocities used in the migration are listed in table 5.6.

Depth range	Migration interval
(metres)	velocity (metres/sec)
0-10	1200
10-22	2400
22-50	2700
50-54	, 2500
54-100	2800

Table 5.6 Migration velocity field used for survey D

The combined upgoing and downgoing reflection sections are presented in figure 5.9. An AGC of length 25 metres has been applied to balance out the variations in signal amplitude down the section. The section possesses some similarities to the previous two surveys. In particular, the reflection from the old mineworkings at around 50m depth has a comparable character. The reflections from the shallower seams whose true depth is around 20m have been imaged shallower, presumably because the velocity field was too large for the migration of the downgoing wavefield. The quality of this image is generally much poorer than that obtained in surveys B and C. This illustrates that there is a maximum limit to the borehole spacing which can be used successfully for a given range of depths of the source and receiver positions.

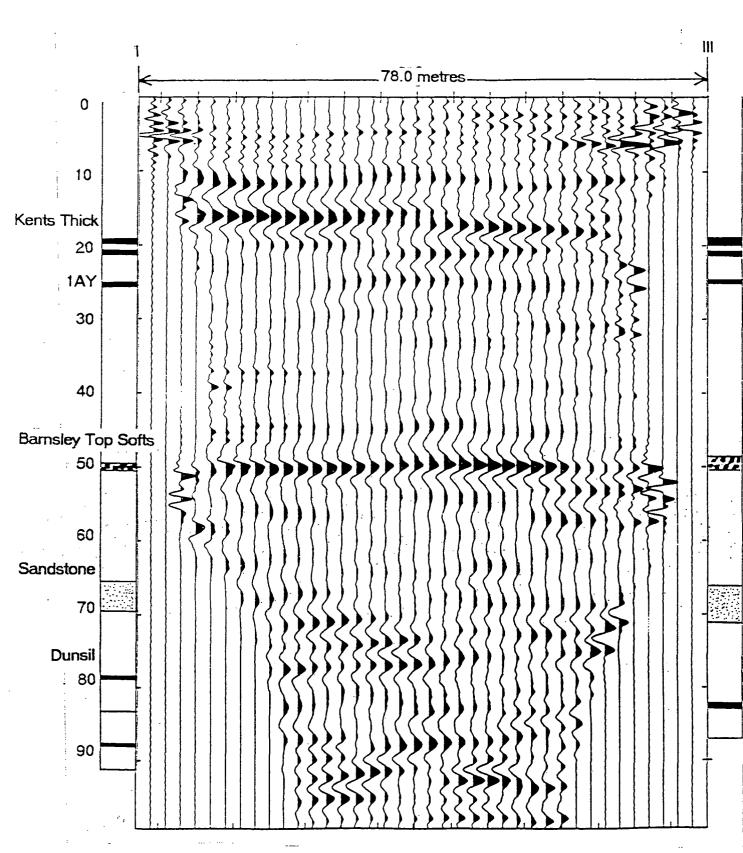


Figure 5.9 Depth section produced by combining Generalised Kirchhoff migrated sections of the upgoing and downgoing reflections for survey D.

The deterioration in the image quality is a consequence of the reflection raypaths becoming more horizontal as the borehole separation increases. This results in a problem in that a very accurate velocity model specification is needed to reduce positioning (and hence stack contribution) errors to an acceptable level (see section 3.7). The processing of shallow dipping reflections is also made more difficult because of the problems in separating the reflected energy from the direct arrivals when the travel times and moveouts are very similar.

#### 5.3.4 Survey E; cross-hole survey through major fault zone

Another survey was carried out at the Lowther South exploration site between boreholes IV and V in a field adjacent to boreholes I, II and III. The boreholes were 32.0m apart, located in the zone of the Methley-Saville fault and the line of the boreholes was approximately perpendicular to the strike of the fault. The principal seam depths taken from the stratigraphic logs are indicated in table 5.7.

Seam	Hole IV	Hole V	Thickness
	Depth to base	Depth to base	(metres)IV/V
	(metres)	(metres)	
Kents Thick	13.4	22.36	1.4/2.4
1AY	ABSENT	27.84	- /0.2
Barnsley Top Softs	28.46	53.32	0.86/1.2
Dunsil	59.26	84.11	0.7/0.5

Table 5.7 Principal seams in boreholes IV and V

Shots were fired in borehole IV at 21 locations at 2m intervals in the depth range 10-50m. Electrical detonators were used as a source. 23 hydrophone positions were used in borehole V at depths between 9.79m and 53.79m. The shot and receiver locations and summary stratigraphic logs are depicted in figure 5.10.

The data were processed as described in chapter III and imaged by means of the G-K migration method with a migration dip aperture of +/-22.5°. The migration interval velocities are described in table 5.8.

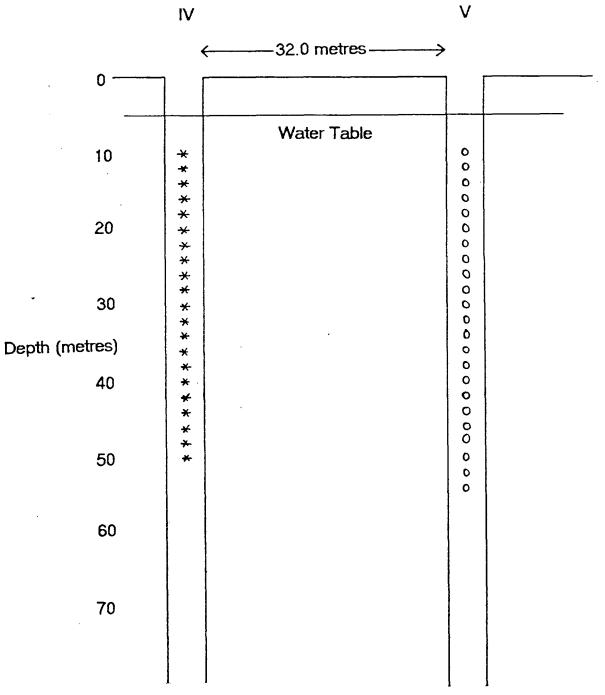


Figure 5.10 Shot and receiver locations for survey E.

Depth range	Migration interval
(metres)	velocity (metres/sec)
0-10	1200
10-20	2200
20-24	2250
24-40	2330
40-46	2210
46-90	2400

Table 5.8 Migration velocity field used for survey E

The combination of the migrations of the upgoing and downgoing wavefields is presented in figure 5.11. The quality of the section is good with clear reflections from the coal seams on the downthrown (right) side of the fault and from the Dunsil seam (around 60m) on the upthrown side. Errors in seam depths are a result of inaccuracies in the migration velocity model.

Interpretation of the borehole logs suggested that the fault intersects borehole IV between the Kents Thick and Barnsley Top Softs seams. It was not known whether the difference in levels of the Kents Thick seam (~7 metres) between the two boreholes was due to dipping strata or a small fault. The cross-hole seismic survey removes this ambiguity since the reflection from the Kents Thick seam is near-horizontal across the section. Therefore a small fault with a throw of 7 metres must intersect the Kents thick seam close to borehole IV where the image quality of the seismic section is poor. The location of the larger fault is clearly defined by the

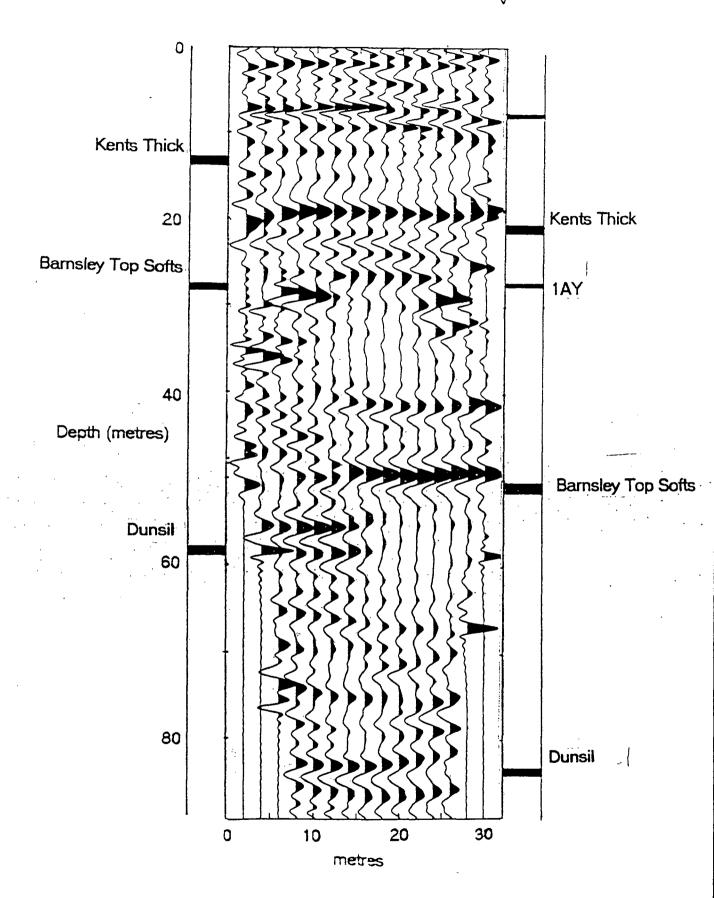


Figure 5.11 Migrated depth section with combined upgoing and downgoing reflections for survey E acquired at Lowther South.

truncations of reflections from the Barnsley Top Softs seam to the right and from the Dunsil seam to the left at the fault zone.

#### 5.4 Lostrigg, Cumbria

The results of a further survey acquired at a British Coal opencast exploration site at Lostrigg in Cumbria are presented.

#### 5.4.1 Survey F; old mineworkings

The target of this survey was the edge of a longwall panel in the Sixquarters seam. The boreholes (A and B) used were separated by 48.4m at the surface. The principal coal seams logged for the two boreholes are listed in table 5.9. The Sixquarters seam was worked in borehole A, but solid in borehole B. It was thought that the extent of the old mineworkings might be delimited by a small fault.

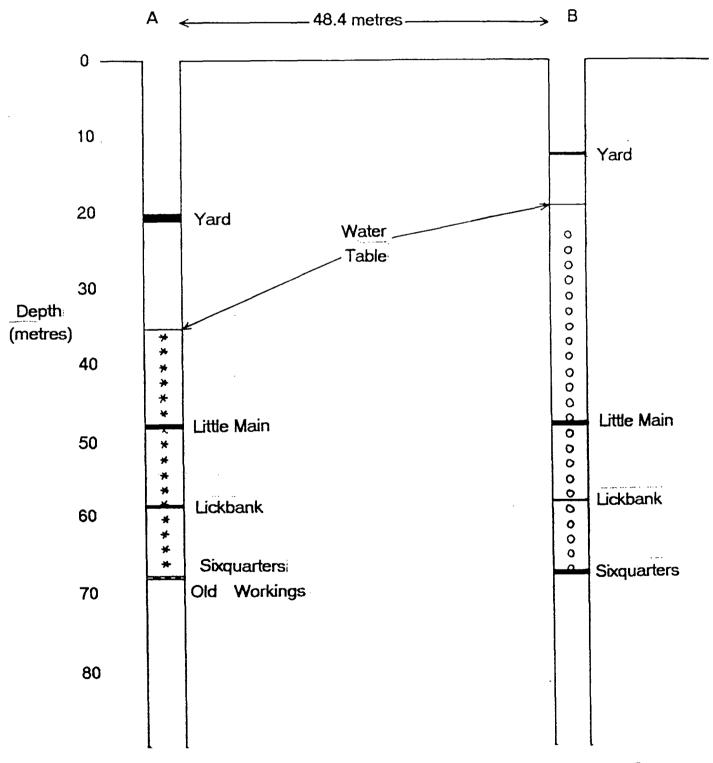


Figure 5.12 Shot and receiver locations and principal coal seams for survey F.

Seam	Hole A  Depth to base	Hole B  Depth to base	Thickness (metres)A/B
	(metres)	(metres)	
Yard	21.20	12.68	1.0/0.3
Lower Yard	21.42	20.87	0.1/0.2
Top Half Yard	34.41	33.40	0.2/0.2
Btm Half Yard	36.26	absent	0.2/
Little Main	48.21	48.06	0.6/0.6
Eighteen Inch	52.99	51.33	0.2/0.2
Lickbank	58.58	57.99	0.4/0.4
Sixquarters	68.12	67.75	0.3*/0.5
* Seam worked	with some coal present		

Table 5.9 Principal seams in boreholes A and B

There were several acquisition problems with this survey. Both boreholes were blocked at the level of the Sixquarters seam and the water tables were at quite different levels in the two boreholes (35m in borehole A and 19m in borehole B). There were also large amounts of tube wave noise generated on most of the shot records and this was difficult to remove successfully.

Altogether 16 shot positions were used in the survey at 2m depth intervals in borehole A ranging from 36m-66m. The hydrophones were positioned at 23 positions at 2m intervals in borehole B ranging from 22.7m-66.7m. The shot positions and principal coal seams are shown in figure 5.12. The data were imaged using the G-K

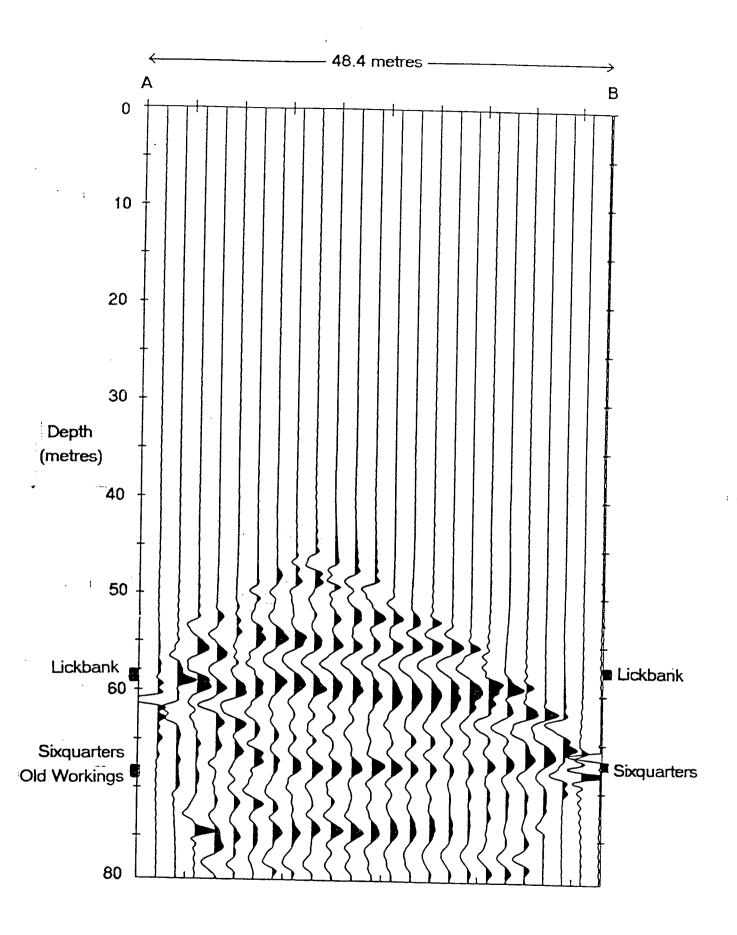


Figure 5.13 Depth section of survey F produced by Generalised Kirchhoff migration of the upgoing reflections.

migration method with a dip aperture of +/-25°. The migration velocity field is shown in table 5.10.

Depth range (metres)	Migration interval velocity (metres/sec)
0-20	1580
20-36	2470
36-80	3000

Table 5.10 Migration velocity field used for survey F

The migrated upgoing wavefield is shown in figure 5.13. The results are disappointing, but not surprising given the problems of reduced shot position coverage, probable significant lateral velocity variations produced by the variation in the water table, and the tube wave noise. A strong reflection is visible from the Lickbank seam, but the quality of the section is too poor to determine whether the old mineworkings were indeed terminated by a small fault.

### Chapter VI

# A comparison of different migration operators for cross-hole seismic data

#### 6.1 Introduction

A comparison of the effectiveness of different migration techniques for crosshole data is discussed in this chapter. The migration operators of a variety of techniques were considered: Finite difference migration in the (x,z,t) domain, diffraction stack summation, Kirchhoff migration, Generalised Kirchhoff (GK) Migration and Generalised Radon Transform (GRT) migration.

#### **6.2 Migration operators**

The migration operators for the various techniques are presented in figures 6.1-6.5. The operators were calculated assuming a single source-receiver pairing in a homogeneous, isotropic medium. The source and receiver were both located at a depth of 20 metres with an offset of 40 metres. The velocity field was assumed to be 3000m/s and a band-limited spike with a travel time of 20 ms was used as input to a single trace migration operation. In all cases a regular grid with sampling at 0.5m intervals in the x and z directions was employed and the source and receiver were assumed to be elements in vertical source and receiver arrays.

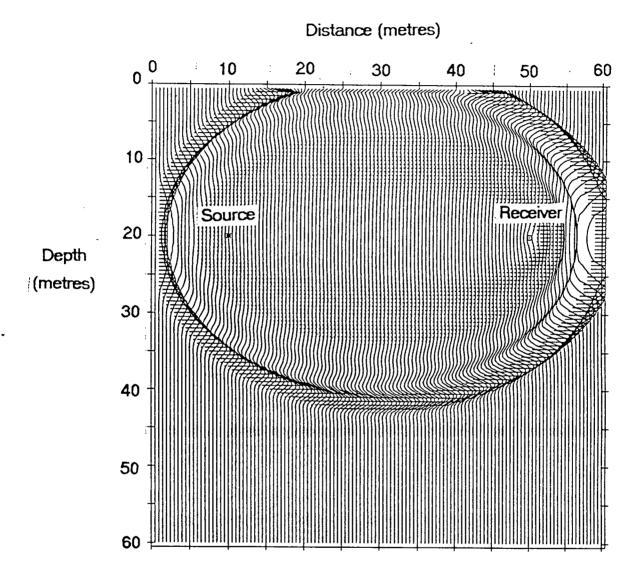


Figure 6.1 Finite-difference migration operator in a homogeneous, isotropic velocity field.

## Distance (metres)

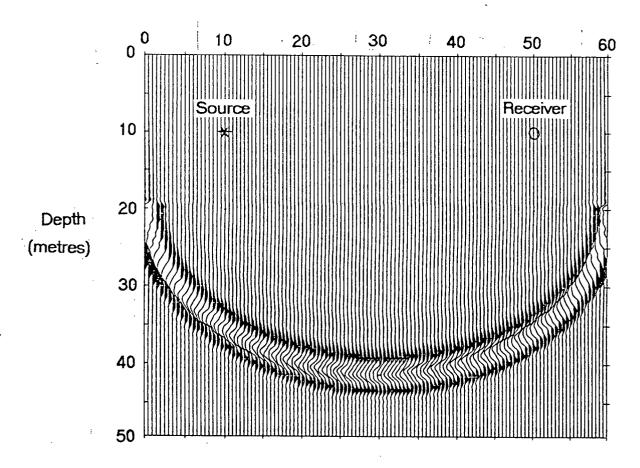


Figure 6.2 Diffraction stack migration operator in a homogeneous, isotropic velocity field.

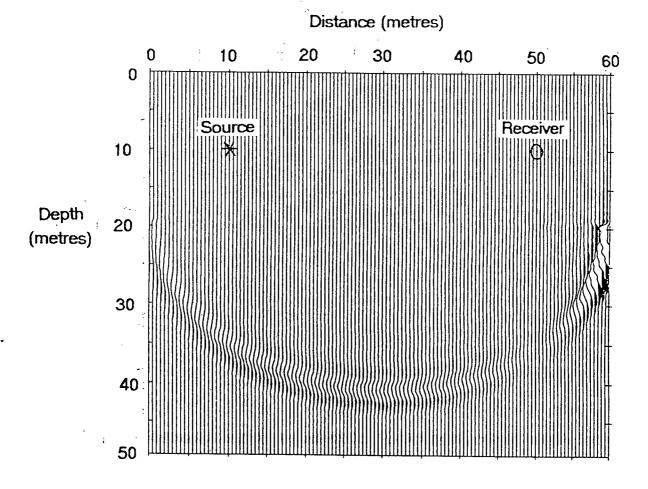


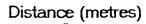
Figure 6.3 Kirchhoff migration operator in a homogeneous, isotropic velocity field.

The finite difference migration is shown in figure 6.1. Absorbing boundary conditions were used at the grid edges. The impulse response is an ellipse with the source and receiver at the focal points and is symmetrical with respect to the source and receiver. This ellipse may be thought of as the locus of possible locations for a diffracting point to produce an arrival corresponding to the input spike at 20 ms. Reverberations within the ellipse are caused by grid dispersion effects (see chapter IV). The finite difference method does not implicitly differentiate between upgoing and downgoing events and so a complete ellipse has been generated.

The result of diffraction stack migration (i.e. without an amplitude and phase correction) is shown in figure 6.2. Again, the impulse response is an ellipse (in this case a half-ellipse as only upgoing wavefields have been considered by the operator) and it is also symmetrical with respect to exchange of the source and receiver. There are fewer reverberations than were obtained by the finite-difference method, although the wavelet of the ellipse is less smooth.

The Kirchhoff migration operator is shown in figure 6.3. In this case the Newman phase and amplitude correction has been applied, but the ellipse is not symmetrical to the exchange of source and receiver positions because of a term proportional to  $\sqrt{\frac{R_s}{R_r}}$  (see equation 4.10 of chapter IV) which magnifies the reflectivity near the receiver position.

The Generalised Kirchhoff migration operator is shown in figure 6.4. This operator is similar to the Kirchhoff operator but is symmetrical to the exchange of source and receiver positions because it contains the term  $\sqrt{\frac{R_S}{R_r}}$  for integration over the receiver array as well as the term  $\sqrt{\frac{R_r}{R_S}}$  for integration over the source array



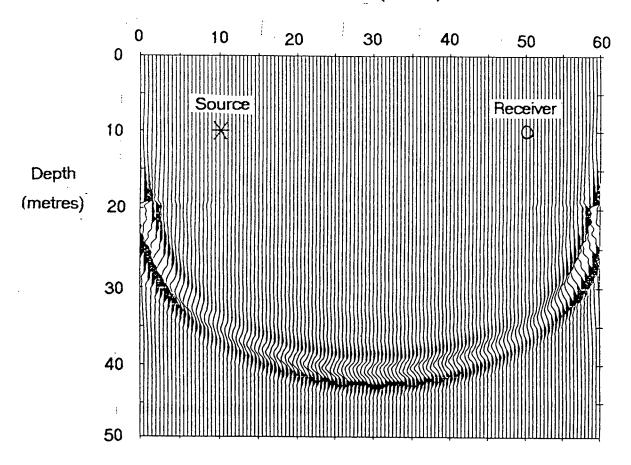


Figure 6.4 Generalised Kirchhoff migration operator in a homogeneous, isotropic velocity field.

#### Distance (metres)

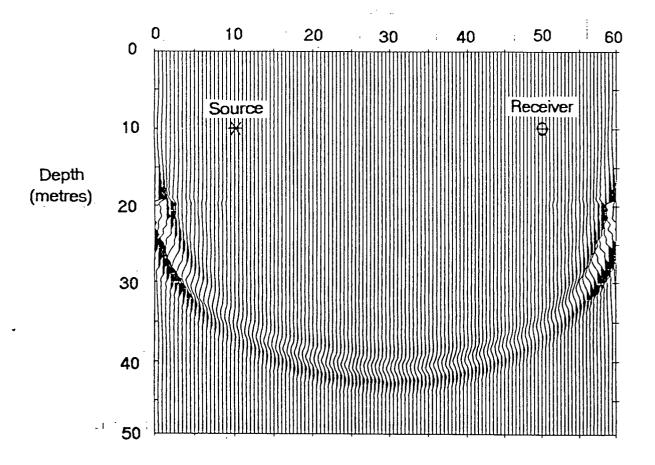


Figure 6.5 Generalised Radon Transform migration operator in a homogeneous, isotropic velocity field.

(see equation 4.11 of chapter IV). The high amplitudes to the left of the source and to the right of the receiver may be removed by a migration dip aperture taper in areas where the geology is known to be reasonably horizontal.

The Generalised Radon Transform (GRT) migration operator (Miller et al., 1987) is shown in figure 6.5. The integral is similar to that of the G-K operator but includes an additional term which depends on the scattering angle  $\phi$  between the source and receiver raypaths at the scattering point. The term is proportional to  $\cos^2 \frac{\phi}{2}$  which results in an almost constant amplitude in the part of the ellipse which lies between the source and the receiver. Again there are high reflectivities for the steeply dipping events beyond the source and receiver positions.

#### 6.2.1 Suitability of impulse response functions for cross-hole data

Clearly the Kirchhoff migration method is unsuitable for the migration of cross-hole data due to the large variations in reflectivity produced between the source and receiver boreholes. The finite difference method is very slow and results in reverberations caused by grid dispersion effects. The diffraction stack operator does not include the theoretically correct amplitude and phase corrections provided by Kirchhoff migration. There is little to choose between the G-K and GRT migration operators. Both produce near-uniform reflectivities in the region of interest between the source and the receiver. In this work the G-K migration operator was used along with suitable controls for the dip aperture to enhance reflections from shallow-dipping strata.

#### **Chapter VII**

## Conclusions and suggestions for future work

A field method for acquiring cross-hole seismic reflection data in shallow strata has been developed. The technique as it stands allows two or three cross-hole surveys to be acquired by a field crew of two or three personnel in one day. Further improvements in acquisition rates may be obtained by the use of a borehole sparker or piezoelectric source instead of a dynamite source.

Cross-hole direct arrival data may be processed using tomographic imaging software as a supplement to the cross-hole reflection method. The velocity field obtained by a tomographic survey, whilst not being successful at imaging faults or old mineworkings between boreholes (Kragh, 1990), is useful in providing a starting model for migration of the cross-hole seismic reflection data.

The cross-hole reflection method provides high-resolution seismic reflection sections of shallow Coal Measures strata. The processing of several trial surveys acquired at British Coal Opencast's exploration sites in the north of England has shown that wavelengths less than 4m are typical for these surveys with recorded reflection data frequencies lying in the bandwidth 100-500 Hz. The most pronounced reflections come from the coal seams.

It is envisaged that, for a practical exploration technique, the cross-hole reflection method should be used in conjunction with hole-to-surface surveys (Kragh, 1990). The zones of reflector coverage of the two types of survey are complementary (see figure 7.1). The cross-hole method provides better imaging in the region

# Surface geophones 0 Downhole × 0 \* Sources 0 receivers \* 0 \* 0 0 0 \* 0 Reflector coverage Cross-hole Hole-to-surface

Figure 7.1 Zones of coverage of cross-hole and hole-to-surface reflection surveys with the shallowest source and down-hole receivers located near the water table.

Common

between the boreholes, but the image quality deteriorates towards the boreholes. The hole-to-surface method provides lower resolution sections (wavelengths are around double that of the cross-hole method) but better imaging near the boreholes. The cross-hole image quality nearer the boreholes should be improved by the inclusion of a near-field correction term to the Kirchhoff integral (Dillon, 1988).

Possible uses of the cross-hole reflection method include the detailed imaging of regions of particular interest such as small-scale faulting at reservoir depths where borehole logging, conventional seismic and VSP methods cannot provide sufficient resolution. It should also be possible to acquire data from surveys beneath obstructions such as buildings, roads and water courses where surface sources and receivers cannot be used.

In addition to imaging "conventional" upgoing reflections, the cross-hole method also gives reflector coverage above the top source and receiver positions. An important characteristic of the cross-hole method is that the frequency content of the data is not effected by the depth of the region of interest as is the case with surface surveys and VSPs, but rather by the separation of the boreholes and therefore we might expect images of deeper strata to be every bit as good as those of the shallow strata included in this work. In fact the greater compaction of rocks at depth should result in better quality data.

Further important development work could include the use of elastic imaging by means of a downhole three-component geophone string. The 24-channel seismograph in use at Durham University would allow a string of eight such geophone units to be employed. This would necessitate further software development in order to implement elastic wave Generalised Kirchhoff migration. The consequential increase in computing costs would be offset by an improvement in imaging,

particularly as tube wave arrivals and other noise events should be more easily suppressed. Beattie's (1990) comparative study showed that tube waves are a bigger problem for geophones than for hydrophones. However, this might be overcome by modifying the geophone design. Also, with a string of downhole geophones, the top and bottom geophones might act as baffles, thus reducing the amplitudes of tube waves on the other geophones.

Borehole blockages restrict the coverage of sources and receivers, especially in those areas of particular interest where small faults and old mineworkings exist. This problem may best be solved by the use of a plastic casing along the full length of the borehole. Plastic is most suitable for ease of use and because the casing must be expendable since there is a high probability that the casing will become stuck in the borehole. However, it is also essential that the tubing is of sufficient strength to withstand borehole collapses and explosions from small seismic sources and also flexible enough to follow the curvature of the borehole.

The restriction in source and receiver coverage imposed by the depth of the water table might be removed by the development of a borehole "packer" which could block the borehole at a shallow depth and allow water to be poured in to fill the borehole.

Finally, more test surveys will be needed to evaluate the above suggestions and, in particular to obtain images of old mineworkings and small faults.

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#### Appendix A

#### Computer software

A number of computer programs were written during the course of this research. These include software for data-processing, migration and plotting.

The programs are all written in IBM-Fortran77 to run on the University of Durham Amdahl 470/V8 mainframe computer. Program listings are included in the following pages of this appendix. External subroutines used include the Culham Laboratory GHOST\*80 graphical subroutine library as well as a library of time series analysis subroutines (TSAR4\_L in user-identifier GLK4) taken from a variety of different sources. Michigan Terminal System (MTS) routines are used for handling data stored on magnetic tape.



## Appendix A.1

## Data processing software

The data processing program is menu driven with a main menu providing access to a series of submenus which carry out operations such as data input/output, data plotting, Fourier transforms, filtering, 2D Fourier transforms, waveshaping deconvolution, first break picking and direct arrival muting. Data may be plotted interactively on screen or sent to plotfiles.

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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        RECDEP (1) - TOPREC
                                                                                                                   CALL RDFILE (NSAMR, NCHR, NRECS, R4DAT, NFIRST, RECDEP, DBGAIN,
                                                                                                                                                                                                                                       CALL MENUIO (NSAMR, NCHR, NRECS, NSHOT, LEN, NFILES, NFILE, IPDISC,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CALL PSPACE (0.10, 0.9, 0.1, 0.75)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CALL PAPER(1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CALL JOSXFF(2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CALL J06XBF (0.0, 1.0, 0.0, 1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL JO6XAF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CALL MAP (0.0, 1.0, 0.0, 1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     WRITE (6,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE
                                                                                                                                                                                                                                                                                                                                                                                                                                CALL GREND
                                                                                                                                                                                                                                                                                                                                                                                                                                                       CALL JO6WZF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CALL JO6AHF ('XHR')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL J06XGF(1.0, 2.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE (6,*)'
                                             WRITE (6, *) NPROCS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IDPROC(1, NPROCS) = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      IF (I .EQ. NCR(2)) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             NFIRST(I) = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              NPROCS = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                END IF
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 GCMSCL(I) = 1.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        DBGAIN(I) = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   IDPROC(1, I) = 0
                                                                                        GCMSCL, NFILES, NFILE, NCR, NSHOT, DT, LEN, SORPOS, NPROCS,
                                                                    IDPROC, IPDISC, IPSOUR, INPOPT, INPCHN, A, PROC)
                                                                                                                                                                                                                IPSOUR, INPOPT, OPDISC, OPFORM, INPCHN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       (6, *)
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    RECDEP(I) = RECDEP(I - 1) + RECSEP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  RECDEP(I) = RECDEP(I -
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  NIMBUS TAPE DATA MANIPULATION PROGRAM'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                ****
                                                                                                                                                                                                                                                                                                                                                          ~ M J FINDLAY
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IF (IANSWR .EQ. 11) CALL PROCES (NPROCS, PROC)
IF (IANSWR .EQ. 12) CALL OPFIRS (NCHR, NFIRST, RECDEP, LEN, IPDISC)
                                                                                                                                           IF (IANSWR .EQ. 10) CALL MENUDS (NCHR, SORPOS, RECDEP, NCR, DT
                                                                                                                                                                                                                                   IF (IANSWR .EQ. 9) CALL MENUIO(NSAMR, NCHR, NRECS, NSHOT, LEN,
                                                                                                                                                                                                                                                                                           IF (IANSWR .EQ. 8) CALL WVSHAP (NSAMR, NCHR, R4DAT, NFIRST, NCR,
                                                                                                                                                                                                                                                                                                                        IF (IANSWR .EQ. 17) CALL GRAINT (NSAMR, NRECS, NSHOT)
                                                                                                                                                                                                                                                                                                                                                                                                               IF (IANSWR .EQ. 6) CALL MENUF(NSAMR, NCHR, R4DAT, DZ, DT, NCR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (IANSWR .EQ. 4) CALL MENUD(NSAMR, NCHR, R4DAT, NTRACE, DT,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (IANSWR .EQ. 3) CALL MENPL2(NSAMR, NRECS, R4DAT, NFIRST,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF (IANSWR .EQ. 3) WRITE (6,*)'NSAMR, NCHANS =', NSAMR, NRECS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   IF (IANSWR .EQ. 2) CALL WRFILA(NSAMR, NCHR, R4DAT, NFIRST, OPFORM,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE (6,*) NPROCS, A
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     WRITE (6,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE
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WRITE
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF (IANSWR .EQ. 5) CALL MENUE (NSAMR, NCHR, R4DAT, DT, FLOWCT,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (IANSWR .EQ. 1) CALL RDFILE(NSAMR, NCHR, NRECS, R4DAT, NFIRST,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IF (NPROCS .GT. 20 .OR. NPROCS .LT. 0) NPROCS = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         READ (5, *) IANSWR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    WRITE (6,*)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    WRITE
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                                                                                                                                                                                                                                                                                                                                                                                (IANSWR .EQ. 7) CALL GNCOMP (NSAMR, NCHR, R4DAT, NFIRST, DBGAIN,
(IANSWR .EQ. 0) CALL EXIT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       SORPOS, NPROCS, IDPROC, IPDISC, IPSOUR, INPOPT, INPCHN, A,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                        FHICUT, FLOOFF, FHIOFF, DBLOW, DBHIGH, FILTAP, BLHPAS,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     RECDEP, NCR, DT, LOCATE, DATE, DEVICE, SORTYP, SORLOC,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  OPDISC, NSHOT, LEN, LOCATE, DATE, DEVICE, SORTYP, SORLOC,
                                                                                     FILREC, TITLE, XLB, YLB)
                                                                                                              LOCATE, DATE, DEVICE, SORTYP, SORLOC, RECTYP, RECLOC, COMSHI,
                                                                                                                                                                               INPCHN)
                                                                                                                                                                                                      NFILES, NFILE, IPDISC, IPSOUR, INPOPT, OPDISC, OPFORM
                                                                                                                                                                                                                                                                                                                                                                                                                                                 LENFIL, NPROCS, IDPROC)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 XLB, YLB, SCAL, PROC)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           RECTYP, RECLOC, COMSHT, FILREC, NSHOT, NPROCS, IDPROC, TITLE,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DBGAIN, GCMSCL, NCR, NPROCS, IDPROC, DT, IOPCHN, PROC)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             RECTYP, RECLOC, COMSHT, FILREC, SORPOS, NRECS, RECDEP,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               RECDEP, DBGAIN, GCMSCL, NFILES, NFILE, NCR, NSHOT, DT, LEN,
                                                                                                                                                                                                                                                                                                                                                         GCMSCL, RECDEP, NCR, IDPROC, NPROCS)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       TITOFF, CHNSPL, POLART, VARARE, NPLFST, NPLLST, IOPT, SORPOS,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     (6, *)
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    Output first break times
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Plot contents of R4DAT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         Write contents of R4DAT to file
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          Read data from file(s)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           Adjust processing record
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       Adjust display parameters
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Adjust I/O parameters
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  First breaks, ramps, AGC, tapers etc '
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              F-K transform traces
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         FFT traces and plot spectra
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        Interactively interpolate saturations'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          Apply filters to traces
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   Menu for adjustment of I/O parameters
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE (6,40) OPDISC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       SUBROUTINE MENUIO (NSAMR, NCHR, NRECS, NSHOT, LEN, NFILES, NFILE,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DZ = ABS(RECDEP(2) - RECDEP(1))
IF (DZ .EQ. 0.0) DZ = 1.0
                                                                                                                                                                                                                                                                                                                                   READ (5, *) IANSWR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE (6,100) INPOPT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WRITE (6,90) NSHOT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE (6,80) NCHR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE (6,60)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           WRITE (6,30) IPDISC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               WRITE (6,20) IPSOUR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                WRITE (6,*)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  GO TO 70
                IF (IANSWR .EQ. 3) THEN
                                      END IF
                                                                                                                                     END IF
                                                                                                                                                                                                                                                                                              IF (IANSWR .EQ. 1) THEN
                                                                                                                                                                                                                                                                                                                                                                          WRITE (6,120)
                                                                                                                                                                                                                                                                                                                                                                                           END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IF (INPOPT .NE. 'NEW') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             LEN = (NSAMR + 2) * 4
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    WRITE (6,70) NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               WRITE (6,50) OPFORM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    WRITE (6,*)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CHARACTER IPDISC*17, OPDISC*17, OPFORM*6, IPSOUR*4, INPOPT*3
                                                                                                                   IF (IANSWR .EQ. 2) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            (4 bytes / sample)
                                                                        WRITE (6, *)'
                                                                                                                                                                                                                                                                                                                                                                                                                                  FORMAT (/'
                                                                                             WRITE (6, *)
                                                                                                                                                                                                                   ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,110) (NFILE(1), I=1, NFILES)
WRITE (6,*)
                                                      READ (5,130) IPDISC
                                                                                                                                                                                                                                                                         IF (IPSOUR .EQ. 'DISC') THEN
                                                                                                                                                                            INPCHN = 10
                                                                                                                                                                                               IPSOUR = 'DISC'
                                                                                                                                                                                                                                    INPCHN = 1
                                                                                                                                                                                                                                                       IPSOUR = 'TAPE'
                                                                                                                                                                                                                                                                                                                                                                                                                 12)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      IPDISC, IPSOUR, INPOPT, OPDISC, OPFORM, INPCHN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    14 SEG-Y output to tape
                                                                                                                                                                                                                                                                                                                                                     0 Return to MAIN MENU
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                7 Shot I.D. number
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           8 Input method
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      6 Number of channels
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                5 Record Length (samples)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          1 Input Source (Tape/Disc)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           4 Output Format
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       2 Input Disc Name
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                3 Output Disc Name
                                                                                                                                                                                                                                                                                                                                                                                                                                  9 I.D. nos. of files
                                                                            Input Disc name
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  I/O Setup Menu
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                :', I3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      :', I3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  :', I4)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           :', A6)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       :', A17
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            :', A4)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ٢
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                :', A17)
                                                                                                                                                                                                                                                                                                                                                                                                                                  :', 1X, I2, 1X,
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0 0
                                                                                                                                                                                                                                      150
                                                                                                                                                                                                                                                                                                                                                       140
Menu for adjustment of DISPLAY parameters
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IF (IANSWR .EQ. 4) THEN
                                                                          SUBROUTINE MENUDS (NRECS, SORDEP, RECDEP, NCR, DT, LOCATE, DATE,
                                                                                                                                                                          IF (INPOPT .NE. 'OLD') NFILES = 1
NRECS = NFILES * NCHR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              Ħ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IF (IANSWR .EQ. 5) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      END IF
                                                                                                                                      RETURN
                                                                                                                                                         IF (IANSWR .NE. 0) GO TO 10
                                                                                                                                                                                                                  END IF
                                                                                                                                                                                                                                                                                                                                                                        IF (IANSWR .EQ. 9 .AND. INPOPT .EQ. 'OLD') THEN
                                                                                                                                                                                                                                                                                                                                                                                              END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF (IANSWR .EQ. 7) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IF (IANSWR .EQ. 6) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IF (IANSWR .EQ. 14) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             (IANSWR .EQ. 8) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE (6,*)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE (6,*)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              READ (5,*) NSHOT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         OPFORM = 'SEG-Y'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               READ (5,130) OPDISC
                                                                                                                                                                                                                                 CONTINUE
                                                                                                                                                                                                                                                                                                                                   WRITE (6,*)'
READ (5,*) NFILES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (6,*)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          READ (5, *) NSAMR
                                                                                                                                                                                                                                                                                         DO 150 I = 1, NFILES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               READ (5,*) IREPLY
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     WRITE (6,*)' 2
WRITE (6,*)' 3
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            READ (5,*) NCHR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WRITE (6, *)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IF (OPFORM .EQ. 'DIRECT') THEN
                                                                                                                                                                                                                                                                                                             IF (NFILES .LT. 1 .OR. NFILES .GT. 2) GO
                                                                                                                                                                                                                                                                                                                                                                                                                 END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         ELSE IF (IREPLY .EQ. 2) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              IF (IREPLY .EQ. 1) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE (6,*)' 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   OPFORM = 'DIRECT'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      OPFORM = 'SEQUEN'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                     INPOPT = 'OLD'
                                                                                                                                                                                                                                                    READ (5, *) NFILE(I)
                                                                                                                                                                                                                                                                      WRITE (6,*)'I.D. File #', I, '
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               INPOPT = 'NEW'
                                                                                                                                                                                                                                                                                                                                                                                                                                   INPOPT = 'SGY'
                                      TITLE, XLB, YLB)
                                                       DEVICE, SORTYP, SORLOC, RECTYP, RECLOC, COMSHT, FILREC,
                                                                                                                                                                                                                                                                                                                                                      No. of files
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Shot I.D.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               Number of samples :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                Number of channels :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                Output Disc name
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     1 SEQUENTIAL SEG-Y TAPE FILE'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    2 SEQUENTIAL SEG-D TAPE FILES'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DIRECT ACCESS FILE '
                                                                                                                                                                                                                                                                                                                 TO 140
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WRITE (6,\*)'

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160 FORMAT (A20)
170 FORMAT (A32)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                     130 FORMAT (' 12 Analogue filters : '.
IF (NCR(1) .NE. 0) WRITE (6,140) NCR(1), NCR(2)
                                                                                                                                                                                                                                                                                                                                                                                                                 150 FORMAT ('
                                                                                                                                                                                                                                                                                                                                                                                                                                                       140 FORMAT (' 13 Common Receiver Channels
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    120 FORMAT ('
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           110 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   100 FORMAT ('
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            80 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       90 FORMAT ('
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   70 FORMAT ('
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         60 FORMAT ('
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              50 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     40 FORMAT ('
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           30 FORMAT ('
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  20 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              10 WRITE (6,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE (6,90) RECTYP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE (6,60) SORTYP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DIMENSION RECDEP (NRECS), NCR(2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               WRITE (6,130) FILREC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               WRITE (6,80) RECLOC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,50) SORLOC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (6,40) DEVICE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CHARACTER*20 FILREC CHARACTER*30 TITLE, XLB, YLB
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,120) DT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (6,100) RECDEP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (6,70) SORDEP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6,30) DATE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WRITE (6,20) LOCATE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    WRITE (6,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CHARACTER*20 LOCATE, DATE, DEVICE, SORTYP, SORLOC, RECTYP, RECLOC,
                                                                                                                                                                                                                                                                                                                                                                         READ (5,*) IANSWR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE (6,110) COMSHT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE (6,*)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE (6,*)'
                                                                                                                                                                                                                                     ELSE IF (IANSWR .EQ. 2) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE (6,150) TITLE, XLB, YLB
                                                                          ELSE IF (IANSWR .EQ. 4) THEN
                                                                                                                                                         ELSE IF (IANSWR .EQ. 3) THEN
                                                                                                                                                                                                                                                                                                                IF (IANSWR .EQ. 1) THEN
ELSE IF (IANSWR .EQ. 5)
                                   WRITE (6, *)' Source hole
                                                        WRITE (6,*)
                                                                                                                WRITE (6, *)' Seismograph
                                                                                                                                                                          READ (5,160) DATE
                                                                                                                                                                                              WRITE (6, *)' Date
                                                                                                                                                                                                                 WRITE (6, *)
                                                                                                                                                                                                                                                   READ (5,160) LOCATE
                                                                                             READ (5,160) DEVICE
                                                                                                                                      WRITE (6, *)
                                                                                                                                                                                                                                                                           WRITE (6, *)' Location
                                                                                                                                                                                                                                                                                               WRITE (6, *)
                  READ (5,160) SORLOC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                37X, 8F5.1)
                                                                                                                                                                                                                                                                                                                                                                                           A30/38X, A30)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              11 Sampling rate (microsecs)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      10 Common shot traces
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     8 Receiver type
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               9 Receiver depths (metres)
                                                                                                                                                                                                                                                                                                                                                                                                                 14 Plot-title and axes labels : ', A30/38X
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  6 Source depth (metres)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       5 Source type
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    3 Recording instrument
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           2 Acquisition date
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                4 Source hole I.D.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                1 Location
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              7 Receiver hole I.D
THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Display Setup Menu (0 to EXIT) '
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            ****** ***** ****
                                                                                                                   ٠.
                                       ٠.
                                                                                                                                                                                                ٠.
                                                                                                                                                                                                                                                                             ٠:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                : ', F5.1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                       : ', I2, 1X, I2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         : ', A20)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              : ', 8F5.1/37X, 8F5.1/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              : ', F4.1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  : ', A20)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       : ', A20)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   : ', A20)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     : ', A15)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    : ', A20)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          : ', A20)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             : ', A20]
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               : ', A20)
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0 0 0 0
                                                                                                                                                                                                                                                                                                                                                                       180
                                                                                                                       10 WRITE (6,*)
                                                                                                                                                                                                                          Subroutine to amend/update processing record
                                                                                                                                                                                                     (All proceesing info is stored in data header)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ELSE IF (IANSWR .EQ. 9) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ELSE IF (IANSWR .EQ. 7) THEN
                                                                                                                                                                                                                                                                                                                                                  END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ELSE IF (IANSWR .EQ. 13) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     ELSE IF (IANSWR .EQ. 12) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ELSE IF (IANSWR .EQ. 11) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   ELSE IF (IANSWR .EQ. 10) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ELSE IF (IANSWR .EQ. 8) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        ELSE IF (IANSWR .EQ. 6) THEN
                   WRITE
                                        WRITE
                                                        WRITE (6,*)
                                                                               WRITE
                                                                                                WRITE
                                                                                                                                            CHARACTER*25 PROCS (20)
                                                                                                                                                                SUBROUTINE PROCES (NPROCS, PROCS)
                                                                                                                                                                                                                                                                                                           RETURN
                                                                                                                                                                                                                                                                                                                             IF (IANSWR .NE.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ELSE IF (IANSWR .EQ. 14) THEN
 WRITE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE (6,*)' Rec depths
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             WRITE (6,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           WRI:E (6,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE (6,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               WRITE (6,*)' Source depth :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE (6,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            READ (5,*) DT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           WRITE (6, *)' Sampling rate (microsecs) :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE (6,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6,*)' Common shot traces :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE (6,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     READ (5, *) (RECDEP(I), I=1, NRECS)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  READ (5,160) RECTYP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE (6,*)' Receiver type:'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                READ (5,160) RECLOC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE (6, *)' Receiver hole:'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 READ (5, *) SORDEP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             READ (5,160) SORTYP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6, *)' Source type :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             READ (5,*) NCR(1), NCR(2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE (6,*)' Common receiver traces :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              READ (5,160) FILREC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WRITE (6,*)' Analogue filters
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         READ (5,160) COMSHT
                                                                                                                                                                                                                                                                                                                                                                     FORMAT (A30)
                                                                                                                                                                                                                                                                                                                                                                                         READ (5,180) XLB
READ (5,180) YLB
                                                                                                                                                                                                                                                                                                                                                                                                                                                     WRITE (6,*)' Enter title and axes labels : '
                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (6,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                 READ (5,180) TITLE
                                                                               (6, *);
                 (6, *)
(6, *)'
                                        (6,*)'
                                                                                                                                                                                                                                                                                                                              0)
GO
Display all process records '
                                      CLEAR all process records '
                                                                                                                                                                                                                                                                                                                                ō
                                                                                                    Process record editor'
                                                                                                                                                                                                                                                                                                                                10
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40
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  20
                 20 FORMAT ('
                                                                                                                                                                                10 WRITE (6,*)'
WRITE (6,*)'
                                                                                                                                                                                                                                                                                                                                                                                     SUBROUTINE TO WRITE OUT FIRST BREAK PICKS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     WRITE (6,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             WRITE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE
WRITE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ELSE IF (IANS .EQ. 2) THEN DO 30 II = 1, NPROCS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,*)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (6,*)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  ELSE IF (IANS .EQ. 4) THEN
WRITE (6,*)'Enter number of process record to ALTER :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      IF (IANS .EQ. 1) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                WRITE (6,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             WRITE (6,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE
                                                                                                                                                                                                                     OPNAME = '-OUT'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ELSE IF (IANS .EQ. 3) THEN WRITE (6,*)'Enter number of process record to display :'
                                                                                                                   WRITE (6,*)'
                                                                                                                                        WRITE (6,*)
                                                                                                                                                         WRITE (6,*)'
                                                                                                                                                                                                                                                             CHARACTER IPDISC*17, A*180, OPNAME*17, TITLE*60, B*480
                                                                                                                                                                                                                                                                                                       REAL RECDEP (NCHR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                 IF (IANS .NE. 0) GO TO 10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ELSE IF (IANS .EQ. 5) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             READ (5, *) IANS
                                        WRITE (6,20) OPNAME
                                                                            WRITE (6,*)'
                                                                                                 WRITE (6,*)
                                                                                                                                                                                                                                             XS = 0.0
                                                                                                                                                                                                                                                                                    INTEGER NCHR, NFIRST (NCHR), LEN, IDOP (60)
                                                                                                                                                                                                                                                                                                                            SUBROUTINE OPFIRS (NCHR, NFIRST, RECDEP, LEN, IPDISC)
                                                                                                                                                                                                                                                                                                                                                                                                                                                 RETURN
WRITE (6,*)
                                                           WRITE (6,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      DO 20 II = 1, 20
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       READ (5,50) PROCS (NPROCS)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE (6,*)'Enter text (<25 characters for record ', NPROCS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         FORMAT (A25)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE (6,40) NPR, PROCS(NPR) WRITE (6,*)'Enter text (<25 characters) to replace above :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   READ (5,*) NPR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                WRITE (6,40) NPR, PROCS(NPR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             FORMAT (/10X, I3, 4X, A25)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              NPROCS = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             NPROCS = NPROCS + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            READ (5,50) PROCS (NPR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     READ (5,*) NPR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  (6, *)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     (6, *)
*
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              (6, *)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,40) II, PROCS(II)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   PROCS(II) = ' '
                    ω
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           G
                                                                                N
                   OUTPUT FILENAME : ', A17)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     EXIT
                                                                                OUTPUT SELECTED RECORDS IN FILE
                                                                                                                      OUTPUT ALL RECORDS IN FILE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     Display particular process record '
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ADD new
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CHANGE particular process record '
                                                                                                                                                                                  FIRST BREAK OUTPUT MENU '
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           process record'
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 IF (IANS .EQ. 1 .OR. IANS .EQ. 2) THEN
WRITE (6,*)'Enter title (<60 characters) :'
READ (5,60) TITLE</pre>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ELSE IF (IANS .EQ. 3) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE (6,*)' 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ELSE IF (IANS .EQ. 2) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 IF (IANS .EQ. 1) THEN WRITE (6,*) 'Enter total number of records on disc :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            READ (5, *) IANS
END
                  RETURN
                                    IF (IANS .NE. 0) GO TO 10
                                                          END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE (6, *)'Enter total no. of records to be Output :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                  FORMAT (F5.1, 30X, F5.1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 FORMAT (A60)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             WRITE (6,*)'Enter XREC in metres :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    FORMAT (A17)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      READ (5,50) OPNAME
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6,*)'Enter name of new output file :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DO 30 II = 1, NOP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               READ (5, *) NOP
                                                                                                                                                                                                                                                                                                                                                           DO 100 II = 1, NOP
                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (18,70) RNOP, RNCHR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 OPEN (18, FILE=OPNAME, STATUS='UNKNOWN', FORM='FORMATTED')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   DO 40 II = 1, NOP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       READ (5,*) NOP
                                                                             CLOSE (10)
                                                                                                                                                                                                                                                                                                                                                                                 WRITE (18, *)'XSHOT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE (18, *)'No. of shots
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             WRITE (18,60) TITLE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         OPEN (10, FILE=IPDISC, STATUS='OLD', ACCESS='DIRECT', RECL=LEN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              RNCHR = REAL (NCHR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          READ (5,*) XR
                                                                                                     CLOSE (18)
                                                                                                                         CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  RNOP = REAL(NOP)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           WRITE (6,*)'Enter i.d. of record #', II, ' :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           READ (5,*) IDOP(II)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IDOP(II) = II
                                                                                                                                                                                                                                                                     READ (10, REC=IDCODE) A, SORPOS, NRECS, RECDEP, RECDEP, RECDEP, NFIRST, A(1:12), B, DT
DO 80 JJ = 1, NCHR
                                                                                                                                             WRITE (6,*)'Done for shot #', IDOP(II)
                                                                                                                                                                                                                                                                                                                                       IDCODE = (IDOP(II) - 1) * (NCHR + 1) + 1
                                                                                                                                                                   FORMAT (F5.1, F9.1, F11.2, F8.1, F14.8, I12)
                                                                                                                                                                                       CONTINUE
                                                                                                                                                                                                          NFIRST (JJ)
                                                                                                                                                                                                                              TT = NFIRST(JJ) * DT / 1E6
WRITE (18,90) XS, SORPOS, XR, RECDEP(JJ), TT,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                EXIT'
                                                                                                                                                                                                                                                                                                                                                                                 ZSHOT
                                                                                                                                                                                                                                                                                                                                                                                   XREC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                    No. of receivers
                                                                                                                                                                                                                                                                                                                                                                                   TTIME'
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110
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90 FORMAT (/'
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         70 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       60 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  50 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              40 FORMAT (/'
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  20 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           10 WRITE (6,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 Subroutine to plot FFT of individual traces in current array
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          Written by M J Findlay 1987-1989
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DIMENSION P(NL), Y(NL), S(NL), G(NL)
                                                                                                                                                                                                                                                                                                                                                                                               IF (IOPT .EQ. 0) RETURN
IF (IOPT .EQ. 1) THEN
WRITE (6,*)'Enter trace number
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE (6,80)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    WRITE (6,70)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6,60)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE (6,50)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     WRITE (6,40)
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE (6,20) NTRACE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE (6,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               WRITE (6,*)'
WRITE (6,*)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  NTRACE = 12
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CALL POWER2 (NSAMR, NSAMP2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             COMPLEX CSX(NL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CHARACTER*20 LOCATE, DATE, DEVICE, SORTYP, SORLOC, RECTYP, RECLOC,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CHARACTER TNAME*6, TITLE*32
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      DIMENSION R4DAT (NSAMR, NCHR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             PARAMETER (NL=2048)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             SUBROUTINE MENUD (NSAMR, NCHR, R4DAT, NTRACE, DT, NSHOT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                  READ (5, *) IOPT
                                                                                                                                                                                                                                                                                                            IF (IOPT .EQ. 2 .OR. IOPT .EQ. 3) THEN
                                                                                                                                                                                                                                                                                                                            IF (NTRACE .LT. 1 .OR. NTRACE .GT. NCHR) GO TO 10
                                        CALL FORK (NSAMP2, CSX, -1.0)
                                                               CALL TIME (KEY, NPR, IRES)
                                                                                                                                NPR = 0
                                                                                                                                                                            CONTINUE
                                                                                                                                                                                                                      DO 110 I = NSAMR + 1, NSAMP2
                                                                                                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                     DO 100 I = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                            READ (5, *) NTRACE
                   KEY = 15
                                                                                      IRES2 = 0
                                                                                                             IRES1 = 0
                                                                                                                                                     KEY = 0
NPR = 0
                                                                                                                                                                                                 CSX(I) = 0.0
                                                                                                                                                                                                                                                                CSX(I) = CMPLX(R4DAT(I,NTRACE),0.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                w
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                COMSHT, FILREC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   7 Cross correlate to find optimum lag ')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         0
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        2 Amplitude and phase spectra ')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    1 Trace number
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             Put Autocorrelograms of traces into R4dat')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       Return to MAIN MENU
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       FFT ALL traces OP to R4dat ')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   Power spectrum
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            Amplitude spectrum only
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Trace Spectral Plot Menu
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Further subroutines for XHR programs

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 190
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IF (IOPT .EQ. 4) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   IF (IOPT .EQ. 5) THEN DO 180 JJ = 1, NCHR
                                                                                                                                                                                                      IF (IOPT .EQ. 6) THEN
                                                                                                                                                                                                                              END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IRES1 = 0
IRES2 = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 130 I = NSAMR + 1, NSAMP2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      DO 120 I = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                THAME = 'SWT014'
TITLE = LOCATE // DATE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CALL TIME (KEY, NPR, IRES1, IRES2)
                                                                                                                                                                             WRITE (6,*)'Enter no. of lags to be calculated
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL GREND
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  PRINT *, 'FMIN, FMAX, PMIN, PMAX', FMIN, FMAX, PMIN, PMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL MINSN(NSAMP2/2 + 1, P, PMIN, II)
CALL MAXSN(NSAMP2/2 + 1, P, PMAX, II)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       FMAX = 0.5E6 / DT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CALL SPECPL (NSAMP2, CSX, DT, TITLE, TNAME, NSHOT, NTRACE, IDSH,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   IDSH = 473
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         PRINT *, 'FFT TIME IN MICROSECS =', IRES1, IRES2
                                                                                                                DO 200 JJ = 1, NCHR
                                                                                                                                     NORM = 1
                                                                                                                                                         READ (5, *) NLAGS
                                                                                                                                                                                                                                                 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CALL PTJOIN(Y, P, 1, NSAMP2/2 + 1, 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 140 I = 1, NSAMP2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    DF = 2.0 * FMAX / REAL(NSAMP2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CALL BORDER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL SCALES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CALL MAP (FMIN, FMAX, PMIN, PMAX)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CALL PSPACE(0.1, 0.9, 0.1, 0.9)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CALL PAPER(1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               FMIN = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL POWERS (G, P, NSAMP2, Y, S)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IDRH = 475
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  G(I) = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               G(I) = R4DAT(I,NTRACE)
                                                                                    CALL ACF (R4DAT(1, JJ), S, NSAMR, NLAGS, NORM, 12ZC)
                                                                                                                                                                                                                                                                         CONTINUE
                                                                                                                                                                                                                                                                                                                      DO 170 \text{ II} = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                  CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                             DO 160 II = NSAMR + 1, NSAMP2
                                                                                                                                                                                                                                                                                                                                                                                                                                    CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DO 150 \text{ II} = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         Y(I) = REAL(I - 1) * DF
CONTINUE
                                           DO 190 II = 1, NLAGS
                                                                CALL ZERO (NSAMR, R4DAT(1, JJ))
                                                                                                                                                                                                                                                                                                                                          CALL FORK (NSAMP2, CSX, -1.0)
                     R4DAT(II,JJ) = S(II)
                                                                                                                                                                                                                                                                                             R4DAT(II, JJ) = CABS(CSX(II))
                                                                                                                                                                                                                                                                                                                                                                                     CSX(II) = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                          CSX(II) = CMPLX(R4DAT(II, JJ), 0.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IDRH)
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                                                                                                                                                                                                                                                                                  10 WRITE (6,*)'
WRITE (6,*)'
                          50 FORMAT (/'
                                                                              40 FORMAT (/'
                                                                                                                                 30 FORMAT (/'
                                                                                                                                                                                20 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              data
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                Subroutine to apply High pass, Low pass, and Band pass filters to
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 And Median filter
                                                                                                                                                                                                                                   WRITE (6, *)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IF (IOPT .EQ. 7) THEN
                                                                                                                                                     WRITE (6,30) FHICUT
                                                                                                                                                                                                                                                              WRITE (6,*)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                    BLHPAS = 'Band pass'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CALL POWER2 (NSAMR, NSAMP2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        REAL S(NL1), Y(NL1), FL, FH, R(NL2), G(NL2), A(NL2), F(NL2),
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   DIMENSION R4DAT (NSAMR, NCHR), IDPROC(5, NCHR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              PARAMETER (NL1=2048, NL2=128, N1=2048, N2=65)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    SUBROUTINE MENUE (NSAMR, NCHR, R4DAT, DT, FLOWCT, FHICUT, FLOOFF,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IF (IOPT .NE. 0) GO TO 10
WRITE (6,60) DBLOW
                                                     WRITE (6,50) FHIOFF
                                                                                                      WRITE (6,40) FLOOFF
                                                                                                                                                                                                             WRITE (6,20) FLOWCT
                                                                                                                                                                                                                                                                                                                                       DBHIGH = 6.0
                                                                                                                                                                                                                                                                                                                                                                  DBLOW = 6.0
                                                                                                                                                                                                                                                                                                                                                                                           FHIOFF = FNYQ
                                                                                                                                                                                                                                                                                                                                                                                                                     FLCOFF = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                              FNYQ = .5E6 / DT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 FILTAP = 'Cosine'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          NRECS = NCHR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CHARACTER FILTAP*9, BLHPAS*9, ANS*1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      COMPLEX CX (NL1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            REAL DUM(NL1), DUM1(NL1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL MAXSN(LG, G, GMAX, II)
CALL CROSS(NSAMR, R4DAT(1, ID2), NSAMR, R4DAT(1, ID1), LG,
CALL MAXSN(LG, G, GMAXI, III)
WRITE (6,*)'OPTIMUM LAG = ', GMAX, ' AT ', II - 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE (7,*)'LAG implies should increase time on 2nd trace.'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             WRITE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CALL CROSS (NSAMR, R4DAT (1, ID1), NSAMR, R4DAT (1, ID2), LG,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          READ (5,*) ID1, ID2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                WRITE (6, *)'ENTER TRACE NUMBERS TO COMPARE :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         READ (5,*) LG
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WRITE (6, *)'ENTER NO. OF LAGS TO BE CALCULATED :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       C(NL1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     (6,*)'LAG implies should increase time on 2nd trace.'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                (7,*) 'OPTIMUM LEAD = ', GMAX1, ' AT ', II1 - 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           (7, *)'OPTIMUM LAG = ', GMAX, ' AT ', II - 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   (7,*)'SHOT NO. :', NSHOT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     (6,*)'OPTIMUM LEAD = ', GMAX1, ' AT ', II1 - 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          FHIOFF, DBLOW, DBHIGH, FILTAP, BLHPAS, LENFIL, NPROCS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      IDPROC)
                        4 Cosine High reject freq (Hz):', F6.1)
                                                                                                                                                                                1 Low cut frequency (Hz)
                                                                                                                            2 High cut frequency (Hz)
                                                                           3 Cosine low reject freq (Hz) :', F6.1)
                                                                                                                                                                                                                                                                *****
                                                                                                                                                                                                                                                                                    Filter Menu
                                                                                                                            :', F6.1)
                                                                                                                                                                                :', F6.1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              9
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             <u>0</u>
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200

CONTINUE

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140
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               110 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         100 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   120 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   90 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  80 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          60 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              70 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6,70) DBHIGH
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,110)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               WRITE (6,100)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           WRITE (6,130)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE (6, 120)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE (6,90)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE (6,80) FILTAP, BLHPAS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  ELSE IF (IANSWR .EQ. 2) THEN
                        ELSE IF (IANSWR .EQ. 8) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      ELSE IF (IANSWR .EQ. 7) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         ELSE IF (IANSWR .EQ. 6) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ELSE IF (IANSWR .EQ. 5) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                READ (5,*) IANSWR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ELSE IF (IANSWR .EQ. 4) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ELSE IF (IANSWR .EQ. 3) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IF (IANSWR .EQ. 1) THEN
                                                                                                                                                                                                                                                                                                                                                                       WRITE (6,*)'Select pass function (Low / High / Band)
                                                                                                                                                                                                                                                                                                                                                                                                     END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IF (ANS .EQ. 'C' .OR. ANS .EQ. 'c') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6,*)'Select taper function (Cosine or Db/octave) :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WRITE (6,*)'Enter High cutoff slope (dB/Octave) :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 READ (5, *) DBLOW
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE (6,*)'Enter Low reject frequency (Hz) :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          READ (5,*) FHICUT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6,*)'Enter High cutoff frequency (Hz) :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            READ (5,*) FLOWCT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE (6,*)'Enter Low cutoff frequency (Hz) :'
DO 180 J = 1, NCHR
                                                END IF
                                                                                                                                                                                                                                                                                                                           IF (ANS .EQ. 'L' .OR. ANS .EQ. '1') THEN
                                                                                                                                                                                                                                                                                                                                                     READ (5, 140) ANS
                                                                                                                                                                                                                                                                                                                                                                                                                                                  ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  FORMAT (A1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              READ (5, *) DBHIGH
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     WRITE (6,*)'Enter Low cutoff slope (dB/Octave) :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   READ (5, *) FHIOFF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE (6,*)'Enter High reject frequency (Hz) :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     READ (5, *) FLOOFF
                                                                                              ELSE
                                                                                                                                                                                                               ELSE IF (ANS .EQ. 'H'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        READ (5,140) ANS
                                                                                                                                                                                                                                                           FLOOFF = 0.0
DBLOW = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                          FILTAP = 'dB/Octave'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                        FILTAP = 'Cosine'
                                                                      BLHPAS = 'Band pass'
                                                                                                                  BLHPAS = 'High pass'
                                                                                                                                          DBHIGH = 0.0
                                                                                                                                                                FHIOFF = FNYQ
                                                                                                                                                                                    FHICUT = FNYQ
                                                                                                                                                                                                                                   BLHPAS = 'Low pass'
                                                                                                                                                                                                                                                                                                       FLOWCT = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   Ľ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     0 Return to MAIN MENU
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 8 Apply BANDPASS filter
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       9 Apply MEDIAN filter
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          6 High dB/Octave slope
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        5 Low dB/Octave slope
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                7 Filter type
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   APPL NEWMAN FILTER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           Apply spiking decon
                                                                                                                                                                                                               .OR. ANS .EQ. 'h') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          :', F6.1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        :', F6.1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                :', 1x, A9,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ٢
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     ٢
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              170
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    150
200
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ELSE IF (IANSWR .EQ. 9) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                            ELSE IF (IANSWR .EQ. 10) THEN
                                                                                                                                                                                                          WRITE (6,*)'WRITE FILTER TO ARRAY R4DAT 1=Y 0=APPLY FILTER ?'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (6,*)'Enter length of median filter (traces) :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,*)'NPROCS = ', NPROCS IF (FILTAP .EQ. 'Cosine') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CONTINUE
                                                                                                                                                                                                                                                                                                                     WRITE (6,*)'Enter filter length in samples :'
                                                                                                                                                                                                                                                                                                                                                                          WRITE (6,*)'Enter %ge white noise to add :'
                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE (6,*)'Apply triangular weighting to ACF (1=y 0=n) :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        PRINT *, NFIRST
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       NPROCS = NPROCS + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CALL MEDFIL (NSAMR, NCHR, R4DAT, NFIRST, LENFIL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     PRINT *, NFIRST
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   READ (5,*) LENFIL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           NPROCS = NPROCS + 1
                                                                                                                                                           DO 230 JJ = 1, NCHR
                                                                                                                                                                                       READ (5, *) IRESP
                                                                                                                                                                                                                                          READ (5, *) MM
                                                                                                                                                                                                                                                                    WRITE (6, *) 'Enter prediction distance in samples :'
                                                                                                                                                                                                                                                                                                READ (5, *) LF
                                                                                                                                                                                                                                                                                                                                                   READ (5, *) RFC
                                                                                                                                                                                                                                                                                                                                                                                                         READ (5, *) IFJ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IDPROC(2, NPROCS) = LENFIL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IDPROC(1, NPROCS) = 8
                                                                                                                             DO 190 I = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE (6,*)'FILTERING CHANNEL #', J
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CONTINUE
CONTINUE
                                                   DO 200 I = NSAMR + 1, NSAMP2
                                                                               CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      IDPROC(4, NPROCS) = NINT(FHICUT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IDPROC(5, NPROCS) = NINT(FHIOFF)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IDPROC(3, NPROCS) = NINT(FLOWCT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 170 I = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        DO 160 I = NSAMR + 1, NSAMP2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IDPROC(5, NPROCS) = NINT(DBHIGH)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IDPROC(3, NPROCS) = NINT(DBLOW)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IDPROC(2, NPROCS) = NINT(FLOWCT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IDPROC(1, NPROCS) = 11
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IDPROC(4, NPROCS) = NINT(FHICUT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IDPROC(2, NPROCS) = NINT(FLOOFF)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              IDPROC(1, NPROCS) = 4
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IF (FILTAP .EQ. 'Cosine') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     R4DAT(I,J) = DUM(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DUM(I) = R4DAT(I,J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CALL BPSDBS (DUM, NSAMP2, CX, FLOWCT, FHICUT, DBLOW, DBHIGH
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CALL BPSCOS (DUM, NSAMP2, CX, FLOWCT, FHICUT, FLOOFF, FHIOFF,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   DUM(I) = 0.0
                       DUM1(I) = 0.0
                                                                                                      DUM1(I) = R4DAT(I, JJ)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    FNYQ)
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DO 150 I = 1, NSAMR

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                                                                                                                                                                                                                                                                                                                                                                                   260
270
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           250
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              240
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  210
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 230
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              220
                                                                                                                                                                                                         Subroutine to obtain F-K spectrum of recorded data
                                                                                                  COMPLEX CP (N4, N2), CW (N2), CTEMP
                                                                                                                      CHARACTER ANS*1, LOGYN*1, ANSWER*1, FNAME*10
                                                                                                                                                                                                                                                 SUBROUTINE MENUF (NSAM, NCHR, R4DAT, DZ, DT, NCR)
                                                                                                                                                                                                                                                                                                                                                             END IF
                                    DOUBLE PRECISION HF, ZBASE, ZMIN, ZMAX, RWS(N3)
                                                          DOUBLE PRECISION AMPSPC(N5,N1), TEMP, CHTS(8), DBCHTS(8), XM
                                                                              REAL KNYQ, FILSPC(N1, N5)
                                                                                                                                              DIMENSION R4DAT (NSAM, NCHR), NCR(2)
                                                                                                                                                                                                                                                                                                                     RETURN
                                                                                                                                                                                                                                                                                                                                         IF (IANSWR .NE. 0) GO TO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   IF (IANSWR .EQ. 11) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             END IF
CALL POWER2 (NSAM, NSAMR)
                                                                                                                                                                  PARAMETER (N1=513, N2=64, N3=5120, N4=1024, N5=65)
                    LOGICAL SOLID
                                                                                                                                                                                                                                                                                                                                                                                   CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 270 J = 1, NCHR
                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 260 I = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 240 I = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ELSE
                                                                                                                                                                                                                                                                                                                                                                                                         CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DO 250 I = 2, NSAMR / 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CX(NSAMR/2 + 1) = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CX(1) = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CALL FORK (NSAMR, CX, -1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CALL ZERO(NLC, CX)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               NLC = 2 * NL1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL FORK (NSAMR, CX, +1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 IF (IRESP .EQ. 1) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CALL PDECON (NSAMP2, DUM1, M, LF, R,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IF (M .GT. LF) GO TO 230
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF (MM .EQ. 0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   3
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        M = 122C
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CX(I) = CMPLX(R4DAT(I, J), 0.0)
                                                                                                                                                                                                                                                                                                                                                                                                                         R4DAT(I, J) = REAL(CX(I))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CX(I) = CX(I) * (1.,1.)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CX(I) = CX(I) * SQRT(REAL(I - 1))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DO 220 I = 1, LF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DO 210 I = 1, LF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL ACF (DUM1, A, NSAMR, 100, 1, 12ZC)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CX(NSAMR + 2 - I) = CONJG(CX(I))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CALL FRECON (NSAMP2, DUM1, DUM, C,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CALL ZERO(NSAMR, R4DAT(1, JJ))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CALL ZERO(NSAMR, C)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                C(I) = F(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     R4DAT(I,JJ) = F(I)
                                                                                                                                                                                                                                                                                                                                         10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     ့
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0 0 0
                                                                           130
                                                                                                                                                                                                                                                                120
                                                                                                                                                                                                                                                                                                                                                                                                          WRITE (6,100)
100 FORMAT (/' 9 Isometric projection plot of spectrum')
                                                                                                                                                                                                                                                                                                                                                                            110 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    80 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                   90 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    50 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                60 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     40 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     10 WRITE (6,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             70 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            30 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               20 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    DBCHTS(1) = 0.01
DBCHTS(2) = 3.0
DBCHTS(3) = 6.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WRITE (6,90) (DBCHTS(I), I=1, NCHTDB)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             WRITE (6,70) (CHTS(I), I=1, NCHTS)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6,20)
                                                                                                                                                                                                                                                                                                                   IF (IANSWR .EQ. 1) THEN
                                                                                                                                                                                                                                                                                                                                                                                             WRITE (6,110)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           WRITE (6,80)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,60)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE (6,50)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE (6,40)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE (6,30)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,*)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     WRITE (6,*)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     PRINT *, 'KNYQ = ', KNYQ, ' FNYQ = ', FNYQ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            FNYQ = .5E6 / DT
KNYQ = .5 / DZ
                                                                                                                                                                                                                                                                                                                                       IF (IANSWR .EQ. 0) RETURN
                                                                                                                                                                                                                                                                                                                                                          READ (5,*) IANSWR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          ISAMP = NINT(FNYQ*2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               NF = N1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  NCHTDB = 5
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      NCHTS = 4
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    DBCHTS(5) = 40.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      DBCHTS(4) = 20.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CHTS(4) = 150.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CHTS(3) = 100.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CHTS(2) = 50.0
                                   SWAP AROUND TWO UPPER QUADRANTS
                                                                                                                                                                                                                                                                             READ (5,120) ANS
                                                                                                                                                                                                                       KCEN = N2 / 2 + 1
                                                                                                                                                                                                                                                                FORMAT (A1)
                                                                                                                                                                                                                                                                                                WRITE (6,*)'To or From F-K space
                                                                                                                                                                                                       IF (ANS .EQ. 'F' .OR. ANS .EQ. 'f') THEN
                                                                                                                                                                                                                                            NCEN = NSAMR / 2 + 1
                                                                                                                                               DO 130 J = 1, N2
                                                                                                                                                                     SIGNB = +1.0
                                                                                                                                                                                       SIGNA = +1.0
DO 150 J = 1, N2 / 2 - 1
                                                                                                           CP (NCEN, J) = CONJG (CP (1, J))
DO 130 I = 1, NSAMR / 2 - 1
                                                                                          CP(NCEN + I, J) = CONJG(CP(NCEN - I, J))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           5 Plot F-K amplitude spectrum ')
                                                                                                                                                                                                                                                                                                                                                                          0 Return to MAIN MENU
                                                                                                                                                                                                                                                                                                                                                                                                                                              8 dB contours for F-K spectrum : ', 8(F4.0,1X))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   7 dB plot of F-K amplitude spectrum ')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               4 Apply filters to array contents')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        6 Contours for F-K spectrum : ', 8(F4.0,1X))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     3 Input complex array from file')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            N
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Output complex array to file ')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              Calculate 2DFFT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   F-K Spectra Menu
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     ****** ****
                                                                                                                                                                                                                                                                                                  (T/F)
              220
                                                                                                                                                                                                                                                                                                                                                                                                                            200
210
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  170
180
190
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              160
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   140
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C Remove common receiver channel
                                                                                                                                                                                                                                                                                                                                                              IRES1 = 0
IRES2 = 0
                                          CALL TIME(KEY, NPR, IRES1)
PRINT *, 'FFT TIME IN MILLISECS =', IRES1
IF (ANS .EQ. 'f' .OR. ANS .EQ. 'f') THEN
                                                                                                                                                                                                                                                                                                              CALL FT2D (N4, N2, CP, SIGNA, SIGNB, CW)
                                                                                                                                        NPR = 0
                                                                                                                                                           KEY = 1
                                                                                                                                                                             PRINT *, 'FFT TIME IN MICROSECS =', IRES1, IRES2
                                                                                                                                                                                                      CALL TIME (KEY, NPR, IRES1, IRES2)
                                                                                                                                                                                                                                                 IRES1 = 0
                                                                                                                                                                                                                                                                           NPR = 0
                                                                                                                                                                                                                                                                                            KEY = 15
                                                                                                                                                                                                                                                                                                                                           CALL TIME (KEY, NPR, IRES)
                                                                                                                                                                                                                                                                                                                                                                                                             NPR = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                    KEY = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                      END IF
                                                                                                                                                                                                                              IRES2 = 0
                                                                                                                 IRES1 = 0
DO 230 J = 1, NCHR
                     PRINT *, 'WRITING CP TO R4DAT'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                               END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              SIGNB = -1.0
NZERO = N2 * N4 * 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IF (NCR(1) .NE. 0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  FORMAT (4(I4,1X,F7.3,1X,F7.3))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 180 J = 1, NCHR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CALL ZERO(NZERO, CP(1,1))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               READ (5, 160) ANSWER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WRITE (6,*)'RESPONSE OF FILTER REQUIRED ?'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         SIGNA = -1.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IF (ANSWER .EQ. 'Y' .OR. ANSWER .EQ. 'y') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        FORMAT (A1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DO 170 I = 1, NSAM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         PRINT *, 'Enter common receiver channel to be ignored :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    R4DAT(512,12) = 1.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CALL ZERO(NCP, R4DAT(1,1))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DO 210 J = NCRIGN, NCHR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     READ (5,*) NCRIGN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             NCP - NSAM * NCHR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       DO 140 I - NCEN + 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              IF (NCRIGN .EQ. 0) GO TO 210
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   DO 200 II = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CP(I,J) = CMPLX(R4DAT(I,J),0.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CP(I, KCEN + J) = CP(I, KCEN - CP(I, KCEN - J) = CTEMP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CTEMP = CP(I, J + KCEN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CP(II,J) = CP(II,J+1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ج
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        240
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      APPLY FILTER FILSPC
                                                                                                                                                                                                                                                                                                                                                                                          rearrange array so that K=0 axis lies at sample N2/2+1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      PUT filter response into array FILSPC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ELSE IF (IANSWR .EQ. 2)
                                                                                    ELSE IF (IANSWR .EQ. 5 .OR. IANSWR .EQ. 7 .OR. IANSWR .EQ. 9)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 ELSE IF (IANSWR . EQ. 4) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DO 300 J = 1, N2
                                                                                                                                                                                                                                      CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       DO 270 I = 1, N2 / 2
                                         PRINT *, 'SELECT MAX FREQY FOR PLOT '
                                                                                                     CLOSE (4)
                                                                                                                                                OPEN (4, FILE=FNAME, STATUS='NEW', FORM='UNFORMATTED')
                                                                                                                                                                        FORMAT (A10)
                                                                                                                                                                                                                                                                                                                                             DO 310 I = 1, N2 / 2
                                                                                                                                                                                                                                                                                                                                                                                                                                       CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DO 290 I = N2 / 2 + 1,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CALL PIE (NK, NF, FILSPC, DK, DF, ANS)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     READ (5,160) ANS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    WRITE (6,*)'PASS or REJECT filter (P/R)?'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           PRINT *, 'NF, NK, DK, DF', NF, NK, DK, DF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DF = 2 * FNYQ / NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        DK = 2 * KNYQ / N2
                  READ (5, *) FMAX
                                                                                                                             WRITE (4) ((REAL(AMPSPC(J, I)), J=1, N2), I=1, NF)
                                                                                                                                                                                             READ (5, 320) FNAME
                                                                                                                                                                                                                 WRITE (6, *)'Enter name of file to write to :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IF (ANS .EQ. 'R') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            NK = N2 + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               NF = NSAMR / 2 + 1
                                                                                                                                                                                                                                                                                                                            DO 310 J = 1, NF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DO 300 I = 1, NF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 280 J = 1, NF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      DO 260 J = 1, NF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DO 250 I = 1, N2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CP(J,I) = CP(J,I) * FILSPC(J,I - N2/2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CP(J,I) = CP(J,I) * FILSPC(J,I + N2/2)
                                                                                                                                                                                                                                                          AMPSPC(I + N2/2, J) = TEMP
                                                                                                                                                                                                                                                                                                                                                                                                                                                         AMPSPC(J,I) = DBLE(CABS(CP(I,J)))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 240 J = 1, NF
                                                                                                                                                                                                                                                                                 AMPSPC(I,J) = AMPSPC(I + N2/2,J)
                                                                                                                                                                                                                                                                                                     TEMP = AMPSPC(I, J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           FILSPC(J,I) = 1.0 -
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           FILSPC(J,I)
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CONTINUE

R4DAT(I,J) = REAL(CP(I,J))

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                                                                                                                                                                                                                                    Now call plotting routine
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Now rearrange K space so that 0.0,0.0 is in centre of K axis
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        write amplitude spectrum to correctly orientated array AMPSPC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   DO 340 J = 1, N2
                                      ELSE
                                                                                           ELSE IF (IANSWR .EQ. 5) THEN
                                                                                                                                                                                                                                                                             CONTINUE
                                                                                                                                                                                                                                                                                                                DO 410 J = 1, NF
                                                                                                                                                                                                                                                                                                                                     CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                    DO 400 I = 1, N2 / 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                         NK = N2 + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IF (IANSWR .EQ. 7 .OR. ISOLOG .EQ. 1) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IF (IANSWR .EQ. 9) THEN
                                                                                                                                                                            IF (IANSWR .EQ. 7) THEN
                                                                                                                                                                                               LOGYN = 'N'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             NF = NSAMR / 2 + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         0 = 50TOS1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 XM = 0.0D0
DO 360 J = 1, NF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CONTINUE
                                                       CALL FKPLOT (NK, NF, AMPSPC, DT,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 380 I = 1, NF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  PRINT *, 'MAX AMPLITUDE = ',
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IF (ANS .EQ. 'Y' .OR. ANS .EQ. 'y') ISOLOG = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                READ (5,120) ANS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               WRITE (6,*)'Log plot required (Y/N) ?'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DO 330 I = 1, NF
CALL JOGWAF
                    CALL PAPER(1)
                                                                             LOGYN = 'N'
                                                                                                                                     CALL FKPLOT(NK, NF, AMPSPC,
                                                                                                                                                                                                                                                                                              AMPSPC(NK, J) = AMPSPC(1, J)
                                                                                                                                                                                                                                                                                                                                                       CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                   DO 390 J = 1, NF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CONTINUE
                                                                                                                                                          LOGYN = 'Y'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 350 I = 1, N2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               AMPSPC(J,I) = DBLE(CABS(CP(I,J)))
                                                                                                                                                                                                                                                                                                                                                                            AMPSPC(I + N2/2, J) = TEMP
                                                                                                                                                                                                                                                                                                                                                                                             AMPSPC(I, J) = AMPSPC(I + N2/2, J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DO 370 J = 1, N2
                                                                                                                                                                                                                                                                                                                                                                                                                 TEMP = AMPSPC(I, J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IF (AMPSPC(I,J) .GT. XM) XM = AMPSPC(I,J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IF (AMPSPC(J, I) .LE. 1.0D-8) THEN
                                                                                                                    TOGAN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         AMPSPC(J,I) = 1000.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    AMPSPC(J,I) = -20 * LOG10(AMPSPC(J,I)/XM)
                                                                                                                                     DT,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     ž
                                                       DZ, FMAX, NCHTS, CHTS, LOGYN)
                                                                                                                                    DZ, FMAX, NCHTDB, DBCHTS,
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                                                                                                                                                                                                                                                                                                                                                            Routine to apply waveshaping filters to dataset.
                                                                                                                                                                                                                                                                                                                                         Version 1.0; Version 2.0 is MUCH better (in XHR.2_U)
                       DEFAULTS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        ELSE IF (IANSWR .EQ. 8) THEN
PRINT *, ' No. of contours required (<=8)
                                                                                                                                                                                                                 REAL C(NS2), ER(NS3), REF(NS1), XPOSNS(NS3), DSERIS(NS1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      ELSE IF (IANSWR .EQ. 6) THEN
                                                                                                                      CHARACTER WEIGHT*3, ANS*1, REPLY*3
                                                                                                                                                                                              REAL BSERIS (NS1)
                                                                                                                                                                                                                                      REAL S1 (NS1), S2 (NS1), S3 (NS1), A(NS1, 3), B(NS1), RDAT (NS1)
                                                                                                                                                                                                                                                                 DIMENSION R4DAT (NSAMR, NCHR), NFIRST (NCHR), NCR (2)
                                                                                                                                                                                                                                                                                        PARAMETER (NS1=1024, NS2=2048, NS3=512)
                                                                                                                                                                                                                                                                                                                                                                                                                 SUBROUTINE WVSHAP (NSAMR, NCHR, R4DAT, NFIRST, NCR, DT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                END IF
                                                                     CALL POWERS (NSAMR, NSAMP2)
                                                                                            LOGICAL FILTER
                                                                                                                                           INTEGER NOPT (6)
                                                                                                                                                                    COMPLEX CMPB(NS1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF (IANSWR .NE. 0) GO TO 10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       DO 420 J = 1, NCHTS
WRITE (6,*)' Contour level', J,':'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            PRINT *, ' No. of contours required (<=8)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DO 430 J = 1, NCHTDB
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   READ (5, *) NCHTDB
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         READ (5, *) NCHTS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CALL JOGWZF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CALL JO6HBF (AMPSPC, NK, NFMAX, NK, HF, IROT, SOLID, IBASE,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    NEMAX - NINT(FMAX*2.0E-6*DT*NF)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           READ (5, *) DBCHTS(J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    WRITE (6,*)' Contour level', J, ':'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                READ (5, *) CHTS(J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          NRWS = 5 * NFMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 PRINT *, 'NFMAX =', NFMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  ZMAX = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ZMIN = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                JSECT = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        ZBASE = 0.0D0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    SOLID = .TRUE.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           HF = 1.0D0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CALL J06AHF ('FK Amplitude Spectrum ')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CALL J06WCF(0.0, 1.0, 0.0, 1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IBASE = +1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IFAIL = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IROT = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            ZBASE, JSECT, ZMIN, ZMAX, RWS, NRWS, IFAIL)
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CALL J06WBF(0.0, 1.0, 0.0, 1.0, 1)

NFILTS = 1

LA = 64

FILTER = .FALSE.

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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               80 FORMAT (/' 7
WRITE (6,90)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    60 FORMAT (/' 5
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                50 FORMAT (/' 4
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   40 FORMAT (/' 3
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               30 FORMAT (/' 2 No. of filters to be calculated (1-3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       20 FORMAT (/' 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               90 FORMAT (/' 8
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               70 FORMAT (/' 6
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                10 WRITE (6,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IDD = NCR(1)

IDB = NCR(2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6,70)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    WRITE (6,50) NL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6,40) LA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     WRITE (6,30) NFILTS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WRITE (6,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    WEIGHT = 'NO'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE (6,80) WEIGHT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE (6,60) LAG1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               WRITE (6,20) IDD, IDB
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE (6,*)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             WRITE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          REPLY = 'YES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               RFC = 0.01
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 LAG1 = -2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IF (FILTER) THEN
                                                                                                                                                                                                                                                                                                                                                          ELSE IF (IANS .EQ. 2) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE (6,100) REPLY
                                                                                                                                             ELSE IF (IANS .EQ. 5) THEN WRITE (6, *)'First lag for waveshaping
                                                                                                                                                                                                                                                                       ELSE IF (IANS .EQ. 3) THEN
WRITE (6,*)'Length of first filter required
                                                                                                                                                                                                                                                                                                                                                                                                                          IF (IANS .EQ. 1) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                    END IF
                                    ELSE IF (IANS .EQ. 7) THEN
                                                                                                                                                                                                                                 ELSE IF (IANS .EQ. 4) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                              READ (5,*) IANS
                                                                                                      ELSE IF (IANS .EQ. 6) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (6,110)
FORMAT (/' 10 Apply filter to alternate traces
                                                                                                                                                                                                                                                                                                                                                                                                  WRITE (6, *)'Nos. of channels for shaping (Reference first) :'
                                                                                                                                                                                       WRITE (6,*)'No. of lags for each filter READ (5,*) NL
                                                                                                                                                                                                                                                                                                                   READ (5,*) NFILTS
                                                                                                                                                                                                                                                                                                                                       WRITE (6,*)'No. of filters to be calculated
                                                                                                                                                                                                                                                                                                                                                                                 READ (5,*) IDD, IDB
                                                                                WRITE (6,*)'Fraction of white noise to add to zero lag ACF :'
                                                                                                                          READ (5,*) LAG1
                                                                                                                                                                                                                                                     READ (5, *) LA
                    IF (WEIGHT .EQ. 'YES') THEN
                                                              READ (5,*) RFC
WEIGHT = 'NO'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          (6,*)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   RFC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               Calculate filter coefficients
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    Shorten IP & REF wavelets
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             Amount of white noise to be added to ACF:', F8.6)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              No. of lags to be considered
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Length of first filter to be calculated :', I4)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           Nos. of channels for shaping (REF 1st)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      First lag for shaping
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     Weighting for ACF ?
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               WAVESHAPING FILTER MENU
                                                                                                                                                                                                                                                                                                                                           ٠: ِ
                                                                                                                                                                                                                                                                               ٠.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               6
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               :', I2, 1X,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                ...
...
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ٢
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    :', A3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       :', 1X, A3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        :', I3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                :', I3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               to EXIT)'
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                                                                                                                                                                                                                                                                                                                                                                                                                            130
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       Shift output trace by optimum lag
                                                                                                                      STARTS FILTER CALCULATION
                                                                                                                                                                                                                       ELSE IF (IANS .EQ. 0) THEN
                                                                                                                                                                                                                                                                                                                                          ELSE IF (IANS .EQ. 9) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ELSE IF (IANS .EQ. 10) THEN
DO 150 I = 1, 512
                                                                                                                                                           IF (IANS .NE. 8) THEN
                                                                                                                                                                               END IF
                                                                                                                                                                                                                                                                                                                                                                 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 140 J = IODDEV, NRECS, 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,*) 'Select required filter (1-3) :'
READ (5,*) IDFILT
                                                           GO TO 10
                                                                                                                                                                                                      RETURN
                                                                                                                                                                                                                                                                                   ELSE
                                                                                                                                                                                                                                                                                                                    IF (REPLY .EQ. 'YES') THEN
                                                                            FILTER = .FALSE.
                                                                                                                                                                                                                                         END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IODDEV = MOD(IDD, 2) + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 IF (IDFILT .GT. NFILTS .OR. IDFILT .LE. 0) GO TO 10
                                                                                                                                                                                                                                                                                                    REPLY = 'NO'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CALL ZERO(NSAMR, S1)
CALL ZERO(NSAMR, S2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    WEIGHT = 'YES'
                                                                                                                                                                                                                                                                REPLY = 'YES'
                                                                                                                                                                                                                                                                                                                                                                                 IF (LAG .GT. 0) CALL ZERO(LAG, R4DAT(NSAMR - LAG + 1,J))
IF (LAG .LT. 0) CALL ZERO(LAG, R4DAT(1,J))
                                                                                                                                                                                                                                                                                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DO 130 I = NXST, NYST, NSTEP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CALL FRECON(NSAMR, R4DAT(1, J), S1, B,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CALL ZERO(NSAMR, S3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DO 120 I = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 LAG = NOPT(IDFILT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      ELSE IF (LAG .LT. 0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (LAG .GT. 0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    LAG = NOPT(IDFILT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      GO TO 140
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     B(I) = A(I, IDFILT)
                                                                                                                                                                                                                                                                                                                                                                                                                                              END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          NSTEP = -1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               NYST = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  NXST = 1024 - LAG
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       NSTEP = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          NYST = 1024 - LAG
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               NXST = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IF (LAG .GT. 0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       R4DAT(I, J) = R4DAT(I + LAG, J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                               R4DAT(I + LAG, J) = R4DAT(I, J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       s2,
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                                                                                                                                                                                                              200
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    180
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      160 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                        DO 270 ICOUNT = 1, NFILTS
                                                                                                                                                                                                                                                                                                                                                                                                  END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IF (REPLY .EQ. 'YES') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      DO 160 I = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  READ (5,*) NLAST1
PRINT *, ' INPUT LAST SAMPLE NO. FOR INPUT TRACE :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        DSERIS(I) = R4DAT(I,IDD)
BSERIS(I) = R4DAT(I,IDB)
                                                                LD = NSAMR

LL = LD + NL / 2 + 1

LC = LA + LB - 1
                                                                                                                                                                                                                                                                                 CONTINUE
                                                                                                                                                                                                                                                                                                                           DO 190 I = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           PRINT *, LASTD, LASTB
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 180 I = 1, NSAMR - IFIRST + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             FORMAT (A1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              READ (5,*) NLAST2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 PRINT *, ' INPUT LAST SAMPLE NO. FOR REFERENCE TRACE :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                XPOSNS(I) = REAL(I)
CALL ZERO(1024, S1)
CALL ZERO(1024, S2)
                                          CALL ZERO(2048, C)
                                                                                                                                                                                                            CONTINUE
                                                                                                                                                                                                                                                             DO 200 I = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                      LA = LA * 2
                                                                                                                                                                                                                                                                                                                                                                                                                          END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 READ (5,170) ANS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            PRINT *, ' TAPER OR MUTE (T/M) ?'
                                                                                                                                                               CALL ZERO (NSAMR, A(1, ICOUNT))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IF (ANS .EQ. 'T' .OR. ANS .EQ. 't') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      LASTB = NLAST2 - IFIRST + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              LASTD = NLAST1 - IFIRST + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IFIRST = MIN(NFIRST(IDB),NFIRST(IDD))
                                                                                                                                         LB = NSAMR
                                                                                                                                                                                        LCD = NSAMR * 2 + LA - 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      BSERIS(I) = BSERIS(I + IFIRST - 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                   NDZ = NSAMR - LASTB
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CALL ZERO(NDZ, DSERIS(LEND + 1))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DSERIS(I) = DSERIS(I + IFIRST - 1)
                                                                                                                                                                                                                                  RDAT(I) = BSERIS(I)
                                                                                                                                                                                                                                                                                                       REF(I) = DSERIS(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                               CALL ZERO(NDZ, BSERIS(LASTB + 1))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CALL ZERO(NDZ, DSERIS(LASTD + 1))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    NDZ = NSAMR - LASTD
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CALL ZERO(NDZ, BSERIS(LENB + 1))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        PRINT *, NDZ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 NDZ = NSAMR - LENB
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CALL FEJER (BSERIS (LASTB), LENB)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CALL FEJER (DSERIS (LASTD), LEND)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      PRINT *, LEND, LENB
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             LENB = (LASTB) * 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             PRINT *, NDZ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   NDZ = NSAMR - LEND
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     LEND = (LASTD) * 2
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                                                                                                                                                                                                                                                                                                                                                                                                                                               230
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          220
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     Plot Reference Traces and filtered output traces together
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        NORMALISE OUTPUT TRACE C(LC)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 Shift output trace by optimum lag
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                LAG1, IND, ER, S1, S2, S3, RFC, IFJ)
PRINT *, 'OPTIMUM LAG :', IND
PRINT *, 'MEAN SQUARE ENERGIES :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CALL SHAPEL(LB,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL ZERO(1024, S3)
CALL ZERO(1024, A(1,ICOUNT))
CONTINUE
                                                                                                                                                                                                     CALL MAP (1.0, SIZE,
                                                                                                                                                                                                                                                                                                                                                                                                                                               CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DO 230 I = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 220 I = 2, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       FNORM = REF(1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                YMIN = 0.95 - 0.3 * ICOUNT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             XMAX = 0.48
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         ERR = ER(IND)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ELSE IF (NOPT (ICOUNT) .LT. 0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE (6, *) (ER(I), I=1, NL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           PRINT *, 'LB, LD, LA, LC, LL, NL, LAG1, RFC, IFJ', LB, LD, LA, LC, LL,
                                                                          DO 240 I = 1, 512
                                                                                                                                                                                                                                CALL PTJOIN(XPOSNS, RDAT, 1, ISIZE, 1)
                                                                                                                                                                                                                                                           CALL MAP (1.0, SIZE, -7.0,
                                                                                                                                                                                                                                                                                    CALL BORDER
                                                                                                                                                                                                                                                                                                             CALL PSPACE(XMIN, XMAX, YMIN, YMAX)
                                                                                                                                                                                                                                                                                                                                       SIZE = REAL(ISIZE)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            YMAX = YMIN + 0.25
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      XMIN = 0.01
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CALL MOVE (1024, 1024, C, NXST, 1024, C, NYST)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IF (NOPT(ICOUNT) .GT. 0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   NOPT(ICOUNT) = LAG1 + IND - 1
                                                                                                                             CALL PTJOIN (XPOSNS, C, 1,
                                                                                                                                                      CALL MAP(1.0, SIZE, -3.0, 5.0)
                                                                                                                                                                               CALL PTJOIN(XPOSNS, REF, 1, ISIZE, 1)
                                                                                                       ERRMAX = 0.0
                                                                                                                                                                                                                                                                                                                                                                IF (REPLY .EQ. 'YES') ISIZE = MAX(LASTB,LASTD)
IF (ISIZE .GT. 512) ISIZE = 512
                                                                                                                                                                                                                                                                                                                                                                                                                  ISIZE = MAX(LB, LD)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             GO TO 210
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         NYST = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               NXST = NOPT (ICOUNT) + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 NYST = 1 - NOPT (ICOUNT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         NXST = 1
                        ERRMAX = AMAX1(ERRMAX, ABS(C(I)))
                                                 C(I) = REF(I) - C(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                     RDAT(I) = BSERIS(I) / FNORM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              C(I) = C(I) / FNORM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       REF(I) = REF(I) / FNORM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   FNORM = AMAX1 (REF(I), FNORM)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   NL, LAG1, RFC, IFJ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            RDAT, LD, REF, LA, A(1, ICOUNT), LC, C, LL, NL,
                                                                                                                                                                                                   -5.0, 3.0)
                                                                                                                                ISIZE, 1)
                                                                                                                                                                                                                                                             1.0)
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 260
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 250
                                                                                                                                                                                                                                  270 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       PLOT FILTER AND ITS AMPLITUDE SPECTRUM
                                                                                                  Subroutine to apply gain compensation across array of traces
                                              SUBROUTINE GNCOMP (NSAMR, NCHR, R4DAT, NFIRST, DBGAIN, GCMSCL,
                                                                                                                                                     GO TO 10
                                                                                                                                                                             FILTER = .TRUE
                                                                                                                                                                                                     CALL GREND
PARAMETER (NS1=1024, NS2=60)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CALL PSPACE(XMIN, XMAX, Y0, YMIN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CALL PTJOIN (XPOSNS, C, 1, ISIZE, 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL MAP (1., SIZE, -1.0, 7.0)
                                                                                                                                                                                                                                                                                                      CALL MAP(1., RLAL, 0.0, BMAX)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DO 250 I = 1, LA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CALL MAP(1., RLA, -AMAX, AMAX)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CALL PLOTCS (0.26, 0.5, 'MEAN SQ. ERR - ')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CALL PLOTCS (0.01, 0.5, 'LENGTH = ')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CALL TYPENF (ERRMAX, 2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CALL PLOTCS(SIZE/2, 0.5, 'MAX ERROR (% of peak ref):')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL CTRMAG(10)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CALL NORMAN (512, C)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                ERRMAX = ERRMAX * 100.0
                                                                                                                                                                                                                                                                                                                                   CALL AXES
                                                                                                                                                                                                                                                                                                                                                         CALL MAP (0.0, FNYQ, 0.0, BMAX)
                                                                                                                                                                                                                                                                                                                                                                                   FNYQ = .5E3 / DT
                                                                                                                                                                                                                                                                                                                                                                                                                                      RLAL = REAL(LA/2) + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                            CALL PSPACE (XMIN, XMAX, YMIN, YMAX)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL MAXSN(LA, B, BMAX, II)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DO 260 I = 1, LA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CALL FORK (LA; CMPB, 1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CALL BORDER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CALL PSPACE (XMIN, XMAX, YMIN, YMAX)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CALL MAXSN(LA, A(1, ICOUNT), AMAX, II)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DX = 0.23
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CALL TYPENI (NOPT (ICOUNT))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL PLOTCS(0.75, 0.5, 'OPT LAG = ')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CALL TYPENE (ERR, 3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CALL TYPENI (LA)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CALL MAP (0.0, 1.0, 0.0, 1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         Y0 = YMIN - 0.05
                                                                                                                                                                                                                                                        CALL PTJOIN (XPOSNS, B, 1, LAL, 1)
                                                                                                                                                                                                                                                                                CALL BORDER
                                                                                                                                                                                                                                                                                                                                                                                                              LAL = LA / 2 + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            XMAX = XMIN + DX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    XMIN = XMAX + 0.02
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL PTJOIN(XPOSNS, A(1, ICOUNT), 1, LA, 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CALL XAXIS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              YMAX = YMIN + 0.25
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                XMAX = XMIN + DX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         XMIN = 0.52
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       RLA = REAL(LA)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      YMIN = 0.95 - 0.3 * (ICOUNT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       B(I) = CABS(CMPB(I))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CMPB(I) = CMPLX(A(I, ICOUNT), 0.0)
                          RECDEP, NCR, IDPROC, NPROCS)
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100	3	E	150	140					130			IF	READ	120 FC PF		110 FC	100 FC	90 FC		80 FC	70 FC	60 FC		50 FC	40 FC	30 FC	20 FC			10 PR	E H CH	DIME! REAL	ם מו	
CONLINGE CALL MAXSN(NCHR, TEMP, BIGAMP, II)	, NPROCS) = = 1, NCHR AXAMP (NSAMR	ELSE IF (IOPT .EQ. 2) THEN  NPROCS = NPROCS + 1  IDPROC(1.NPROCS) = 2	PRINT *, GCMSCL	R4DAT(I,J) = R4DAT(I,J) * SCALE CONTINUE	J) * SCAL	'SCALE #', J, '	IF (TEMP(J) .EQ. 0.0) GO TO 150  SCALE = RMSMAX / TEMP(J)	MAXSN(NCHR, TEMP, RMSMAX,		DO 130 J = 1, NCHR  CALL RMSERR(NSAMR, R4DAT(1, J), TEMP(J))	ROC (2, NPROC	.EQ. 1) THE	AD (5,*) IOPT	FORMAT (/' ll Apply mute to channels (Cos taper) PRINT*	(6, 120)	WKITE (6,110) FORMAT (/' 10 Enter first break samples		FORMAT (/' 8 Correct trace misalignment WRITE (6,100)	(6,90)	WRITE (6,80) FORMAT (/′ 7 Remove spike / D.C. from data	H.	FORMAT (/' 5 Apply tapers to data spatially WRITE (6.70)	(6,60)	WRITE (6,50) FORMAT (/' 4 Apply AGC or T-squared ramp to traces	FORMAT (// 3 Kill / Mute traces	3	FORMAT (/' l Normalise each trace wrt rms energy WRITE (6.30)	(6, 20)	PRINT *, ' GAIN COMPENSATION MENU	PRINT *, '	CTER ANS*1  ER KILLID(NS2)	DIMENSION RECDEP(NCHR), IDPROC(5,NCHR), NCR(2) REAL TEMP(NS1)	R4DAT (NSAMR, NCHR), NFIRST (NCHI GCMSCL (NCHR)	
														٢		٤	٢	٢	٠	<i>-</i>	Ĵ	ن		<i>:</i>	٤	<i>:</i>	ن							

SCALE = BIGAMP / TEMP(J) GCMSCL(J) = GCMSCL(J) * SC GCMSCL(J) = GCMSCL(J) * SC GCMSCL(J) = GCMSCL(J) * SC CONTINUE CONTINUE CONTINUE PRINT *, GCMSCL PRINT *, GCMSCL PRINT *, Enter 1 to kill c READ (5,*) IKM IF (IKM .EQ. 1) THEN PRINT *, 'Enter No. of ch READ (5,*) NKILLS DO 190 I = 1, NKILLS PRINT *, 'KILL S' CONTINUE DO 200 I = 1, NKILLS CONTINUE CONTINUE LISE WRITE (6,*)'(TAPERS TO ZE READ (5,*) NTPST, NTPEND IF (NTPST .LT. NTPEND) TH LENTAP = NTPST, NTPEND IF (NTPST .LT. NTPEND) TH LENTAP = NTPST, NTR LENTAP = NTPST, NTR READ (5,*) NTRO, NTR1 DO 230 J = NTRO, NTR1 DO 250 J = NTRO, NTR1 DO 260 J = NTPST - NTPEND FAC = REAL(LENTAP - RADAT(I,J) = 0.0 CONTINUE CONTINUE ELSE LENTAP = NTPST - I, LENTAP FAC = REAL(LENTAP - RADAT(I,J) = 0.0 CONTINUE CONTINUE CONTINUE ELSE ELSE ELSTAP = NTPST - I,J CONTINUE CONTINUE CONTINUE ELSE END IF END IMPEDD EN		IF (TEMP(J) .EQ. 0) GO TO 180	
DO 170 I = 1, NSAMER  RADAT(I,J) = RADAT(I,J) * SCALE  CONTINUE  CONTINUE  PRINT *, GCMSCL  PRINT *, CENTER I to kill channels; 0 to TAPER ends :'  READ (5,*) IKM  IF (IRM RED. 1) THEN  PRINT *, 'Enter 1 to kill channels to be killed :'  READ (5,*) IKM  PRINT *, 'Enter No. of channels to be killed :'  READ (5,*) IKM  PRINT *, 'Enter No. of channels to be killed :'  READ (5,*) IKM  PRINT *, 'Enter No. of channels to be killed :'  READ (5,*) IKM  PRINT *, 'Enter No. of channels to be killed :'  READ (5,*) IKM  READ (5,*) KILLID(I)  CONTINUE  DO 200 I = 1, NKILLS  CALL ZERO (NSAME, RADAT(1, KILLID(I)))  CONTINUE  LEWRAP INTERNO - NUTST AND END OF TAPER IN SAMPLES :  WRITE (6,*) ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NUTRO, NUTRI  DO 230 J = NUTRO, NUTRI  DO 250 J = NUTRO, NUTRI  DO 260 J = NUTRO J = NU		ALE = BIGAMP / TEMP(J)	
RADAT(I,J) = RADAT(I,J) * SCALE  CONTINUE  PRINT *, GEMSCL  PRINT *, CEMSCL  PRINT *, CEMSCL  PRINT *, Enter 1 to kill channels; 0 to TAPER ends :'  READ (5,*) IRM  IF (IKM .EQ. 1) THEN  PRINT *, 'Enter No. of channels to be killed :'  READ (5,*) KILL  DO 190 I = 1, NKILLS  DO 190 I = 1, NKILLS  DO 200 I = 1, NKILLS  CONTINUE  DO 200 I = 1, NKILLS  CONTINUE  LENTAP = NTPEND, THEN  MRITE (6,*) 'ENTER START AND END OF TAPER IN SAMPLES:  WRITE (6,*) 'ITAPERS TO ZERO AT TAPER END)'  READ (5,*) NTPST, NTPEND  IF (MTPST. LT. NTPEND) THEN  LENTAP = NTPEND - NTPST + 1  WRITE (6,*) 'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTRI  DO 230 J = NTRO, NTRI  DO 240 J = 1, LENTAP  FAC = REAL(LENTAP - 1) / REAL(LENTAP)  RADAT(I + NTPST, J) = RADAT(I + NTPST, J) * FAC  CONTINUE  CONTINUE  LENTAP = NTPEND + 2, NSAMR  RADAT(I, J) = 0.0  CONTINUE  LENTAP = NTPST - NTPEND + 1  WRITE (6,*) 'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTRI  DO 240 I = 1, LENTAP  FAC = REAL(LENTAP - 1) / REAL(LENTAP)  RADAT(I,J) = 0.0  CONTINUE  LENTAP = NTPST - NTPEND + 1  WRITE (6,*) 'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTRI  DO 240 I = 1, LENTAP  FAC = REAL(LENTAP - 1) / REAL(LENTAP)  RADAT(I,J) = 0.0  CONTINUE  LENTAP = NTPEND + 1  WRITE (6,*) 'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTRI  DO 240 I = 1, NTPEND + 1  WRITE (6,*) 'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTRI  DO 260 J = NTRO  CONTINUE  LENTAP - NTRI  DO 260 J = NTRO  CONTINUE  DO 260 J = N		170 I = 1, NSAMR	
CONTINUE  PRINT *, GCMSCL PRINT *, CACMSCL PRINT *, CACMSCL PRINT *, CACMSCL PRINT *, CACMSCL IF (IOPT_EQ. 3) THEN  PRINT *, Enter 1 to kill channels; 0 to TAPER ends :'  READ (5,*) IRM  IF (IM.EQ. 1) THEN  PRINT *, Enter No. of channels to be killed :'  READ (5,*) NKILLS  DO 190 I = 1, NKILLS  PRINT *, KILL #, I, ' : '  READ (5,*) NKILLS  PRINT *, KILL #, I, ' : '  READ (5,*) NKILLS  DO 200 I = 1, NKILLS  CONTINUE  CONTINUE  ELSE  WRITE (6,*) 'ENTER START AND END OF TAPER IN SAMPLES :  WRITE (6,*) 'ENTER START AND END OF TAPER END)'  READ (5,*) NTPST, NTPEND  IF (WTPST. LT. NTPEND) THEN  LENTAP = NTPEND - NTPST + 1  WRITE (6,*) 'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTR1  DO 210 I = 1, LENTAP  FAC = REAL(LENTAP - 1) / REAL(LENTAP)  RADAT(I, J) = 0.0  CONTINUE  CONTINUE  CONTINUE  ELSE  LENTAP = NTPEND + 1  WRITE (6,*) 'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTR1  DO 240 I = NTPEND + 1  WRITE (6,*) 'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTR1  DO 240 I = NTPEND + 1  WRITE (6,*) 'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTR1  DO 240 I = NTPEND + 1  WRITE (6,*) 'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTR1  DO 240 I = NTPEND + 1  WRITE (6,*) 'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTR1  DO 240 I = NTPEND + 1  WRITE (6,*) 'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTR1  DO 240 I = NTPEND + 1  WRITE (6,*) 'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTR1  DO 240 I = NTPEND + 1  WRITE (6,*) 'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTR1  DO 240 I = NTPEND + 1  WRITE (6,*) 'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTR1  DO 240 I = NTPEND + 1  WRITE (8,*) 'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTRO, NTR1  DO 240 I = NTPEND + 1  WRITE (8,*) 'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTRO	;	I,J) = R4DAT(I,J) *	
PRINT *, GCMSCL ELSE IF (IOPT_EQ. 3) THEN PRENT *, 'GOTTEN EQ. 3) THEN PRENT *, 'Enter I to kill channels; 0 to TAPER ends :' READ (5,*) IKM IF (IKM .EQ. 1) THEN  PRINT *, 'Enter No. of channels to be killed :' READ (5,*) NKILLS DO 190 I = 1, NKILLS PRINT *, 'Enter No. of channels to be killed :' READ (5,*) KILLID(I)  CONTINUE DO 200 I = 1, NKILLS CALL ZERO(NSAME, RADAT(1,KILLID(I))) CONTINUE DO 200 I = 1, NKILLS CALL ZERO(NSAME, RADAT(1,KILLID(I))) CONTINUE ELSE WRITE (6,*)'ENTER START AND END OF TAPER IN SAMPLES : WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NPEND - NPEND THEN LENTAP = NTPEND - NPEND AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTRI DO 200 I = 1, LENTAP FAC = REAL(LENTAP - I) / REAL(LENTAP) RADAT(I + NTPEND + 2, NSAME RADAT(I,J) = 0.0  CONTINUE ELSE LENTAP = NTPENT - NTPEND + 1 WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTRI DO 200 I = NTRO, NTRI DO 260 J = NTRO, NTRI DO 26	180	CONTINUE	
PRINT *, 'Enter I to kill channels; 0 to TAPER ends :'  READ (5,*) IKM  IF (IKM EQ. 1) THEN  PRINT *, 'Enter No. of channels to be killed :'  READ (5,*) NKILLS  DO 190 I = 1, NKILLS  PRINT *, 'KILL \$', I, ':'  READ (5,*) KILLID(I)  CONTINUE  DO 200 I = 1, NKILLS  CALL ZERO(NSAMS, RADAT(1, KILLID(I)))  CONTINUE  ELSE  WRITE (6,*)'ENTER START AND END OF TAPER IN SAMPLES :  WRITE (6,*)'TAPERS TO ZERO AT TAPER END)'  READ (5,*) NTPST, NTPEND  IF (NTPST .I.' NTPEND) THEN  LENTAP = NTPEND - NTPST + 1  WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO  READ (5,*) NTRO, NTRI  DO 230 J = NTRO, NTRI  DO 230 J = NTRO, NTRI  DO 230 J = NTRO, NTRI  DO 240 I = 1, LENTAP  FAC = REAL(LENTAP - I) / REAL(LENTAP)  RADAT(I, J) = 0.0  CONTINUE  CONTINUE  CONTINUE  LESE  LENTAP = NTPST - NTPEND + 1  WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO  READ (5,*) NTRO, NTRI  DO 260 J = NTRO  CONTINUE  ELSE  LENTAP FAC REAL(LENTAP - I) / REAL(LENTAP)  RADAT(I, J) = 0.0  CONTINUE  ELSE IF (IOPT .EQ. 4) THEN  NERCCS = NERCCS + 1  IDPROCCS = NERCCS + 1  IDPROCCI, NERCCS) = 6  WRITE (6,*)'RAMP OF AGC OF FEDEFINE data :'  DO 260 T AGD OF AGC OF TEDEFINE data :'		INT *, GCMSCL	
READ (5,*) IKM IF (IM :GQ. 1) THEN PRINT *, 'Enter No. of channels to be killed :' READ (5,*) NKILLS DO 190 I = 1, NKILLS PRINT *, 'Kill #', I, ':' READ (5,*) KILLD(I) CONTINUE DO 200 I = 1, NKILLS CALL ZERO(NSAMR, RADAT(1,KILLD(I))) CONTINUE ELSE  WRITE (6,*)'ENTER START AND END OF TAPER IN SAMPLES : WRITE (6,*)'ENTERS TO ZERO AT TAPER END)' READ (5,*) NUTPST, NUTPEND LENTAP = NUTPEND - NUTPST + 1 WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NUTPST, NUTPST + 1 WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NUTPST, NUTPST - 1) / REAL(LENTAP) FAC = REAL(LENTAP - 1) / REAL(LENTAP) RADAT(I + NUTPST, J) = RADAT(I + NUTPST, J) * FAC CONTINUE CONTINUE CONTINUE ELSE LENTAP = NUTPST - NUTPEND + 1 WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NUTRO, NUTRI DO 260 J = NUTRO CONTINUE ELSE IF (DOTT.EQ. 4) THEN NUTRO CONTINUE ELSE IF (DOTT.EQ. 4) THEN NUTRO CONTINUE ELSE IF (DOTT.EQ. 4) THEN		INT *, 'Enter 1 to kill channels; 0 to TAPER ends	
FRINT *, 'Enter No. of channels to be killed :'  READ (5,*) NILLS  DO 190 I = 1, NKILLS  PRINT *, 'Kill *, I, ': '  READ (5,*) KILLID(I)  CONTINUE  DO 200 I = 1, NKILLS  CALL ZERO(NSAMR, R4DAT(1,KILLID(I)))  CONTINUE  DO 200 I = 1, NKILLS  CALL ZERO(NSAMR, R4DAT(1,KILLID(I)))  CONTINUE  WRITE (6,*)'ENTER START AND END OF TAPER IN SAMPLES :  WRITE (6,*)'ENTER START AND END OF TAPER IN SAMPLES :  WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTPST, NTPEND THEN  LENTAP = NTPEND - NTPST + 1  WRATTE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRI  DO 210 I = 1, LENTAP  FAC = REAL(LENTAP - I) / REAL(LENTAP)  RADAT(I, J) = 0.0  CONTINUE  CONTINUE  ELSE  LENTAP = NTPST - NTPEND + 1  WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRI  DO 260 J = NTRO, NTRI		(5, *) IKM	
PRAD (5,*) NKILLS DO 190 I = 1, NKILLS PRINT *, 'Kill #', I, ': ' READ (5,*) KILLID(I)  CONTINUE DO 200 I = 1, NKILLS CONTINUE CONTINUE  ELSE  WRITE (6,*)'ENTER START AND END OF TAPER IN SAMPLES : WRITE (6,*)'ENTER START AND END OF TAPER IN SAMPLES : WRITE (6,*)'ENTER START AND END OF TAPER END)' READ (5,*) NTPST, NTPEND  IF (NTPST, LIT. NTPEND) THEN  LENTAP = NTPEND - NTPST + 1  WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTPO, NTR1 DO 210 I = 1, LENTAP FAC = REAL(LENTAP - I) / REAL(LENTAP) FAC = REAL(		PRINT *, 'Enter No. of channels to be killed	
DO 190 I = 1, NKILLS  PRINT *, 'Kill #', I, ':'  READ (5,*) KILLID(I)  CONTINUE  DO 200 I = 1, NKILLS  CALL ZERO (NSAMR, R4DAT(1,KILLID(I)))  CONTINUE  DO 200 I = 1, NKILLS  CALL ZERO (NSAMR, R4DAT(1,KILLID(I)))  CONTINUE  ELSE  WRITE (6,*)'ENTER START AND END OF TAPER IN SAMPLES : WRITE (6,*)'ENTER START AND END OF TAPER IN SAMPLES : WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTRI  DO 210 I = 1, LENTAP  FAC = REAL(LENTAP - I) / REAL(LENTAP)  RADAT(I + NTEST, J) = R4DAT(I + NTEST, J) * FAC  CONTINUE  DO 220 I = NTERD + 1  WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO  CONTINUE  CONTINUE  ELSE  LENTAP = NTEST - NTPEND + 1  WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO  CONTINUE  ELSE  LENTAP = NTEST - NTPEND + 1  WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO  CONTINUE  CONTINUE  ELSE  LENTAP = REAL(LENTAP - 1) / REAL(LENTAP)  RADAT(NTEST - I, J) = R4DAT(NTEST - I, J) * FAC  CONTINUE  DO 250 I = 1, NTPEND - 1  RADAT(I, J) = 0.0  CONTINUE  END IF  END IF  END IF  ELSE IF (IOPT .EQ. 4) THEN  NERCCS = NERCCS + 1  IDPROC(1, NERCCS) = 6  WRITE (6,*)'RAMP OF AGC OF FEDEFINE data :'  **CREAT (ACC) ** AND OF AGC OF FEDEFINE data :'  ***CREAT (ACC) ** AND OF AGC OF FEDEFINE data :'  ****CREAT (ACC) *****  *****CREAT (ACC) *****  ******  ******  ******  *****  ****			
READ (5,*) KILLID(I)  CONTINUE  DO 200 I = 1, NKILLS  CALL ZERO(NSAMR, R4DAT(1,KILLID(I)))  CONTINUE  DO 200 I = 1, NKILLS  CALL ZERO(NSAMR, R4DAT(1,KILLID(I)))  CONTINUE  ELSE  WRITE (6,*)'ENTER START AND END OF TAPER IN SAMPLES : WRITE (6,*)'ENTER START AND END OF TAPER IN SAMPLES : WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTPSND - NTPSND THEN  LENTAP = NTPEND - NTR1  DO 230 J = NTR0, NTR1  DO 230 J = NTPST, J) = R4DAT(I + NTPST, J) * FAC  CONTINUE  CONTINUE  CONTINUE  ELSE  LENTAP = NTPST - NTPEND + 1  WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTR0, NTR1  DO 240 I = 1, LENTAP  FAC = REAL(LENTAP - I) / REAL(LENTAP)  RADAT(NTPST - I,J) = R4DAT(NTPST - I,J) * FAC  CONTINUE  ELSE  LENTAP = RADAT(NTPST - I,J) = R4DAT(NTPST - I,J) * FAC  CONTINUE  ELSE  LENTAP = RADAT(I,J) = 0.0  CONTINUE  ELSE IF (10PT .EQ. 4) THEN  NPROCS = NPROCS + 1  IDPROC(1,NPROCS) = 6  WRITE (6,*)'RAMP OR AGC OF reDefine data:'  DO 200 I = 1, NTPST - NTPEND - 1  DO 200 I = NTR0, NTR1  NPROCS = NPROCS + 1  IDPROC(1,NPROCS) = 6  WRITE (6,*)'ADAM ON AGC OF REDEFINE data:'		190 I = 1, NKILLS	
CONTINUE  DO 200 I = 1, NKILLS  CALL ZERO(NSAMR, R4DAT(1,KILLID(I)))  CONTINUE  CALL ZERO(NSAMR, R4DAT(1,KILLID(I)))  CONTINUE  ELSE  WRITE (6,*)'ENTER START AND END OF TAFER IN SAMPLES : WRITE (6,*)'ENTER START AND END OF TAFER IN SAMPLES : WRITE (6,*)'ENTER START AND END OF TAFER IN SAMPLES : WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTRI  DO 210 I = 1, LENTAP  FAC = REAL(LENTAP - I) / REAL(LENTAP)  R4DAT(I + NTPEND + 1) / REAL(LENTAP)  R4DAT(I + NTPEND + 2, NSAMR  R4DAT(I,J) = 0.0  CONTINUE  ELSE  LENTAP = NTPEN - NTPEND + 1  WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTRI  DO 240 I = 1, LENTAP  FAC = REAL(LENTAP - I) / REAL(LENTAP)  R4DAT(NTPEST - I,J) = R4DAT(NTPEST - I,J) * FAC  CONTINUE  ELSE IF (10PT LEQ. 4) THEN  NPROCS = NPROCS + 1  IDPROC(1,NPROCS) = 6  WRITE (6,*)'CAMPAD OF AGC OF reDefine data:'  CALL ZERO(1,NPROCS) = 6  WRITE (6,*)'CAMPAD OF AGC OF REDEFINE data:'		Τ,	
CALL ZERO (NSAMR, R4DAT(1,KILLID(1)))  CONTINUE  ELSE  WRITE (6,*)'ENTER START AND END OF TAPER IN SAMPLES:  WRITE (6,*)'(TAPERS TO ZERO AT TAPER END)'  READ (5,*) UTEST, WITEND  IF (NTPST, LIT. NIPEND) THEN  LENTAP = NTPEND - NIPST + 1  WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NITRO, NITRI  DO 210 I = 1, LENTAP  FAC = REAL(LENTAP - I) / REAL(LENTAP)  R4DAT(I + NIPST,J) = R4DAT(I + NIPST,J) * FAC  CONTINUE  DO 220 I = NITRO, NITRI  DO 220 I = NITPEND + 1, NSAMR  R4DAT(I,J) = 0.0  CONTINUE  ELSE  LENTAP = NIPST - NITEND + 1  WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NITRO, NITRI  DO 240 I = 1, LENTAP  FAC = REAL(LENTAP - I) / REAL(LENTAP)  R4DAT(NIPST - I,J) = R4DAT(NIPST - I,J) * FAC  CONTINUE  ELSE IF (10PT LEQ. 4) THEN  NPROCS = NPROCS + 1  IDPROC(1,NPROCS) = 6  WRITE (6,*)'ENTER FIRST CONTINUE CONTINUE  ELSE IF (10PT LEQ. 4) THEN  NPROCS = NPROCS = 6  WRITE (6,*)'ENTER FIRST CONTINUE CONTINUE CONTINUE CONTINUE CONTINUE CONTINUE  ELSE IF (10PT LEQ. 4) THEN  NPROCS = NPROCS = 6  WRITE (6,*)'CANAME OF AGC OF REDefine data:'	190	CONTINUE	
CALL ZERO (NSAMR, RADAT(1,KILLID(I))) CONTINUE  ELSE  WRITE (6,*)'ENTER START AND END OF TAPER IN SAMPLES: WRITE (6,*)'(TAPERS TO ZERO AT TAPER END)' READ (5,*) NTPST, NTPEND  IF (NTPST .LT. NTPEND) THEN LENTAP = NTPEND - NTPST + 1 WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTR1 DO 230 J = NTRO, NTR1 DO 230 J = NTRO, NTR1 DO 230 J = NTPST, J) = RADAT(I + NTPST, J) * FAC CONTINUE FAC = REAL(LENTAP - I) / REAL(LENTAP) RADAT(I + NTPST, J) = RADAT(I + NTPST, J) * FAC CONTINUE CONTINUE ELSE  LENTAP = NTPST - NTPEND + 1 WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTR1 DO 260 J = NTPEND - 1 RADAT(NTR) DO 260 J = NTRO, NTR1 DO 260 J = NTPST J =		200	
ELSE  WRITE (6,*)'ENTER START AND END OF TAPER IN SAMPLES: WRITE (6,*)'(TAPERS TO ZERO AT TAPER END)' READ (5,*) NTPST, NTPEND  IF (NTPST .LT. NIPEND) THEN  LENTAP = NTPEND - NTPST + 1  WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO  READ (5,*) NTRO, NTR1  DO 230 J = NTRO, NTR1  DO 230 J = NTRO, NTR1  DO 230 J = NTPST - I) / REAL(LENTAP)  FAC = REAL(LENTAP - I) / REAL(LENTAP)  FAC = REAL(LENTAP - I) / REAL(LENTAP)  FAC = REAL(LENTAP - I) / REAL(LENTAP)  RADAT(I + NTPST, J) = RADAT(I + NTPST, J) * FAC  CONTINUE  ELSE  LENTAP = NTPST - NTPEND + 1  WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO  READ (5,*) NTRO, NTR1  DO 260 J = NTPST J J J = NTPEND J J + FAC  CONTINUE  CONTINUE  ELSE IF (10PT LO 20 J + NTRO, NTR1  DO 260 J = NTRO, NTR1  DO 26		CALL ZERO(NSAMR, R4DAT(1,KILLID(I)))	
WRITE (6,*)'ENTER START AND END OF TAPER IN SAMPLES: WRITE (6,*)'(TAPERS TO ZERO AT TAPER END)' READ (5,*) NTPST, NTPEND  IF (NTPST . LT. NTPEND) THEN  LENTAP = NTPEND - NTPST + 1  WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO  READ (5,*) NTRO, NTR1  DO 210 I = 1, LENTAP - 1) / REAL(LENTAP) FAC = REAL(LENTAP - 1) / REAL(LENTAP) RADAT(I + NTPST,J) = R4DAT(I + NTPST,J) * FAC  CONTINUE  DO 220 I = NTPEND + 2, NSAWR RADAT(I,J) = 0.0  CONTINUE  CONTINUE  ELSE  LENTAP = NTPST - NTPEND + 1  WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO  READ (5,*) NTRO, NTR1  DO 260 J = 1, LENTAP  FAC = REAL(LENTAP - I) / REAL(LENTAP)  RADAT(NTPST - I,J) = R4DAT(NTPST - I,J) * FAC  CONTINUE  DO 250 I = 1, NTPEND - 1  RADAT(I,J) = 0.0  CONTINUE  END IF  END IF  END IF  ELSE IF (IOPT .EQ. 4) THEN  NPROCS = NPROCS + 1  IDPROC(1, NPROCS) = 6  WRITE (6,*)'RAMP OF AGC OF reDefine data :'	0	ELSE	
WRITE (6,*)'(TAPERS TO ZERO AT TAPER END)' READ (5,*) NTPST, NTTEND  IF (NTPST .LT. NTPEND) THEN  LENTAP = NTPEND - NTPST + 1  WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO  READ (5,*) NTRO, NTR1  DO 210 I = 1, LENTAP - I) / REAL(LENTAP)  RADAT (I + NTPST, J) = R4DAT(I + NTPST, J) * FAC  CONTINUE  DO 220 I = NTPEND + 2, NSAMR  RADAT (I, J) = 0.0  CONTINUE  CONTINUE  ELSE  LENTAP = NTPST - NTPEND + 1  WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO  READ (5,*) NTRO, NTR1  DO 260 J = NTRO, NTR1  CONTINUE  FAC = REAL(LENTAP - I) / REAL(LENTAP)  RADAT (NTPST - I,J) = R4DAT (NTPST - I,J) * FAC  CONTINUE  CONTINUE  END IF  END IF  END IF  ELSE IF (IOPT .EQ. 4) THEN  NPROCS = NPROCS + 1  IDPROCS   NPROCS + 1  IDPROCC   NPROCS   = 6  WRITE (6,*)'RAMP OF AGC OF reDefine data :'		ITE (6,*)'ENTER START AND END OF TAPER IN SAMPLES	
HEAD (5,*) NUFST, NIFEND  IENTAP = NTPEND THEN  LENTAP = NTPEND THEN  WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO  READ (5,*) NTRO, NTRI  DO 230 J = NTRO, NTRI  DO 210 I = 1, LENTAP  FAC = REAL(LENTAP - I) / REAL(LENTAP)  RADAT(I + NTPST,J) = R4DAT(I + NTPST,J) * FAC  CONTINUE  CONTINUE  CONTINUE  CONTINUE  ELSE  LENTAP = NTPST - NTPEND + 1  WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO  READ (5,*) NTRO, NTRI  DO 260 J = NTRO, NTRI  DO 240 I = 1, LENTAP  FAC = REAL(LENTAP - I) / REAL(LENTAP)  RADAT(NTPST - I,J) = R4DAT(NTPST - I,J) * FAC  CONTINUE  DO 250 I = 1, NTPEND - 1  RADAT(LJ) = 0.0  CONTINUE  CONTINUE  END IF  END IF  END IF  ELSE IF (IOPT .EQ. 4) THEN  NPROCS = NPROCS + 1  IDPROCS = NPROCS + 1  IDPROCE = NPROCE + NPROCE + 1  IDPROCE = NPROCE + NPROCE		)' (TAPERS TO ZERO AT	
LENTAP = NTPEND - NTPST + 1  WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTR1 DO 230 J = NTRO, NTR1 DO 210 I = 1, LENTAP = 1) / REAL(LENTAP) FAC = REAL(LENTAP - I) / REAL(LENTAP) R4DAT(I + NTPST,J) = R4DAT(I + NTPST,J) * FAC CONTINUE DO 220 I = NTPEND + 2, NSAMR R4DAT(I,J) = 0.0  CONTINUE CONTINUE  ELSE LENTAP = NTPST - NTPEND + 1 WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTR1 DO 260 J = NTRO, NTR1 DO 240 I = 1, LENTAP FAC = REAL(LENTAP - I) / REAL(LENTAP) RADAT(NTPST - I,J) = R4DAT(NTPST - I,J) * FAC CONTINUE DO 250 I = 1, NTPEND - 1 RADAT(I,J) = 0.0 CONTINUE CONTINUE END IF		TE (NEEST, NEEST, NEEST) THEN	
WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTRI DO 230 J = NTRO, NTRI DO 210 I = 1, LENTAP FAC = REAL(LENTAP - I) / REAL(LENTAP) RADAT (I + NTPST,J) = R4DAT (I + NTPST,J) * FAC CONTINUE DO 220 I = NTPEND + 2, NSAMR R4DAT (I,J) = 0.0  CONTINUE CONTINUE ELSE LENTAP = NTPST - NTPEND + 1 WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTRI DO 260 J = NTRO, NTRI DO 260 J = NTRO, NTRI DO 240 I = 1, LENTAP FAC = REAL(LENTAP - I) / REAL(LENTAP) RADAT (NTPST - I,J) = R4DAT (NTPST - I,J) * FAC CONTINUE DO 250 I = 1, NTPEND - 1 RADAT (I,J) = 0.0 CONTINUE CONTINUE END IF ELSE IF (IOPT .EQ. 4) THEN NPROCS = NPROCS + 1 IDPROCS   SAMP OF AGC OF reDefine data :'		LENTAP = NTPEND - NTPST +	
READ (5,*) NTRU, NTRL  READ (5,*) NTRU, NTRL  DO 230 J = NTRO, NTRL  DO 210 I = 1, LENTAP - I) / REAL(LENTAP)  FAC = REAL(LENTAP - I) / REAL(LENTAP)  RADAT(I + NTPST, J) = R4DAT(I + NTPST, J) * FAC  CONTINUE  DO 220 I = NTPEND + 2, NSAMR  R4DAT(I, J) = 0.0  CONTINUE  CONTINUE  ELSE  LENTAP = NTPST - NTPEND + 1  WRITE (6,*) 'ENTER FIRST AND LAST TRACE TO APPLY TO  READ (5,*) NTRO, NTRL  DO 260 J = NTPAP  FAC = REAL(LENTAP - I) / REAL(LENTAP)  FAC = REAL(LENTAP - I) / REAL(LENTAP)  R4DAT(NTPST - I, J) = R4DAT(NTPST - I, J) * FAC  CONTINUE  DO 250 I = 1, NTPEND - 1  R4DAT(I, J) = 0.0  CONTINUE  END IF  EN		(6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO	
DO 210 I = 1, LENTAP  FAC = REAL(LENTAP - I) / REAL(LENTAP)  ROD 220 I = NTPEND + 2, NSAMR  ROD 220 I = NTPEND + 2, NSAMR  ROD 220 I = NTPEND + 1  WALTE (6,*) 'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTRI  DO 260 J = NTRO, NTRI  DO 260 J = NTRO, NTRI  DO 240 I = 1, LENTAP  FAC = REAL(LENTAP - I) / REAL(LENTAP)  FAC = REAL(LENTAP - I) / REAL(LENTAP)  ROD 250 I = 1, NTPEND - 1  ROD 250 I = 1, NTPEND - 1  ROD 1F  END IF  END		30 J = NTRO.	
FAC = REAL(LENTAR - 1) / REAL(LENTAP)  RADAT(I + NTPST,J) = RADAT(I + NTPST,J) * FAC  CONTINUE  DO 220 I = NTPEND + 2, NSAMR  RADAT(I,J) = 0.0  CONTINUE  CONTINUE  CONTINUE  ELSE  LENTAP = NTPST - NTPEND + 1  WRITE (6,*) 'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRL  DO 260 J = NTRO, NTRL  DO 250 I = 1, LENTAP  RADAT(NTPST - I,J) = RADAT(NTPST - I,J) * FAC  CONTINUE  CONTINUE  CONTINUE  END IF  EN		210 I = 1, LENTAP	
CONTINUE  DO 220 I = NTPEND + 2, NSAMR  R4DAT(I,J) = 0.0  CONTINUE  CONTINUE  ELSE  LENTAP = NTPST - NTPEND + 1  WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTRI  DO 260 J = NTRO, NTRI  DO 240 I = 1, LENYAP  FAC = REAL(LENTAP - I) / REAL(LENTAP)  FAC = REAL(LENTAP - I) / REAL(LENTAP)  R4DAT(NTPST - I,J) = R4DAT(NTPST - I,J) * FAC  CONTINUE  DO 250 I = 1, NTPEND - 1  R4DAT(I,J) = 0.0  CONTINUE  CONTINUE  END IF  END IF  END IF  END IF  ELSE IF (IOPT .EQ. 4) THEN  NPROCS = NPROCS + 1  IDPROC(1,NPROCS) = 6  WRITE (6,*) RAMP OF AGC OF reDefine data :'		(T + NEDSE T) = RADAT(T + NEDSE T) *	
DO 220 I = NTPEND + 2, NSAMR  RADAT(I,J) = 0.0  CONTINUE  CONTINUE  ELSE  LENTAP = NTPST - NTPEND + 1  WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTR0, NTR1  DO 260 J = NTR0, NTR1  DO 240 I = 1, LENTAP  FAC = REAL(LENTAP - I) / REAL(LENTAP)  FAC = REAL(LENTAP - I) / REAL(LENTAP)  RADAT(NTPST - I,J) = RADAT(NTPST - I,J) * FAC  CONTINUE  DO 250 I = 1, NTPEND - 1  RADAT(I,J) = 0.0  CONTINUE  END IF  END IF  END IF  END IF  END IF  ELSE IF (IOPT .EQ. 4) THEN  NPROCS = NPROCS + 1  IDPROC(1,NPROCS) = 6  WRITE (6,*) RAMP OF AGC OF reDefine data :'	210	The state of the s	
CONTINUE  CONTINUE  CONTINUE  CONTINUE  ELSE  LENTAP = NTPST - NTPEND + 1  WRITE (6,*)'ENVER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTRI  DO 260 J = NTRO, NTRI  DO 240 I = 1, LENTAP  FAC = REAL(LENTAP - I) / REAL(LENTAP)  RADAT(NTPST - I,J) = RADAT(NTPST - I,J) * FAC  CONTINUE  DO 250 I = 1, NTPEND - 1  RADAT(I,J) = 0.0  CONTINUE  CONTINUE  END IF  END		220 I = NTPEND + 2,	
CONTINUE  ELSE  ELSE  LENTAP = NTPST - NTPEND + 1  WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5,*) NTRO, NTR1  DO 260 J = NTRO, NTR1  DO 240 I = 1, LENTAP  FAC = REAL(LENTAP - I) / REAL(LENTAP)  RADAT(NTPST - I,J) = RADAT(NTPST - I,J) * FAC  CONTINUE  DO 250 I = 1, NTPEND - 1  RADAT(I,J) = 0.0  CONTINUE  CONTINUE  END IF  END	220	۱, ر) =	
ELSE  LENTAP = NTPST - NTPEND + 1  WRITE (6, *) 'ENTER FIRST AND LAST TRACE TO APPLY TO READ (5, *) NTRO, NTR1  DO 260 J = NTRO, NTR1  DO 240 I = 1, LENTAP  FAC = REAL(LENTAP - I) / REAL(LENTAP)  RADAT(NTPST - I,J) = R4DAT(NTPST - I,J) * FAC  CONTINUE  DO 250 I = 1, NTPEND - 1  RADAT(I,J) = 0.0  CONTINUE  CONTINUE  END IF  END IF  ELSE IF (IOPT .EQ. 4) THEN  NPROCS = NPROCS + 1  IDPROC(1,NPROCS) = 6  WRITE (6,*) 'Ramp or AGC or reDefine data:'  DETAL (100) AND OR AGC or reDefine data:'	230	CONTINUE	
LENTAF = NUFERT - NUFERD + 1  WRITE (6,*)'ENTER FIRST AND LAST TRACE TO APPLY TO  READ (5,*) NUTRO, NUTRI  DO 260 J = NUTRO, NUTRI  DO 240 I = 1, LENTAP  FAC = REAL(LENTAP - I) / REAL(LENTAP)  FAC = REAL(LENTAP - I) / REAL(LENTAP)  RADAT(NUFST - I,J) = RADAT(NUTST - I,J) * FAC  CONTINUE  DO 250 I = 1, NUTPEND - 1  RADAT(I,J) = 0.0  CONTINUE  CONTINUE  END IF  END IF  ELSE IF (IOPT .EQ. 4) THEN  NPROCS = NPROCS + 1  IDPROC(1,NPROCS) = 6  WRITE (6,*)'RAMP OF AGC OF TEDEFINE data:'  DEED 15  ELSE IF (10PT .EQ. 4) THEN  NPROCS = NPROCS + 1  IDPROC(1,NPROCS) = 6  WRITE (6,*)'RAMP OF AGC OF TEDEFINE data:'			
READ (5,*) NITRO, NITRI  DO 260 J = NITRO, NITRI  DO 240 I = 1, LENTAP  FAC = REAL(LENTAP - I) / REAL(LENTAP)  FAC = REAL(LENTAP - I) / REAL(LENTAP)  RADAT(NITEST - I,J) = RADAT(NITEST - I,J) * FAC  CONTINUE  DO 250 I = 1, NITPEND - 1  RADAT(I,J) = 0.0  CONTINUE  CONTINUE  CONTINUE  END IF  ELSE IF (IOPT .EQ. 4) THEN  NPROCS = NPROCS + 1  IDPROC(1,NPROCS) = 6  WRITE (6,*)'RAMP OF AGC OF FEDEFINE data:'  DEED (5,*) RAMP OF AGC OF FEDEFINE data:'		+ 1	
DO 260 J = NTRO, NTR1 DO 240 I = 1, LENTAP FAC = REAL(LENTAP - I) / REAL(LENTAP) FAC = REAL(LENTAP - I) / REAL(LENTAP) R4DAT(NTPST - I,J) = R4DAT(NTPST - I,J) * CONTINUE DO 250 I = 1, NTPEND - 1 R4DAT(I,J) = 0.0 CONTINUE CONTINUE END IF END IF ELSE IF (IOPT .EQ. 4) THEN NPROCS = NPROCS + 1 IDPROC(1,NPROCS) = 6 WRITE (6,*)'Ramp or AGC or reDefine data :' DEAT (5.00) RAMP or AGC or reDefine data :'		(5,*) NTRO, NTR1	
DO 240 I = 1, LENTAP  FAC = REAL(LENTAP - I) / REAL(LENTAP)  R4DAT(NTPST - I,J) = R4DAT(NTPST - I,J) *  CONTINUE  DO 250 I = 1, NTPEND - 1  R4DAT(I,J) = 0.0  CONTINUE  CONTINUE  CONTINUE  END IF  ELSE IF (IOPT .EQ. 4) THEN  NPROCS = NPROCS + 1  IDPROC(1,NPROCS) = 6  WRITE (6,*)'Ramp or AGC or reDefine data :'  DEAD (5.00) Ramp or AGC or redefine data :'		260 J = NTR0,	
FAC = REAL(LENTAY - 1) / REAL(LENTAY)  R4DAT(NTPST - 1,J) = R4DAT(NTPST - 1,J) *  CONTINUE  DO 250 I = 1, NTPEND - 1  R4DAT(I,J) = 0.0  CONTINUE  CONTINUE  CONTINUE  END IF  ELSE IF (IOPT .EQ. 4) THEN  NPROCS = NPROCS + 1  IDPROC(1,NPROCS) = 6  WRITE (6,*) 'Ramp or AGC or reDefine data :'  DEAD (5 AGO) RAME  RADA (100) RAME  REAL (100) RAME  RE		240 I = 1, LENTAP	
CONTINUE  DO 250 I = 1, NTPEND - 1  R4DAT(I,J) = 0.0  CONTINUE  CONTINUE  CONTINUE  END IF  END IF  ELSE IF (IOPT .EQ. 4) THEN  NPROCS = NPROCS + 1  IDPROC(1,NPROCS) = 6  WRITE (6,*) 'Ramp or AGC or reDefine data :'  DEAD (5.400) NAME or AGC or reDefine data :'		= REAL(LENTAP - I) / REAL(LENTAP)	
DO 250 I = 1, NTPEND - 1  R4DAT(I,J) = 0.0  CONTINUE  CONTINUE  END IF  ELSE IF (IOPT .EQ. 4) THEN  NPROCS = NPROCS + 1  IDPROC(1,NPROCS) = 6  WRITE (6,*)'Ramp or AGC or reDefine  BEDD 15	240	107 - 107 - 100 -	
CONTINUE  CONTINUE  CONTINUE  CONTINUE  ELSE IF (IOPT .EQ. 4) THEN  NPROCS = NPROCS + 1  IDPROC(1, NPROCS) = 6  WRITE (6,*) Ramp or AGC or reDefine  DEAD 16 AGO AND OR AGC or reDefine		250 I = 1, NTPEND $R4DAT(I.J) = 0.0$	
CONTINUE  END IF  END IF  ELSE IF (IOPT .EQ. 4) THEN  NPROCS = NPROCS + 1  IDPROC(1,NPROCS) = 6  WRITE (6,*) Ramp or AGC or reDefine  PERO AGON AND OR AGC OF REDEFINE	250		
D IF  IF (IOPT .EQ. 4) THEN  ROCCS = NPROCS + 1  PROC(1, NPROCS) = 6  PROC(1, NPROCS) = 6  PROC(1, NPROCS) = 6  PROC(1, NPROCS) = 6	260	CONTINUE	
IF (IOPT .EQ. 4) THEN  ROCS = NPROCS + 1  PROC(1, NPROCS) = 6  ITE (6,*)'Ramp or AGC or reDefine		H 8	
IF (IOPT .EQ. 4) THEN  ROCS = NPROCS + 1  ROC(1, NPROCS) = 6  ITE (6,*)'Ramp or AGC or reDefine			
C(1,NPROCS) = 6 (6,*)'Ramp or AGC or reDefine		IF (IOPT .EQ. 4) ROCS = NPROCS + 1	
		C(1,NPROCS) = 6 (6,*)'Ramp or AGC or reDefine (5,490) ANS	

270 280 360 370 340 290 300 380 390 310 320 330 ELSE IF (ANS .EQ. 'D' .OR. ANS .EQ. 'd') THEN ELSE DO 280 J = 1, NCHR ELSE IF (IOP .EQ. 4) THEN ELSE IF (IOP .EQ. 3) THEN IF (IOP .EQ. 1) THEN WRITE (6, \*)'T-.5 RAMP(5)' WRITE (6,\*)'ENTER SPIKE (1), FLAT(2), T-RAMP(3), T1/2-RAMP(4)' END IF IF (ANS .EQ. 'Y' .OR. ANS .EQ. 'y') THEN WRITE (6,\*)'Taper (Y/N)' CONTINUE ELSE IF (IOP .EQ. 5) THEN ELSE IF (IOP .EQ. 2) THEN READ (5, \*) IOP READ (5,490) ANS DO 400 J = 1, NCHR IDPROC(2, NPROCS) = LENAGC READ (5,\*) LENAGC END IF WRITE (6,\*)'Enter length of AGC window in samples :' DO 350 J = 1, NCHR CONTINUE NTAPO = NSAMR - LENTAP CONTINUE DO 270 I = 1, NSAMR DO 370 J = 1, NCHR CONTINUE DO 330 J = 1, NCHR DO 310 J = 1, NCHR CONTINUE DO 300 J = 1, NCHR READ (5, \*) LENTAP WRITE (6,\*)'Enter length of taper in samples :' CONTINUE DO 390 J = 1, NCHR CONTINUE CONTINUE CALL AGC (NSAMR, 1, R4DAT(1,J), LENAGC) R4DAT(I,J) = R4DAT(I,J) \* (I - 1) \*\* 2 / 10000DO 360 I = 1, NSAMR CONTINUE DO 340 I = 1, NSAMR CONTINUE DO 320 I = 1, NSAMR R4DAT(NSAMR/2 + 1, J) = 1.0CALL ZERO (NSAMR, R4DAT(1,J)) DO 290 I = NTAPO, NSAMR CONTINUE DO 380 I = 1, NSAMR CONTINUE CONTINUE R4DAT(I,J) = 1.0R4DAT(I, J) = SQRT(REAL(I - 1))R4DAT(I, J) = 1. / SQRT(REAL(I))R4DAT(I, J) = REAL(I - 1)R4DAT(I,J) = R4DAT(I,J) \* TAPIF (I .GT. NTAPO + LENTAP) TAP = 0.0 TAP = 1.0 - REAL(I - NTAPO) / REAL(LENTAP)

IF (ANS .EQ. 'R' .OR. ANS .EQ. 'r') THEN

400

CONTINUE

```
430
440
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     410
420
                            460
                                                                                                                                                                                           450
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            ELSE IF (IOPT .EQ. 5) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 ELSE IF (IOPT .EQ. 7) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        ELSE IF (IOPT .EQ. 6) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           READ (5,*) LTAPER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         READ (5,490) ANS
                                                                                                                                                                 ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          READ (5,490) ANS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (6,*)'Remove Spike or D.C. (S/D) ?'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             RECDEP (NCHR) = RECDEP (2) - RECDEP (1) + RECDEP (NCHR - 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       NFIRST (NCHR) = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CALL ZERO (NSAMR, R4DAT (1, NCHR))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DO 440 J = NCHNLO, NCHR - 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      READ (5, *) NCHNLO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6, *)'Enter no. of channel to be removed :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 420 J = 1, LTAPER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     WRITE (6, *)'Apply / Remove Taper (A/R):'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               PI = 3.1415926535
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         READ (5,*) NTRACO, NTRAC1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,*)'Enter first and last traces with significant data:'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               WRITE (6,*)'Length of taper to be applied in traces' //
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (ANS .EQ. 'S' .OR. ANS .EQ. 's' .OR. ANS .EQ. 'M')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      NTRO = NTRACO - 1 + J
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   RECDEP(J) = RECDEP(J + 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  NTR1 = NTRAC1 + 1 - J
IF (NTRO .LE. O .OR. NTR1 .GT. NCHR) GO TO 420
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 430 I = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (ANS .EQ. 'R' .OR. ANS .EQ. 'r') FAC = 1.0 / FAC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               FAC = 0.5 * (1.0 - COS(THETA))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       THETA - PI * REAL(J) / REAL(LTAPER)
                                                                                                                                       DO 480 J = 1, NCHF
                                                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                  READ (5,*) NTRSPK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6,*)'ENTER TRACE NUMBER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                NFIRST(J) = NFIRST(J + 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 410 I = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                    DO 450 I = NSMSPK, LSMSPK
                                                                                                                                                                                                                                                                                                                                                                                                              READ (5,*) NSMSPK, LSMSPK
                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE (6,*)'ENTER SAMPLE RANGE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      R4DAT(I,NTR0) = R4DAT(I,NTR0) * FAC
R4DAT(I,NTR1) = R4DAT(I,NTR1) * FAC
                            CONTINUE
                                                                                DC = 0.0
DO 460 I = 1, NSAMR
                                                                                                                                                                                                                       R4DAT(I, NTRSPK) = ALPHA
                                                                                                                                                                                                                                                                                                     ELSE
                                                                                                                                                                                                                                                                                                                                                         IF (ANS .EQ. 'M') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               R4DAT(I, J) = R4DAT(I, J + 1)
                                                                                                                                                                                                                                                 END IF
DC = DC / REAL(NSAMR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       '(affects L-1 traces):'
                                                    DC = DC + R4DAT(I, J)
                                                                                                                                                                                                                                                                           ALPHA = .5 * (R4DAT(I - 1, NTRSPK) + R4DAT(I + 1, NTRSPK))
                                                                                                                                                                                                                                                                                                                               ALPHA = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        THEN
```

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500
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         490
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         470
                                                                                                                 520
                                                                                                                                                                                                     510
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   ELSE IF (IOPT .EQ. 8) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,*)'CALCULATE COMMON TRACE MISALIGNMENT (1=Y)?'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     FORMAT (A1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           WRITE (6,*)'Shift single or range of traces (S/R) ?'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             READ (5,*) ICORR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              IF (ANS .EQ. 'S' .OR. ANS .EQ. 's') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     READ (5,490) ANS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF (ICORR .EQ. 1) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE (6,*)'ENTER 0 TO EXIT 1 TO CONTINUE:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CALL MAXSN(LG, TEMP, GMAX1, II1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE (6,*)'ENTER CHANNELS #1, READ (5,*) I1, I2
                                                                                                                    CONTINUE
                                                                                                                                                                                                                                                                                    DO 510 I = NSAMR - NCHANG + 1, NSAMR
                                                                                                                                                                                                                                                                                                                    CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              READ (5, *) ITOSHF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE (6, *) 'ENTER FIRST SAMPLE TO SHIFT :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               READ (5, *) NCHANG
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE (6,*)'Enter shift (rotational) to be applied :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE (6, *)'POSITIVE shift reduces travel time!'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      READ (5, *) NTRA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6, *)'Enter no. of trace
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IF (IGO .NE. 1) GO TO 570
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 READ (5,*) IGO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE (6, *)'LAG implies INCREASE times on trace2.'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IF (GMAX1 .GT. GMAX) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE (6,*) GMAX, II, GMAX1, II1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CALL CROSS (NSAMR, R4DAT(1, I2), NSAMR, R4DAT(1, I1), LG,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CALL MAXSN(LG, TEMP, GMAX, II)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL CROSS (NSAMR, R4DAT(1, I1), NSAMR, R4DAT(1, I2), LG,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     READ (5, *) LG
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                WRITE (6, *) 'ENTER MAX LAG :'
                        IF (ANS .EQ. 'Y' .OR. ANS .EQ. 'y') THEN
                                                                                                                                                                                                     CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DO 500 I = ITOSHF, NSAMR - NCHANG
                                                        READ (5, 490) ANS
                                                                                   WRITE (6,*)'Taper the trace (Y/N) ?'
                                                                                                                                                                       DO 520 I = 1, NSAMR
                                                                                                                                          R4DAT(I,NTRA) = TEMP(I)
                                                                                                                                                                                                                              TEMP(I) = R4DAT(I - NSAMR + NCHANG, NTRA)
                                                                                                                                                                                                                                                                                                                                               END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6,*)'TRACE 2 LAGS TRACE1 BY:', II - 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    WRITE (6,*)'TRACE 2 LEADS TRACE1 BY :', II1 - 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DO 470 I = 1, NSAMR
                                                                                                                                                                                                                                                           IF (I .GT. NSAMR) GO TO 510
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF ((I + NCHANG) .LT. ITOSHF) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (I .GT. NSAMR) GO TO 500
WRITE (6,*)'Enter start of taper in samples :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        R4DAT(I,J) = R4DAT(I,J) -
                                                                                                                                                                                                                                                                                                                                                                                                                                   GO TO 500
                                                                                                                                                                                                                                                                                                                                                                                                                                                               TEMP(I) = 0.0
                                                                                                                                                                                                                                                                                                                                                                           TEMP(I) = R4DAT(I + NCHANG, NTRA)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         #2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ٠.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      TEMP)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            TEMP)
```

PRINT \*, ' TRACE ', J, ' DC = ', DC

```
550
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    540
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        530
                                                                                                                                                                                                                                                                                                                                                                          560
570
                                                                                                                                                                                                                                                                                                                         ELSE IF (IOPT .EQ. 9) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         ELSE
                                                                                                                                                                                                                                    READ (5,490) ANS IF (ANS .EQ. 'a') THEN
                                                                                                                                                                                                                                                                                                                                               END IF
                                                                                                                                                                                                                                                                                                WRITE (6, *)'Apply current gains or enter New ones (A/N)?'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE (6,*)'POSITIVE shift reduces travel time of traces!'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            END IF
                                                                                                                                                                                                                                                                                                                                                                          CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 570 J = NTOGOO, NTOGO1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE (6,*)'ENTER SHIFT TO APPLY IN SAMPLES :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       READ (5,*) NTOGOO, NTOGO1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               WRITE (6,*)'ENTER 1ST AND LAST TRACES TO SHIFT : '
                                                                                                                         END IF
                                                                                                                                                                                                NCR(2) = 14
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   READ (5,*) NSHIFT
                                                                                                  DO 590 J = 1, NCHR
                                                                                                                                                                        IF (NCR(1) .EQ. 12 .AND. NCR(2) .GE. 13) THEN
                                                                                                                                                                                                                         NCR(1) = 12
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   DO 540 I = 1, 50
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 530 I = NTAPO, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  NFIRST(J) = NFIRST(J) - NSHIFT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                WRITE (6,*)'Enter length of taper in samples :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     READ (5,*) NTAPO
                       DO 580 I = 1, NSAMR
                                                 DBGAIN(J) = 0.0
                                                                        RMULT = 10 ** (-DBGAIN(J)/20.0)
                                                                                                                                                 CALL ZERO (NCHR, DBGAIN)
                                                                                                                                                                                                                                                                                                                                                                                                  CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DO 560 I = I0, IL, ISIG
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IF (ISIG .LT. 0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 I0 = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ISIG = ISIGN(1, ISHIFT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ISHIFT = NSHIFT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     AVERAG = 2.0 * AVERAG / REAL (NSAMR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 550 I = NSAMR / 2 + 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     AVERAG = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           AVER0 = AVER0 / 50.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           AVER0 = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           READ (5, *) LENTAP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IL = NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            TAP = 1.0 - REAL(I - NTAPO) / REAL(LENTAP)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    AVERAG = AVERAG + R4DAT(I, J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           R4DAT(I,NTRA) = R4DAT(I,NTRA) * TAP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IF (I .GT. NTAPO + LENTAP) TAP = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                         END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                        ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IL = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          AVER0 = AVER0 + R4DAT(I, J)
R4DAT(I,J) = R4DAT(I,J) * RMULT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ELSE IF (I + ISHIFT .LE. NSAMR) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      IF (I + ISHIFT .LE. 0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      IO = NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          R4DAT(I, J) = AVER0
                                                                                                                                                                                                                                                                                                                                                                                                                                               R4DAT(I, J) = AVERAG
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                R4DAT(I,J) = R4DAT(I + ISHIFT,J)
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C
C ASSUME NCR(1) IS HIGHER COMMON TRACE
C AND COMMON SHOT TRACES AF
C
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         000
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           O
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  620
630
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               600
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          590
                                                                                                                                                                                                                                                                                                                                                                                                                        640
                                                                                         650
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           Z.B.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            COMMON SHOT TRACES ARE TOP 12 AND BOTTOM 12
                                                                                                                                                                                                                                                                                                                                                                           ELSE IF (IOPT .EQ. 10) THEN
                                                                                                                                                                                                                                                                                                                                                    WRITE (6,*)'AUTOMATIC PICK : 1=Y 0=N ?'
                                                                                                                                                                                                                                                                                                                                 READ (5,*) IREPLY
                                                                                                                                                                                                                                                                                                                                                                                                    END IF
                                                                                                                                                                                                                                                                                                              IF (IREPLY .EQ. 1) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CHANGED NEXT LINE
                                                                                                                                                                                                                                                                                                                                                                                                                       CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       DO 640 I = 1, NCHR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IF (ANS .EQ. 'Y' .OR. ANS .EQ. 'y') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WRITE (6,*)'Equate rms amps of common receiver channels ?'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CONTINUE
                                                                                                                                                                                                                                           WRITE (6, *) 'ENTER significant no. of S.D.s:'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  READ (5,490) ANS
                                                                                                                                                                                                  DO 680 J = 1, NCHR
                                                                                                                                                                                                                        READ (5, *) SSDS
                                                                                                                                                                                                                                                                  READ (5, *) NO
                                                                                                                                                                                                                                                                                       WRITE (6, *)'ENTER FIRST SAMPLE TO BEGIN ESTIMATE:'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IDPROC(2, NPHOCS) = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   NPROCS = NPROCS + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IDPROC(1, NPROCS) = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CALL RMSERR(NSAMR, R4DAT(1,NCR(1)), SCALE1, INDAMP)
CALL RMSERR(NSAMR, R4DAT(1,NCR(2)), SCALE2, INDAMP)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        SCALE = SCALE1 / SCALE2
                                                                                                                                                                     DO 670 I = NO, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                          READ (5, *) DBGAIN(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6,*)'Enter gain in dB for channel #', I
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IF (NCR(1) .EQ. 12 .AND. NCR(2) .GE. 13) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  PRINT *, 'IDTRAC =', IDTRAC,
DO 630 J = IDTRAC, NCHR, 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DO 610 J = 13, 24
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IDPROC(2, NPROCS) = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CONTINUE
                      DO 660 III = 1, I - 1
                                               RMERR = 0.0
                                                                  RMEAN = RMEAN / REAL(I - 1)
                                                                                         CONTINUE
                                                                                                                                   DO 650 III = 1, I - 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IDTRAC = 2 - MOD(NCR(2), 2)
                                                                                                                                                        RMEAN = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 600 I = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DO 620 I = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CONTINUE
DIF = R4DAT(III, J) - RMEAN
                                                                                                            RMEAN = RMEAN + R4DAT(III, J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        R4DAT(I, J) = R4DAT(I, J) * SCALE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         R4DAT(I,J) = R4DAT(I,J) * SCALE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         COMMON SHOT TRACES ARE ALTERNATE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          SHOULD BE
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    670
680
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               660
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              690
                                                                                                                                                                                                                       740
                                                                                                                                                                                                                                                                     720
730
                                                                                                                                                                                                                                                                                                                                                                    710
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        700
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Deviations from mean value to that sample.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       Criterion that 1st difference is greater than NSSDS Standard
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                ELSE IF (IOPT .EQ. 11) THEN
                                                                                                                                                                                                                                              ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             WRITE (6,*)'APPLY SAME MUTE TO ALL TRACES (1=Y;0=N) :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    WRITE (6,*) NFIRST
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IF (IOANS .EQ. 1) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        READ (5,*) IOANS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 690 I = 1, NCHR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 730 J = 1, NCHR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                READ (5,*) NTAP10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CONTINUE
                                                                 READ (5,*) NGOO, NGO1
                                                                                            WRITE (6,*)'ENTER FIRST AND LAST TRACES TO APPLY MUTE'
                                                                                                                 READ (5,*) NTAP00
                                                                                                                                             WRITE (6,*)'Enter start of cosine taper (0=1st break):'
                                                                                                                                                                  IF (NTAP1 .EQ. 0) GO TO 780
                                                                                                                                                                                           READ (5,*) NTAP10
                                                                                                                                                                                                                  WRITE (6, *)'Enter length of cosine taper (0=NO mute):'
                                                                                                                                                                                                                                                                   CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           READ (5,*) NTAP00
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE (6,*)'Enter start of cosine taper (0=1st break):'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IF (NTAP10 .EQ. 0) GO TO 730
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE (6,*)'Enter length of cosine taper in samps :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CONTINUE
                                              DO 780 J = NG00, NG01
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   READ (5, *) NFIRST(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CONTINUE
                     NTAPO = NFIRST(J) + NTAPOO
                                                                                                                                                                                                                                                                                          CONTINUE
                                                                                                                                                                                                                                                                                                                                             DO 720 I = 1, NTAPO
                                                                                                                                                                                                                                                                                                                                                                    CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    DO 710 I = NTAPO + 1, NTAP1 - 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     NTAP1 = NTAP10 + NTAP0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            NTAPO = NFIRST(J) + NTAPOO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE (6,*)'Enter 1st break SAMPLE for channel #', I
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 END IF
NTAP1 = NTAP10 + NTAP0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IF (NTAP1 - 1 .GT. NSAMR .OR. NTAPO .LT. 1) THEN
                                                                                                                                                                                                                                                                                                                                                                                         R4DAT(I,J) = R4DAT(I,J) * FAC
                                                                                                                                                                                                                                                                                                                                                                                                                                       FAC = FAC * 3.1415926535
                                                                                                                                                                                                                                                                                                                                                                                                                                                                 FAC = REAL(I - NTAPO) / REAL(NTAP1 - NTAPO)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        GO TO 700
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             WRITE (6,*)'ERROR NTAP0, NTAP1 = ', NTAP0, NTAP1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE (6,*)'CHANNEL', J
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (DIFO .GT. SSDS*RMERR) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           RMERR = RMERR / REAL(I - 1)
RMERR = SQRT(RMERR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                FAC = 0.5 * (1.0 - COS(FAC))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        DIFO = ABS(R4DAT(I,J) - R4DAT(I - 1,J))
                                                                                                                                                                                                                                                                                                                   R4DAT(I,J) = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          GO TO 680
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             NFIRST(J) = I
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    RMERR = RMERR + DIF ** 2
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C.Subroutine to carry out simple 2D Fourier transform (Claerbout)
                                                                                                       10 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                10 CONTINUE
                                                                                                                                                                                                                                                                                                                  10 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                   DO 10 I = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                        SUBROUTINE MAXAMP (NSAMR, X, AMPMAX, INDAMP)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             RMS = SQRT (RMS)
                                                                                                                                                                                                                                                                                  END
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DO 10 I = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    REAL X (NSAMR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   SUBROUTINE RMSERR (NSAMR, X, RMS)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         END
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       GO TO 10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         ELSE IF (IOPT .EQ. 0) THEN
                                                                                    DO 40 J = 1, N1
                                                                                                                                        DO 10 I = 1, N2
                                                                                                                                                          REAL SIGNA, SIGNB
                                                                                                                                                                           COMPLEX CP (N1, N2), CW (N2)
                                                                                                                                                                                                           SUBROUTINE FT2D (N1, N2, CP, SIGNA, SIGNB, CW)
                                                                                                                                                                                                                                                                                                    RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                         AMPMAX = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                         REAL X (NSAMR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 RMS = RMS / NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    RMS = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         END IF
                                                                                                                                                                                          INTEGER N1, N2
                                    CONTINUE
                                                                    DO 20 K = 1, N2
                                                                                                                   CALL FORK(N1, CP(1,1), SIGNA)
                                                                                                                                                                                                                                                                                                                                  END IF
                                                                                                                                                                                                                                                                                                                                                                                      IF (ABS(X(I)) .GT. AMPMAX) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 RMS = RMS + X(I) ** 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           END IF
DO 30 L = 1, N2
                CALL FORK (N2, CW, SIGNB)
                                                  CW(K) = CP(J, K)
                                                                                                                                                                                                                                                                                                                                                      INDAMP = I
                                                                                                                                                                                                                                                                                                                                                                     AMPMAX = ABS(X(I))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 IF (NTAP1 - 1 .GT. NSAMR .OR. NTAP0 .LT. 1) THEN
WRITE (6,*)'ERROR NTAP0,NTAP1 = ', NTAP0, NTAP1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 770 I = 1, NTAPO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DO 760 I = NTAPO + 1, NTAP1 - 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  GO TO 780
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         R4DAT(I,J) = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             FAC = FAC * 3.14159265
FAC = 0.5 * (1.0 - \cos(FAC))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            R4DAT(I,J) = R4DAT(I,J) * FAC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              FAC = REAL(I - NTAPO) / REAL(NTAP1 - NTAPO)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          0 0 0 0 0 0 0 0 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                           റററ
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40 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          START PLOTTING ROUTINES
                                                                                         IHIGH = 0
IGRID = 0
                                                                PRINT *, 'NK, NF, NCHTS, CHTS, IFAIL, ICH', NK, NF, NCHTS, CHTS, IFAIL,
                                                                                                                                                                                                                                                                                                                                                                                                                                                             CALL PSPACE(0.05, 0.75, 0.05, 0.9)
CALL MAP(0.0, 1.0, 0.0, 1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       NLF = NINT (FMAX*NF/FNYQ)
                  CALL PSPACE(0.05, 0.75, 0.05, 0.9)
                                                                                                                                                                                                                                                         END IF
                                                                                                                                                                                                                                                                                                       ELSE
                                                                                                                                                                                                                                                                                                                                                                                                 CALL JO6XFF(2)
                                                                                                                                                                                                                                                                                                                                                                                                                   CALL J06XBF (0.0, 1.0, 0.0, 1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                               CALL JOSKAF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         PRINT *, 'NK, NF =', NK, NF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              KNYQ = .5 / DZ

FMIN = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CHARACTER LOGYN*1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            END
CALL MAP (0.0, 1.0, 0.0, 1.0)
                                                                                                                                                                                                                                                                                                                                                    IF (LOGYN .EQ. 'Y') THEN
                                                                                                                                                                                                                                                                                                                                                                          CALL J06XGF (1.0, 2.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL GPSTOP (30)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL PAPER(1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               PRINT *, IFACE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CALL JOOAAF (IFACE)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CALL X04AAF(1, 10)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  PRINT *, 'KMIN, KMAX =', KMIN, KMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  KMAX = -KMIN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          KMIN = - (KNYQ)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DOUBLE PRECISION ARR(NK,NF), CHTS(8)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   SUBROUTINE FKPLOT(NK, NF, ARR, DT, DZ, FMAX, NCHTS, CHTS, LOGYN)
                                                                                                                                       ILAB = 2
                                                                                                                                                                MB = NK
                                                                                                                                                                                      NA = 1
                                                                                                                                                                                                            MA = 1
                                                                                                                                                                                                                                  IFAIL = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ICH = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           FNYQ = .5E6 / DT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   EXTERNAL JOGGBY, JOGGBW
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            REAL DT, DZ, KNYQ, KMIN, KMAX, FMIN, FMAXD
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     INTEGER NK, NF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         LOGICAL UNUSED (65, 1024)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     N.B. Sample order in K --->
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         Routine to plot F-K amp. spectrum contained in the array ARR(NK,NF)
                                                                                                                                                                                                                                                                                                                        CALL J06AHF('F-K Amplitude Spectrum (dB)')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DT, DZ
                                                                                                                                                                                                                                                                               CALL J06AHF ('F-K Amplitude Spectrum (linear)')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CP (J, L) =
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     no. of contour levels
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          temporal and spatial sampling intervals in microsecs and metres
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  no. of frequencies ,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CW(L)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                wavenumbers for plot
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 nk/2 + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 = -knyq
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      = +knyq
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DRAW CONTOUR KEY
                                                                                                                                                                                                                                                      10
spectrum
                        . subroutine to calculate pie slice filter for application to FK
                                                                                                                                         20
30
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 10 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     Apply agc of length LEN to data in array X
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      IF (LOGYN .EQ. 'Y') CALL PCSCEN(0.5, 0.8, 'dB scale') CALL PSPACE(0.77, 0.99, 0.5, 0.78)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL CTRMAG(15)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             PRINT *, 'KMIN, KMAX, FMIN, FMAX = ', KMIN, KMAX, FMIN, FMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            PRINT *, 'IFAIL =', IFAIL CALL PSPACE(0.05, 0.75, 0.05, 0.9)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL JO6GBF (ARR, NK, MA, MB, NA, NLF, NCHTS, CHTS, ICH, JO6GBY,
                                                                                  END
                                                                                                                                         CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                REAL X (NSAMR, NCHR), XPRIME (1024)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          SUBROUTINE AGC (NSAMR, NCHR, X, LEN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL GREND
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CALL CTRMAG(12)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CALL MAP (0.0, 1.0, YSIZE, 0.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 YSIZE = REAL(NCHTS) + 0.1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CALL BORDER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CALL CTRMAG(20)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CALL MAP (0.0, 1.0, 0.0, 1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CALL PSPACE(0.77, 0.99, 0.8, 0.9)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  PRINT *, 'IFAIL = ', IFAIL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL AXES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL AXORIG(KMIN, FMIN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CALL BORDER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL MAP (KMIN, KMAX, FMIN, FMAX)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CALL J06XGF(1.0, 2.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL JOSXFF(2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CALL J06XBF(0.0, 1.0, 0.0, 1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        DO 30 J = 1, NCHR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      DO 10 I = 1, NCHTS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CALL PCSCEN(0.5, 0.3, 'CONTOUR KEY')
                                                                                                               RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL PLOTNI (0.1, XI, I)
CALL PLOTNE (0.35, XI, HEIGHT, 1)
                                                                                                                                                                    CONTINUE
                                                                                                                                                                                                                    DO 20 I = 1, NSAMR
                                                                                                                                                                                                                                                      CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                           DO 10 ICEN = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              HEIGHT = REAL(CHTS(I))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           XI = REAL(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CALL ZERO(NSAMR, XPRIME)
                                                                                                                                                                                              X(I,J) = XPRIME(I)
                                                                                                                                                                                                                                                                                                                                 CALL RMSERR(LO, X(ICEN - LO/2, J), RMS)
                                                                                                                                                                                                                                                                              XPRIME(ICEN) = X(ICEN, J) / RMS
                                                                                                                                                                                                                                                                                                                                                                                 IF (ICEN .LE. LEN/2) L0 = 2 \times ICEN - 1
                                                                                                                                                                                                                                                                                                                                                                                                                     LO = LEN
                                                                                                                                                                                                                                                                                                         IF (RMS .EQ. 0.0) GO TO 10
                                                                                                                                                                                                                                                                                                                                                                IF (ICEN .GT. NSAMR - LEN/2) L0 = (NSAMR - ICEN + 1) * 2 - 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             ILAB, IHIGH, JO6GBW, IGRID, UNUSED, IFAIL)
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                40
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    20 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Note: must wrap around sample #1 to sample #nk before calling routine
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    REMEMBER TO TRANSFORM TO CORRECT QUADRANTS IN MAIN ROUTINE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       sample ordering in K space is 1 = -KNQ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                               READ (5, 10) ANS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ELSE IF (ANS .EQ. 'R' .OR. ANS .EQ. 'r') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DO 20 K = 1, NK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          FL = NF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           READ (5, 10) ANS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,*)'ZERO QUADRANT (L/R/No) ?
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              KKNYQ = NK / 2 * DK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    DOUBLE PRECISION HISLOP, HICTSL, LOSLOP, LOCTSL, M3, M6
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE (6,*)'TAPER INWARDS OR OUTWARDS FROM SLOPE (1/0) ?'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF (ANS .EQ. 'L' .OR. ANS .EQ. 'l') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     KL | NK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               KO = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     F0 = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           KNYQ = NK / 2 + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         PI = 3.1415926535
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CHARACTER*1 ANS, PORR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              INTEGER KNYQ, FNYQ, KO, KL, FO, FL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             REAL PIEFLT (NF, NK), DIST, RHISLO, RHICTS, RLOSLO, RLOCTS, RM3,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       SUBROUTINE PIE(NK, NF, PIEFLT, DK, DF, PORR)
                                                                                                                                                                                                                                                                                                                                                                                            IF (ANS .EQ. 'O' .OR. ANS .EQ. 'o') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                          READ (5,*) HISLOP
                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE (6,*)'INPUT HIGH CUTOFF SLOPE (m/sec) (-VE for L quad)
END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CONTINUE
                                                                                                                                                                                                                                                         ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              KL = KNYQ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DO 30 K = 1, KNYQ - 1
                                                                                                                                                                                                                                                                                                                                  READ (5,*) HICTSL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      DO 40 K = KNYQ + 1, NK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              KO = KNYQ
                                                                                                                                                                                                                                                                                                              IF (HISLOP + HICTSL .EQ. 0.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL ZERO(NF, PIEFLT(1,K))
                             IF (HISLOP .LT. 0.0 .AND. HICTSL .GE. HISLOP) MULT2 = -1
                                                     IF (HICTSL .LT. 0.0) MULT1 = -1
                                                                                     MULT2 = 1
                                                                                                             MULT1 = 1
                                                                                                                                        PRINT *, 'HISLOP, HICTSL, M3', HISLOP, HICTSL, M3
                                                                                                                                                                        END IF
                                                                                                                                                                                                                                                                                                                                                                    WRITE (6, *)'INPUT HIGH CUTOFF TAPER SLOPE
                                                                                                                                                                                                                         M3 = ((HISLOP*HICTSL - 1) - SQRT(HISLOP**2 + HICTSL**2 + (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CALL ZERO(NF, PIEFLT(1,K))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         must also have data arranged in appropriate sequence
                                                                                                                                                                                                HISLOP*HICTSL)**2 + 1)) / (HISLOP + HICTSL)
                                                                                                                                                                                                                                                                                      M3 = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CALL ZERO(NF, PIEFLT(1,K))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   require an odd no. of samples e.g 65,129,257
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    RM6, KKNYQ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   nk = +KNYQ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 nk/2+1 = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      (L = -Kspace)'
                                                                                                                                                                                                                                                                                                                                                                    (m/sec) :'
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0 0 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      50
                                                                                                                   NOTE : COSM3 TERM CANCELS OUT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  RLOCTS = REAL(LOCTSL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IF (ANS .EQ. 'O' .OR. ANS .EQ. 'o') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           RM6 = REAL(M6)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         RM3 = REAL(M3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              RLOSLO = REAL(LOSLOP)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         RHICTS = REAL(HICTSL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        RHISLO = REAL(HISLOP)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   READ (5, *) LNTAPF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE (6,*)'INPUT LENGTH OF TAPER FOR F-SPACE (samples) :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           READ (5, *) LNTAPK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (6,*)'INPUT LENGTH OF TAPER FOR K-SPACE (samples) :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              READ (5, *) NWRAPS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             WRITE (6, *)'Enter no. of wraparounds required'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        READ (5,*) LOSLOP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WRITE (6,*)'INPUT LOW CUTOFF SLOPE (m/sec) (-VE for L quad) :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IF (ANS .EQ. 'O' .OR. ANS .EQ. 'o') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IF (ANS .EQ. 'I' .OR. ANS .EQ. 'i') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       MULT3 = 1
MULT4 = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              READ (5,*) NSAMTP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE (6,*)'INPUT LOW CUTOFF TAPER SLOPE (m/sec) :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    DO 70 J = K0, KL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE (6,*)'Enter frequency axis intercepts Hicut, Hizero,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    WRITE (6,*)'INPUT DISTANCE IN SAMPLES FOR TAPER :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IF (LOCTSL .LT. 0.0) MULT3 = -1
IF (LOSLOP .LT. 0.0 .AND. LOCTSL .LE. LOSLOP) MULT4 = -1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (6,*)'RHICTS, RHCTIN, MULT1 ', RHICTS, RHCTIN, MULT1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  READ (5,*) RHSLIN, RHCTIN, RLSLIN, RLCTIN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 PRINT *, 'LOSLOP, LOCTSL, M6', LOSLOP, LOCTSL,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IF (LOSLOP + LOCTSL .EQ. 0.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     READ (5, *) LOCTSL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               WRITE (6,*)'RHISLO, RHSLIN, MULT2', RHISLO,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             LOSLOP*LOCTSL)**2 + 1)) / (LOSLOP + LOCTSL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      M6 = ((LOSLOP*LOCTSL - 1) - SQRT(LOSLOP**2 + LOCTSL**2 + (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                M6 = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                       DO 60 I = 1, NF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                     X = DK * (J - KNYQ)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                PRINT *, 'J = ', J
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          JIND = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IF (NWRAPS .EQ. 0 .AND. J
                                                                                                                                                                                                                                                                                                                                                                          IF (DIST(X, Y, RHICTS, RHCTIN, MULT1) .GT. 0.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                           Y = DF * (I - 1)
                                                                                                                                                                                                                                                                                                                     ELSE IF (DIST(X, Y, RHISLO, RHSLIN, MULT2) .GT. 0.0)
ELSE IF (DIST(X,Y,RLOSLO,RLSLIN,MULT3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     'Locut, Lozero :'
                                                                                                                                                                        D2 = (Y - HICTSL*X - RHCTIN) / (HICTSL - M3)
D1 = ABS(D1)
D2 = ABS(D2)
                         RESP = 0.5 \times (1 - \cos(\text{THETA}))
                                                                                                                                                                                                                                                                D1 = (Y - HISLOP * X - RHSLIN) / (HISLOP - M3)
                                                         THETA = PI * D2 / (D1 + D2)
                                                                                                                                                                                                                                                                                                                                                      RESP = 0.0
                                                                                                                                                                                                                                                                                               THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            EQ.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            33) JIND = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  RHSLIN,
  .GT.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      30
  .0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    MULT2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   .
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70
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DO 90 J = K0, KL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      MULT = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF (NWRAPS .NE. 0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    PRINT *, 'HISLOP, LOSLOP, D0, D1', HISLOP, LOSLOP, D0, D1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    D1 = -D0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                D0 = -REAL(NSAMTP)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IF (HISLOP .LT. 0.0 .AND. LOSLOP .GT. 0.0) MULT = -1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             HISLOP = HISLOP / (DF/DK)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  LOSLOP = LOSLOP / (DF/DK)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DO 80 I = 1, NF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               GO TO 50
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 RHSLIN = 2.0 * ABS (RHISLO) * KKNYQ + RHSLIN RLSLIN = 2.0 * ABS (RLOSLO) * KKNYQ + RLSLIN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           PRINT *, 'INTERCEPTS :', RHCTIN, RHSLIN, RLSLIN, RLCTIN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         RLCTIN = 2.0 * ABS(RLOCTS) * KKNYQ + RLCTIN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           RHCTIN = 2.0 * ABS(RHICTS) * KKNYQ + RHCTIN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               X = REAL(J - KNYQ)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         NWRAPS = NWRAPS - 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             ELSE
                                                                                                                                                                                                                                                                                                                                                                                               ELSE IF (DIST(X, Y, RHISLO, RHSLIN, MULT) .GT. DO .AND. DIST(X,
                                                                                                                                                                                                                                                                                                                                                                                                                                                   IF (DIST(X, Y, RHISLO, RHSLIN, MULT) .GT. 0.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Y = REAL(I - 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 IF (PIEFLT(I,J) .GT. 0.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          ELSE IF (DIST(X, Y, RLOCTS, RLCTIN, MULT4) .GT. 0.0)
                           ELSE
                                                                                                                                                                    ELSE IF (DIST(X, Y, RLOSLO, RLSLIN, 1) .GT. D1) THEN
                                                                                                             ELSE IF (DIST(X, Y, RLOSLO, RLSLIN, 1) .GT. 0.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IF (RESP .EQ. 0.0) GO TO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  PIEFLT(I, J) = RESP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      PIEFLT(I, J) = PIEFLT(I, J) * RESP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      RESP = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             RESP = 0.5 * (1 - COS(THETA))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 D2 = ABS(D2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            D1 = ABS(D1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   D1 = (Y - LOSLOP*X - RLSLIN) / (LOSLOP -
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        RESP = 1.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      THETA - PI * D2 / (D1 + D2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          D2 = (Y - LOCTSL*X - RLCTIN) / (LOCTSL -
RESP = 0.0
                                                      RESP = 0.5 * (1 - COS(THETA))
                                                                                                                                           RESP = 1.0
                                                                                                                                                                                                  END IF
                                                                                                                                                                                                                                                                               IF (DIST(X,Y,RLOSLO,RLSLIN,1) .LE. D1) THEN
                                                                                                                                                                                                                                                                                                                                           THETA = DIST(X,Y,RHISLO,RHSLIN,MULT) * PI / DO
                                                                                                                                                                                                                                                                                                                                                                                                                                  RESP = 0.0
                                                                               THETA = DIST(X,Y,RLOSLO,RLSLIN,1) * PI / D1
                                                                                                                                                                                                                                                                                                                  RESP = 0.5 * (1 - COS(THETA))
                                                                                                                                                                                                                             RESP = RESP * 0.5 * (1 - \cos(THETA))
                                                                                                                                                                                                                                                         THETA = DIST(X, Y, RLOSLO, RLSLIN, 1) * PI / D1
                                                                                                                                                                                                                                                                                                                                                                         Y, RLOSLO, RLSLIN, 1) .GT. 0.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          M6)
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    140 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        110
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            100
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        90
                       10 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  NOW SET LOW NYQUIST (-KNYQ) TO HIGH NYQUIST (+KNYQ)
                                                                                                                                                                                                                                                                                                                                                                                                   Subroutine to bandpass filter data using linear dB/Octave taper
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DO 140 I = 1, NF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         FUNCTION DIST(X, Y, M, INTERC, MULT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            END IF
                                                                     DO 10 I = 1, NSAMR
                                                                                                                                                                                                    DDBHIG = (ABS(DBHIGH))
                                                                                                                                                                                                                              DDBLOW = (ABS(DBLOW))
                                                                                                                                                                                                                                                                     REAL ALPHA, DDBLOW, DDBHIG, F, FOLOW, FOHIGH
                                                                                                                                                                                                                                                                                                                                               SUBROUTINE BPSDBS(X, NSAMR, CX, FLOWCT, FHICUT, DBLOW, DBHIGH
                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DIST = ((Y - M*X - INTERC)/SQRT(1 + M**2)) * MULT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        REAL DIST, M, INTERC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IF (LNTAPF .GT. 0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   IF (LNTAPK .GT. 0) THEN
CALL FORK (NSAMR, CX, -1.0)
                                                                                                                            FOHIGH = FNYQ
                                                                                                                                                  IF (DDBLOW .GT. 1E-3) FOLOW = FLOWCT * 2.0E0 ** (3.0E0/DDBLOW)
                                                                                                                                                                              F0LOW = 0.0D0
                                                                                                                                                                                                                                                      COMPLEX CX (NSAMR)
                                                                                                  IF (DBHIGH .GT. 1E-3) FOHIGH = FHICUT * 2.0E0 ** (-3.0E0/DDBHIG)
                                                                                                                                                                                                                                                                                                    REAL X (NSAMR)
                                             CX(I) = CMPLX(X(I), 0.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          PIEFLT(I,1) = PIEFLT(I,NK)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DO 130 J = 1, NK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DO 110 J = KL - LNTAPK, KL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 120 I = 1, LNTAPF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       FAC = 0.5 * (1.0 - COS(THETA))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      LOWLT = KL - J + KO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   DO 100 I = 1, NF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           THETA = PI - THETA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 THETA = REAL(J - (KL - LNTAPK)) / LNTAPK * PI
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  THETA = REAL(I - 1) / LNTAPF * PI

FAC = 0.5 * (1.0 - COS(THETA))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    PIEFLT(I, LOWLT) = PIEFLT(I, LOWLT) * (FAC)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            PIEFLT(I,J) = PIEFLT(I,J) * FAC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         PIEFLT(I, J) = PIEFLT(I, J) \star (FAC)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IF (PIEFLT(I, J) .GT. 0.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           PIEFLT(I, J) = RESP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         PIEFLT(I,J) = PIEFLT(I,J) * RESP
                                                                                                                                                                                                                                                                                                                            FNYQ)
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ი :
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            30 CONTINUE
                          20 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                        10 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            40 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      20 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          SUBROUTINE TO BANDPASS FILTER DATA USING COSINE TAPER
                                                                                                                                                                                                                                                                                                                                                                                                                              CALL FORK (NSAMR, CX, -1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DO 10 I = 1, NSAMR

CX(I) = CMPLX(X(I), 0.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DO 30 I = LL + 1, NSAMR

CX(I) = CONJG(CX(NSAMR - I + 2))
                                                                                                                                                                                                                                                                                                                                                                       DO 20 I = 1, LL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 40 I = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        SUBROUTINE BPSCOS (X, NSAMR, CX, FLOWCT, FHICUT, FLOOFF, FHIOFF,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DO 20 I = 1, LL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DF = 2.0 * FNYQ / NSAMR
DO 30 I = LL + 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                 LL = NSAMR / 2 + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IHIOFF = INT(FHIOFF*SAMHZ) + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IHICUT = INT(FHICUT*SAMHZ) + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  LOOFF = INT(FLOOFF*SAMHZ) + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        LOCUT = INT(FLOWCT*SAMHZ) + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  SAMHZ = 0.5 * NSAMR / FNYQ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          PI = 3.1415926535
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  COMPLEX CX (NSAMR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            REAL X (NSAMR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CALL FORK (NSAMR, CX, +1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  LL = NSAMR / 2 + 1
                                                                                                                                                                                                  ELSE IF (I .LE. IHICUT) THEN
CX(I) = CX(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  X(I) = REAL(CX(I))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   F = ((I - 1)*DF)
                                                  END IF
                                                                                                  ELSE
                                                                                                                                                                            ELSE IF (I .LE. IHIOFF) THEN
                                                                                                                                                                                                                                                                                                    ELSE IF (I .LE. LOCUT) THEN
                                                                                                                                                                                                                                                                                                                                                      IF (I .LE. LOOFF) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CX(I) = CX(I) * REAL(ALPHA)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          ALPHA = 10.0E0 ** ALPHA
ELSE IF (F .LT. FOHIGH) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  ELSE IF (F .LT. FOLOW) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF (F .LT. 1E-2) THEN
                                                                                                                     IHICUT)))
                                                                                                                                                                                                                                                      LOOFF)))
                                                                                                                                                                                                                                                                       CX(I) = CX(I) * 0.5 * (1.0 + COS((LOCUT - I)*PI/(LOCUT - I))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          ALPHA = 10.0D0 ** ALPHA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            ALPHA = 0.0
                                                                       CX(I) = 0.0
                                                                                                                                                  CX(I) = CX(I) * 0.5 * (1.0 + COS((I - IHICUT)*PI/(IHIOFF -
                                                                                                                                                                                                                                                                                                                              CX(I) = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ALPHA - 1.0E0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          ALPHA = DDBLOW / 20.0E0 * (LOG10(F/F0LOW)) / (LOG10(2.0E0))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  ALPHA = DDBHIG / 20.0E0 * (LOG10(F0HIGH/F)) / (LOG10(2.0E0))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  FNYQ)
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CX(I) = CONJG(CX(NSAMR - I + 2))
30 CONTINUE
CALL FORK(NSAMR, CX, +1.0)
DO 40 I = 1, NSAMR
X(I) = REAL(CX(I))
40 CONTINUE
RETURN
END
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20
                   60
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               Open disc file if needed
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            RADAT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       Written by M J Findlay 1987-1989
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            requires SUBROUTINE RDNIM1 in NIMRWSUB for TAPES : reads in arrays to
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         Additional subroutines for use with XHR programs
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CHARACTER*25 PROC(20)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            SUBROUTINE RDFILE (NSAMR, NCHR, NRECS, R4DAT, NFIRST, RECDEP,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      IF (IPSOUR .EQ. 'DISC') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CHARACTER IPDISC*17, IPSOUR*4, A*180, INPOPT*3, B(9)*20
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   DIMENSION GCMSCL(NCHR), NFILE(2), NCR(2), IDPROC(5,NCHR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DIMENSION R4DAT (NSAMR, NCHR), NFIRST (NCHR), RECDEP (NCHR),
                                                                                                                                                                                                                                                                                                                                                                               ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (NFILES .EQ. 1) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL ZERO(K24, R4DAT(1,1))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          K24 = 1024 * NCHR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF (INPOPT .EQ. 'NEW') GO TO 70 IF (INPOPT .EQ. 'SGY') GO TO 160
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CHARACTER ANS*1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   INTEGER*2 I2DAT (NS1, NS2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  PARAMETER (NS1=1024, NS2=12)
END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              OPEN (10, FILE=IPDISC, STATUS='OLD', ACCESS='DIRECT', RECL=ILEN)
                                                                                                                                                                                                                                                                                                                                                                                                 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   DO 20 J = 1, NCHR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CALL RDNIM1 (12DAT, NCHR, NSAMR, NFILE (1), INPCHN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          PRINT *, NCHR, NSAMR, NFILE(1), INPCHN
                   CONTINUE
                                                                                                                                                             CALL RDNIM1 (I2DAT, NCHR, NSAMR, NFILE(2), INPCHN)
                                                                                                                                                                                                                                                                                                                                  DO 40 J = 1, NCHR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      ILEN = 25000
                                                                                                                                             DO 60 J = 1, NCHR
                                                                                                                                                                                      CALL REWIND (INPCHN)
                                                                                                                                                                                                            CONTINUE
                                                                                                                                                                                                                                                                                                                                                      CALL RDNIM1(I2DAT, NCHR, NSAMR, NFILE(1), INPCHN)
                                       CONTINUE
                                                                                                                           X # 2 * J
                                                                                                                                                                                                                                                                                        DO 30 I = 1, NSAMR
                                                                                                                                                                                                                                                                                                              K = 2 \times J - 1
                                                                                                                                                                                                                                                                                                                                                                                                                     CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 10 I = 1, NSAMR
                                                                                                     DO 50 I = 1, NSAMR
                                                                                                                                                                                                                              CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    TEMP (NS1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DBGAIN (NCHR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      DBGAIN, GCMSCL, NFILES, NFILE, NCR, NSHOT, DT, LEN, SORPOS, NPROCS, IDPROC, IPDISC, IPSOUR, INPOPT, INPCHN,
                                                                                                                                                                                                                                                R4DAT(I,K) = REAL(IVAL)
                                                                                                                                                                                                                                                                                                                                                                                                                                         R4DAT(I, J) = REAL(IVAL)
                                                         R4DAT(I,K) = REAL(IVAL)
                                                                               IVAL = I2DAT(I, J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                             IVAL = I2DAT(I, J)
                                                                                                                                                                                                                                                                      IVAL = I2DAT(I, J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ဂ ဂ
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                                                                                                                                                                                                                                                  100
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110 CONTINUE
120 FORMAT (A1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               NSHOT = NO. OF SHOT (1.d.)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      70 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             90 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           READ IN HEADER PARAMETERS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 Open disc file if needed
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            READ IN SEISMOGRAM RECORDS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DO 110 J = 1, NCHR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 PRINT *, 'READING HEADERS .....'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF (IPSOUR .EQ. 'DISC') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              READ (5,*) ISTACK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         PRINT *, IDCODE, NSHOT WRITE (6,*)'Stack or New (1 or 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IF (INPCHN .EQ. 1) CALL REWIND (INPCHN)
IF (INPCHN .EQ. 10) CLOSE (INPCHN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       DO 90 J = 1, NCHR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       K24 = 1024 * NCHR
                       READ (5, 120) ANS
                                                  PRINT *, 'Reset parameters to defaults (Y/N)?'
                                                                          IF (INPCHN .EQ. 10) CLOSE (INPCHN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              READ (10, REC=IDCODE) A, SORPOS, NRECS, RECDEP, DBGAIN, GCMSCL,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   NPROCS = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   IF (ISTACK .EQ. 0) CALL ZERO(K24, R4DAT(1,1))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              IDCODE = (NSHOT - 1) * (NCHR + 1) + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        PRINT *, LEN
                                                                                                       IF (INPCHN .EQ. 1) CALL REWIND (INPCHN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IF (GCMSCL(1) .EQ. 0.0) GCMSCL(1) = 1.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          ISTACK = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CALL ZERO(K24, R4DAT(1,1))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       OPEN (10, FILE=IPDISC, STATUS='OLD', ACCESS='DIRECT', RECL=LEN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DO 80 I = 1, 4
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      NREC = IDCODE + J
                                                                                                                                                                                                                                                                                                  CALL MAXSN(NSAMR, R4DAT(1,J), XMAX, IMAX)
                                                                                                                                                                                                                                                                                                                                   CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 100 I = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         READ (10, REC=NREC) (TEMP(I), I=1, NSAMR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               NFIRST, NCR, NPROCS, IDPROC, DT, PROC
                                                                                                                                                                   END IF
                                                                                                                                                                                                                                             IF (ABS (XMIN) .GT. XMAX) THEN
                                                                                                                                                                                                                                                                            CALL MINSN (NSAMR, R4DAT(1, J), XMIN,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IDPROC(I, J) =
                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF (ISTACK .GE. 0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                  ELSE
                                                                                                                                                                                           IMAX = IMIN
                                                                                                                                                                                                                     XMAX = -XMIN
                                                                                                                                                                                                                                                                                                                                                           END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                        R4DAT(I,J) = R4DAT(I,J) + TEMP(I)
                                                                                                                                                                                                                                                                                                                                                                                      R4DAT(I,J) = R4DAT(I,J) - TEMP(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           -1 == REVERSE POLARITY ) :'
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        130
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           170 RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                140
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       160 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            Subroutine to write out data to disc file
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          READ IN SEGY TAPE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                Check for saturation -- code removed
                                                                                                                                                                                                                A(3) = A3
A(4) = A4
A(5) = A5
A(6) = A6
A(7) = A7
                                                                                                                                                                                                                                                                                                                                                                                                                               CHARACTER OPDISC*17, OPFORM*6, A*20
CHARACTER*20 A1, A2, A3, A4, A5, A6, A7, A8, A9
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ဌ
                                                                                                                                                                                                                                                                                                                                                A(2) = A2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DIMENSION DBGAIN (NCHR), GCMSCL (NCHR), NCR (2), IDPROC (5, NCHR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          SUBROUTINE WRFILA (NSAMR, NCHR, R4DAT, NFIRST, OPFORM, OPDISC, NSHOT, LEN, A1, A2, A3, A4, A5, A6, A7, A8, A9, SORPOS,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL SEGYRD (R4DAT, NRECS, NSAMR, NSHOT, INPCHN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              INPCHN = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                GO TO 170
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      END IF
                                                     ELSE IF (OPFORM .EQ. 'DIRECT') THEN
                                                                                                                                                                                                                                                                                                                                                                              A(1) = A1
                                                                                                                                                                                                                                                                                                                                                                                                          CHARACTER*25 PROC(20)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DIMENSION R4DAT (NSAMR, NCHR), NFIRST (NCHR), RECDEP (NCHR), A (9)
                                                                                                          IF (OPFORM .EQ. 'SEQUEN') THEN
                                                                                                                                        NRECS = NCHR
                                                                                                                                                                A(9) = A9
                                                                                                                                                                                         A(8) = A8
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  (ANS .EQ. 'Y' .OR. ANS .EQ. 'y') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         TOPREC, RECSEP, SA
FORMAT (14/12/11/13/13/12/12/12/F6.2/F6.2/F6.2/F6.2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (6,*) B
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              A = B(1) // B(2) // B(3) // B(4) // B(5) // B(6) // B(7) // B(
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   READ (0,130) B, INPOPT, IPDISC, OPDISC, OPFORM, IPSOUR FORMAT (A20, 8(/A20)/A3/A16/A6/A4)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        REWIND (0)
                                                                              PRINT *, 'OPTION NOT AVAILABLE YET'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        DO 150 I = 2, NRECS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  RECDEP(1) = TOPREC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            READ (0,140) NA, NA, NA, NA, NA, NA, NCR(1), NCR(2), SA,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          NRECS = NCHR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE (6,*) A
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     8) // B(9)
OPEN (2, FILE=OPDISC, STATUS='UNKNOWN', FORM='UNFORMATTED',
                         IDCODE = (NSHOT - 1) * (NRECS + 1) + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IF (I .EQ. NCR(2)) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 NRECS, RECDEP, DBGAIN, GCMSCL, NCR, NPROCS, IDPROC, DT,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IOPCHN, PROC)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   RECDEP(I) = RECDEP(I - 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  RECDEP(I) = RECDEP(I - 1) + RECSEP
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               10
                                                                                                                                      20 CONTINUE
                                                                                                                                                                                                                               10 DO 20 J = 1, NCHANS
30 WRITE (6,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           OUTPUT PROCESSING AND DISPLAY PARAMETERS
                                                                    MENU FOR PLOT OPTIONS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 Subroutine for graphics output of array R4DAT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                Allows manual (interactive) first break picking/confirmation.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            Plenty of interactive options included to obtain required scaled data.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ARRAY Plotting subroutine for seismic data
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             WRITE SEISMOGRAM RECORDS
                                                                                                                                                                                                                                                                                                       SET UP DUMMY PLOT ARRAY RDAT (NSAMR, NCHANS)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                Can apply AGC etc to plot without affecting original data
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CHARACTER*20 FILREC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              SUBROUTINE MENPL1 (NSAMR, NCHANS, R4DAT, NFIRST, TITOFF, CHNSPL,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                REAL RECDEP (NCHANS)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CHARACTER TITLE*20, STR1*3, FLAGBR*3, COMENT*40, ANS*1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   END
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   RETURN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CLOSE (2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CALL TIME (6, 0, RES)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CHARACTER VARARE*3, TITOFF*3, CHNSPL*26, POLART*7, NONE*4, STRING*
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CHARACTER*20 LOCATE, DATE, DEVICE, SORTYP, SORLOC, RECTYP, RECLOC,
                                                                                                                                                                                                                                                                                                                                                                                                     FLAGBR = 'OFF'
                                                                                                                                                                                                                                                                                                                                                                                                                                  TITLE = 'X-hole Reflection'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           INTEGER NFIRST (NCHANS), NCR(2), IDPROC(5, NCHANS)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   REAL A(NS1), B(NS1), RDAT(NS1,NS2), R4DAT(NSAMR,NCHANS)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CHARACTER*4 RES (5)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    PARAMETER (NS1=2048, NS2=60)
                                                                                                                                                                                                  DO 20 I = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (2, REC=IDCODE) A, SORPOS, NRECS, RECDEP, DBGAIN, GCMSCL,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CALL SEGYWR (R4DAT, NRECS, NSAMR, NSHOT, IOPCHN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 IOPCHN = 19
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6, *)'SEG-Y OUTPUT TO TAPE ATTACHED TO UNIT 19 :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DO 10 J = 1, NRECS
                                                                                                                                                                RDAT(I, J) = R4DAT(I, J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE (2, REC=NREC) (R4DAT(I, J), I=1, NSAMR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               NREC - IDCODE + J
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ACCESS='DIRECT', RECL=LEN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      NFIRST, NCR, NPROCS, IDPROC, DT, PROC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            POLART, VARARE, NPLFST, NPLLST, IOPT, SORPOS, RECDEP,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   RECLOC, COMSHT, FILREC, NSHOT, NPROCS, IDPROC)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               NCR, DT, LOCATE, DATE, DEVICE, SORTYP, SORLOC, RECTYP,
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140 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              130 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     120 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        110 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                100 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                90 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        80 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      40 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  60 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     50 FORMAT (/'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             70 FORMAT (/'
                                                        END IF
                                                                                                                                                                       IF (IANSWR .EQ. 4) THEN
                                                                                                                                                                                           END IF
                                                                                                                                                                                                                                                                                                                                                                                                                           END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF (IANSWR .EQ. 2) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE (6,140)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WRITE (6,130)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (6,120)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE (6,110)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WRITE (6,100) FLAGBR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (6,90)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE (6,80) VARARE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE (6,70) POLART
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE (6,60) CHNSPL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE (6,50) NPLFST, NPLLST
                                   IF (IANSWR .EQ. 5) THEN
                                                                                                                                                                                                                                                                                                                                                                                                       IF (IANSWR .EQ. 3) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 IF (IANSWR .EQ. 1) THEN
IF (TITOFF .EQ. ."OFF') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         READ (5,*) IANSWR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE (6,40) TITOFF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WRITE (6, *)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,*)'
                  IF (VARARE .EQ. 'OFF') THEN
                                                                           END IF
                                                                                                                                                    IF (POLART .EQ. 'REVERSE') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                            READ (5,*) NPLFST, NPLLST
                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6,*)'1st and last samples to be plotted :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ELSE
                                                                                                                                                                                                                              IF (IOPT .EQ. 3)
                                                                                                                                                                                                                                                                 IF (IOPT .EQ. 1) CHNSPL = 'ALL'
                                                                                                                                                                                                                                                                                         READ (5,*) IOPT
                                                                                                                                                                                                                                                                                                         WRITE (6, *)' 4
                                                                                                                                                                                                                                                                                                                               WRITE (6, *) '
                                                                                                                                                                                                                                                                                                                                                                                     WRITE (6,*)'
                                                                                                                                                                                                               IF (IOPT .EQ. 4)
                                                                                                                                                                                                                                                    IF (IOPT .EQ. 2) CHNSPL = 'ODD'
                                                                                                                                                                                                                                                                                                                                                WRITE (6,*)'
                                                                                                                                                                                                                                                                                                                                                                    WRITE (6,*)' 1
VARARE = 'ON'
                                                                                                                                  POLART = 'NORMAL'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                TITOFF = 'ON'
                                                                                             POLART = 'REVERSE'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           TITOFF = 'OFF'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         10 Apply AGC / Time ramp
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        0 Return to MAIN MENU')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  9 PRINT out window of trace
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             7 First break flags
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                6 Plot Seismograms
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      5 Variable Area
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             3 Channels to be plotted
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   2 First and last samples
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           4 Normal/Reverse Polarity
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        1 Titles off or on
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        Include comment
                                                                                                                                                                                                            CHNSPL = 'ALL W/O TOP COMMON CHANNEL
                                                                                                                                                                                                                                CHNSPL = 'EVEN'
                                                                                                                                                                                                                                                                                                                                                                 All channels
                                                                                                                                                                                                                                                                                                        All omitting top common channel'
                                                                                                                                                                                                                                                                                                                            Even channels
                                                                                                                                                                                                                                                                                                                                              Odd channels
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   **** ***** ****
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              Plot Options Menu
                                                                                                                                                                                                                                                                                                                                                                                      SELECT OPTION
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           :', A3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 :', A3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        :', A7)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              :', A26
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 :', I3, 1x,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        :', A3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  ٢
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       LX=NSAMR, LY=NCHR2, X=R4DAT, NFILE=NFILE(1), NFILE2=NFILE(2), NSH=IDSH, NR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              units : DT in microsecs
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             Initialise the plotting format
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              NCR1, NCR2=NCR(1), NCR(2), A & B ARE ARRAYS OF LEN 1024 TIMES IS ARRA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF (IANSWR .EQ. 6) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CALL J06XBF(0.0, 1.0, 0.0, 1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        SAMF = REAL (NPLFST)
                                                                  CALL TYPENF (SORPOS, 1)
                                                                                                                                                     CALL TYPECS ('Source type
                                                                                                                                                                                                      CALL TYPECS ('Source location CALL TYPECS (SORLOC)
                                                                                                                                                                                                                                                   CALL CRINED
                                                                                                                                                                                                                                                                      CALL TYPECS (DEVICE)
                                                                                                                                                                                                                                                                                                                     CALL CRINED
                                                                                                                                                                                                                                                                                                                                        CALL TYPECS (DATE)
                                                                                                                                                                                                                                                                                                                                                          CALL TYPECS ('Date recorded
                                                                                                                                                                                                                                                                                                                                                                                     CALL CRINED
                                                                                                                                                                                                                                                                                                                                                                                                        CALL TYPECS (LOCATE)
                                                                                                                                                                                                                                                                                                                                                                                                                              CALL TYPECS ('Site
                                                                                                                                                                                                                                                                                                                                                                                                                                                   CALL HLINFD(1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL CTRMAG(14)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CALL CSPACE (0.73, 1.00, 0.49, 0.77)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CALL BORDER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CALL PSPACE(0.73, 0.99, 0.49, 0.77)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL PCSCEN(0.875, 0.78, TITLE)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CALL CTRMAG(20)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CALL J06XGF(1.0, 2.0)
IF (TITOFF .EQ. 'OFF') GO TO 160
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CALL JOSXFF(2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CALL JOSXAF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CALL MAP (0.0, 1.0, 0.0, 1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              RNCHR = REAL(NCHR2) + 1.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   SAML = REAL (NPLLST)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DZ = RECSEP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     THYD = TOPREC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         TMAX = (NPLLST - 1) * DT * 1E-3
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              TMIN = (NPLFST - 1) * DT * 1E-3
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     NONE = 'None'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           NCHR2 = NCHANS
CALL TYPECS ('Receiver location :')
                         CALL CRINED
                                            CALL TYPECS(' metres')
                                                                                       CALL TYPECS ('Source depth
                                                                                                                CALL CRINED
                                                                                                                                    CALL TYPECS (SORTYP)
                                                                                                                                                                                 CALL CRLNFD
                                                                                                                                                                                                                                                                                          CALL TYPECS ('Seismograph type
                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CALL PLACE(1, 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CALL PSPACE(0.0, 1.0, 0.0, 1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL PAPER(1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  VARARE = 'OFF'
                                                                                                                                                                                                                                                                                             :
                                                                                                                                                                                                                           :
                                                                                                                                                                                                                                                                                                                                                              .:
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CALL TYPECS (RECLOC)

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Greek
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           COMMA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    3
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CALL TYPECS ('Receiver type
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CALL MAP (0.0, 1.0, 0.0, 1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CALL PSPACE(0.73, 0.99, 0.17, 0.47)
CALL CSPACE(0.73, 0.99, 0.17, 0.47)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CALL CTRFNT(2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CALL CRINED
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL TYPECS (COMSHT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CALL TYPECS ('Common shot setup :')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CALL CRINED
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CALL TYPECS (RECTYP)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DO 150 KK = 1, NPROCS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CALL HLINFD(1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CALL CRINFD
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL TYPECS ('PROCESSING SEQUENCE')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CALL BORDER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CALL CRINED
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CALL TYPECS (FILREC)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CALL TYPECS ('Analogue filters
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CALL CRINFD
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CALL TYPECS ('secs')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CALL CTRFNT(1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL TYPENC (109)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CALL TYPENF (DT, 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CALL TYPECS ('Sample rate
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CALL CRINED
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              IF (NCR(1) .NE. 0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CALL TYPECS ('Common receivers
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL PLACE(5, 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CALL TYPENC(44)
                                                   ELSE IF (IDPROC(1, KK) .EQ. 4) THEN
                                                                                                                                                                                                                                                                                                            ELSE IF (IDPROC(1, KK) .EQ. 3) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                       ELSE IF (IDPROC(1, KK) .EQ. 2) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IF (IDPROC(1, KK) .EQ. 1) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CALL TYPECS (NONE)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CALL TYPENI(NCR(2))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL TYPENI (NCR(1))
                                                                                                                                                                                                                                                                                                                                                                                                                CALL TYPECS ('Gain comp : ')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CALL TYPECS ('Gain recovered ')
                                                                                                                                                       CALL TYPENI (IDPROC(3, KK))
                                                                                                                                                                                                                                                                                 CALL TYPECS('Tapering :')
                                                                                                                                                                                                                                                                                                                                     CALL TYPECS (STRING)
                                                                                                                                                                                                                                                                                                                                                             IF (IDPROC(2,KK) .EQ. 1) STRING = 'Norm Peak'
                                                                                                                                                                                                                                                                                                                                                                                          STRING = 'Norm RMS'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                   END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IF (IDPROC(2, KK) .EQ. 1) THEN
                      CALL TYPECS ('Bandpass : ')
                                                                             CALL TYPECS (STRING)
                                                                                                 IF (IDPROC(2,KK) .EQ. 1) STRING = ' Samples'
                                                                                                                        IF (IDPROC(2,KK) .EQ. 0) STRING = ' Traces'
                                                                                                                                                                                    CALL TYPECS (STR1)
                                                                                                                                                                                                        IF (IDPROC(2,KK) .EQ. 0) STR1 = ' Z '
IF (IDPROC(2,KK) .EQ. 1) STR1 = ' T '
                                                                                                                                                                                                                                                             STRING = ' '
CALL TYPENI(IDPROC(2, KK))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CALL TYPECS(' Shot sizes equated')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                :
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      ::
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            ..
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CALL CRINED

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CALL CSPACE(0.0, 1.0, 0.0, 1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL PLACE(1, 1)
                                                        CALL PSPACE (0.0, 1.0, 0.0, 1.0)
                                                                                      CALL CTRMAG(10)
                                                                                                                  CONTINUE
                                                                                                                                              CALL TYPECS (RES (5))
                                                                                                                                                                          CALL TYPECS (RES (4)
                                                                                                                                                                                                         CALL TYPECS (RES(3))
                                                                                                                                                                                                                                       CALL SPACE (2)
                                                                                                                                                                                                                                                                 CALL TYPECS (RES (2))
                                                                                                                                                                                                                                                                                             CALL TYPECS (RES(1))
                                                                                                                                                                                                                                                                                                                           CALL PLACE (3, 7)
                                                                                                                                                                                                                                                                                                                                                          CALL BORDER
                                                                                                                                                                                                                                                                                                                                                                                   CALL CSPACE (0.73, 0.99, 0.04, 0.08)
                                                                                                                                                                                                                                                                                                                                                                                                                CALL PSPACE (0.73, 0.99, 0.04, 0.08)
                                                                                                                                                                                                                                                                                                                                                                                                                                              CALL TYPECS (COMENT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CALL BORDER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CALL CSPACE(0.73, 0.99, 0.09, 0.16)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CALL PSPACE(0.73, 0.99, 0.09, 0.16)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CONTINUE
CALL MAP(0.0, 1.0, 0.0, 1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ELSE IF (IDPROC(1,KK) .EQ. 9) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        ELSE IF (IDPROC(1,KK) .EQ. 6) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            ELSE IF (IDPROC(1,KK) .EQ. 5) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CALL HLINFD (1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL CRINFD
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         ELSE IF (IDPROC(1, KK) .EQ. 10) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ELSE IF (IDPROC(1, KK) .EQ. 7) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     ELSE IF (IDPROC(1, KK) .EQ. 8) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CALL TYPENI(IDPROC(3, KK))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL TYPECS ('True amplitude recovered ')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CALL TYPECS ('D.C. Removed ')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CALL TYPENI (IDPROC(3, KK))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CALL TYPECS ('/')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CALL TYPECS ('/')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CALL TYPENI (IDPROC (2, KK))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CALL TYPECS ('Waveshaping :')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CALL TYPENI (IDPROC(2, KK))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CALL TYPECS ('Median Filter length:')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CALL TYPENI (IDPROC (5, KK))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL TYPECS ('/')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL TYPECS('/')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CALL TYPENI (IDPROC (2, KK))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL TYPECS ('FK Pie slice filter : ')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CALL TYPENI (IDPROC (4, KK))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CALL TYPENI (IDPROC (5, KK))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CALL TYPENI (IDPROC (4, KK))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CALL TYPECS ('/')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CALL TYPENI (IDPROC (3, KK))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CALL TYPECS ('/')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CALL TYPECS ('/')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CALL TYPENI (IDPROC (4, KK))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              IF (IDPROC(2, KK) .EQ. 0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CALL TYPECS ('/')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CALL TYPECS ('T-squared ramp')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CALL TYPENI (IDPROC(2, NPROCS))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL TYPECS ('AGC : Window size = ')
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CALL PCSCEN(0.028, 0.4, 'Receiver Depth (metres)')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CALL PCSCEN(0.4, 0.790, 'Travel Time (milliseconds)')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL ANNOTP (1, 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     DO 170 J = 1, NCHR2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CALL MAP (0.0, 1.0, RNCHR, 0.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CALL PSPACE(0.0, 1.0, 0.07, 0.75)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CALL CTRORI (0.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CALL CTRORI (90.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CALL PCSCEN(0.4, 0.025, 'Sample Number')
                                                                                                                                                                                                                                                                                                                                                                                                                                      ELSE IF (IOPT .EQ.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IF (IOPT .EQ. 1) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CALL XAXIS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CALL ANNOTP (0, 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL AXORIG (SAMF, RNCHR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CALL XGRAT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL YAXISI(1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CALL XAXIS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CALL AXORIG (TMAX, 0.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CALL MAP (TMIN, TMAX, RNCHR, 0.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CALL BORDER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CALL PSPACE(0.07, 0.70, 0.07, 0.75)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               RI = 0.035
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ELSE IF (IOPT .EQ.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     ELSE IF (IOPT .EQ. 2) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL SAMNOR (NSAMR, NCHR2, RDAT, NPLFST, NPLLST)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       XDIV = (SAML - SAMF) / 10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CALL MAP (SAMF, SAML, RNCHR, 0.0)
                                                                                                                                                                                                                                                                                                                                 DO 210 J = N1, N2, NSTEP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            N1 = 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    N1 = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CALL TYPENF (RECDEP (J), 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CALL POSITN(RI, RJ)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      RJ = REAL(J)
                                                                                                                                                                                                                                                                                                                                                                             NSTEP = 1
                                                                                                                                                                                                                                                                                                                                                                                                  N2 = NCHR2 - 1
                                                                                                                                                                                                                                                                                                                                                                                                                       N1 = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        N2 = NCHR2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        NSTEP = 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           N2 = NCHR2 - 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  N1 = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   N2 = NCHR2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                   NSTEP = 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            NSTEP = 1
                                                                                                                                                                                                IF (IOPT .EQ. 4 .AND. J .EQ. NCR(1)) GO TO 210 DO 180 I = 1, NSAMR
                                                                                                                                                                                                                                                                                                          DEP = REAL(J)
CONTINUE
                                                                                                                                                                                                                                                                                       IF (IOPT .EQ. 4 .AND. J .GT. NCR(1)) THEN
                                                                                                                                                                                                                                                               DEP = DEP - 1.0
                                                                                       ELSE
                    END IF
                                                                                                                                                        IF (POLART .EQ. 'REVERSE') THEN
                                                                                                                                                                           A(I) = FLOAT(I)
                                           ISIGN = +1
                                                              B(I) = RDAT(I, J) + DEP
                                                                                                                               B(I) = DEP - RDAT(I, J)
                                                                                                          ISIGN = -1
                                                                                                                                                                                                                                                                                                                                                                                                                                              4
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                              THEN
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190
                                                                                                                                                                                      250
260
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210
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   220
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              230
                                                                                                                                                                                                                                                                                                                                                                                                                                                                    240 FORMAT (A1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF (IANSWR .EQ. 9) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   ELSE IF (IANSWR .EQ. 8) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF (IANSWR .EQ. 7) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                            IF (IANSWR .EQ. 10) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             FORMAT (A40)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       PRINT *, 'COMMENT :'
READ (5,220) COMENT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CALL CTRMAG(10)
CALL GREND
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IF (FLAGBR .EQ. 'OFF') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     GO TO 10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      FORMAT (4(I4,1X,F12.1,2X))
WRITE (6,*)'Select first break sample no. :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        READ (5,*) NSAMO, NSAM1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE (6,*)'Range of samples to be printed :'
                                                                                                                                                                                                                                                                                                                                                                    IF (ANS .EQ. 'R' .OR. ANS .EQ. 'r') THEN
                                                                                                                                                                                                                                                                                                                                                                                                READ (5,240) ANS
                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE (6, *)'Ramp or AGC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              READ (5,*) NFIRST (IDCHAN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                WRITE (6,230) ((I,R4DAT(I,IDCHAN)), I=NSAMO,NSAM1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  READ (5,*) IDCHAN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE (6,*)' No. of channel to be printed :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           FLAGBR = 'ON'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ARROWD = DEP - 0.3
DO 190 I = NPLFST, NPLLST
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IF (FLAGBR .EQ. 'OFF') GO TO 190
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               FLAGBR = 'OFF'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DO 200 I = NPLFST, NPLLST

IF (RDAT(I,J)*ISIGN .GT. - 0.01) GO TO 200
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CALL CTRMAG(20)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF (VARARE .EQ. 'OFF') GO TO 200
                                                                                                                                                                                                                                                                                                                          READ (5,240) ANS
                                                                                                                                                                                                                                                                                                                                                WRITE (6,*)'T-Squared or Exponential (S or E) ?'
                                                                                                                                                                                                                                                                                                      IF (ANS .EQ. 'S' .OR. ANS .EQ. 's') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 IF (I .EQ. NFIRST(J)) CALL PLOTNC(A(I), ARROWD, 187)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CALL JOIN(A(I), B(I))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CALL POSITN(A(I), DEP)
                                                                                                                                                                                                                                                                                DO 260 J = 1, NCHANS
                                                                                        DO 280 J = 1, NCHANS
                                                                                                                    READ (5, *) ALPHA
                                                                                                                                      WRITE (6,*)'Enter Alpha (Exponential constant) :'
                                                                                                                                                                                      CONTINUE
                                                                                                                                                                                                                                                        DO 250 I = 1, NSAMR
                                                                      DO 270 I = 1, NSAMR
                                                                                                                                                                                                              CONTINUE
                                                                                                                                                                                                                                  RDAT(I, J) = RDAT(I, J) * (I - 1) ** 2
RDAT(I, J) = RDAT(I, J) * TI * T1
                        T1 = EXP(ALPHA*TI)
                                                TI = REAL(I - 1)
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280
                       60
                                                                                                                                                                                                                                                                      40 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                   20
30
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         10 FORMAT (A1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    Shift the traces :
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        Really only useful for zero-offset VSP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               Subroutine to median filter seismic data
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DIMENSION R4DAT (NSAMR, NCHR), NFIRST (NCHR)
                                                                                                                                                                                                                                                                                                                                                         DO 50 J = 1, NRECS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      PRINT *, 'REMOVE COMMON TRACE (Y/N) ?'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       REAL X(NS1), Y(NS1), DGDAT(NS2,NS3), UGDAT(NS2,NS3) CHARACTER*1 ANS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          SUBROUTINE MEDFIL (NSAMR, NCHR, R4DAT, NFIRST, LENFIL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 RETURN
                                                                                                             DO 80 J = 1, NRECS
                                                                                                                                     NALIGN = 50
                                                                                                                                                        PRINT *, 'ALIGNING TRACES...'
                                                                                                                                                                               END IF
                                                                                                                                                                                                                                           IF (NFIRST(1) .EQ. 0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IF (ANS .EQ. 'Y' .OR. ANS .EQ. 'y') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  READ (5,10) ANS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CALL ZERO(LENDU, UGDAT(1,1))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      LENDU = NS2 * NS3 .
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   NRECS = NCHR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        PARAMETER (NS1=60, NS2=1024, NS3=60)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      IF (IANSWR .NE. 0) GO TO 30
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           END IF
                       CONTINUE
                                                                                  NDT = NFIRST(J) - NALIGN
                                                                                                                                                                                                                      PRINT *, 'INPUT FIRST BREAK SAMPLES :'
                                                                                                                                                                                                                                                                                         CONTINUE
                                                                                                                                                                                                                                                                                                                                    DO 40 I = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                   NFIRST(NRECS) = 100
                                                                                                                                                                                                                                                                                                                                                                                                                       CALL ZERO(NSAMR, R4DAT(1, NRECS))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE (6,*)'Enter no. of trace to be removed :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                END IF
                                                                                                                                                                                                  READ (5, *) NFIRST
                                                                                                                                                                                                                                                                                                                                                                                                                                                   CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DO 30 J = NDEAD, NRECS - 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             READ (5, *) NDEAD
                                                                 DO 60 I = 1, NSAMR - NDT
DO 70 I = NSAMR - NDT + 1, NSAMR
                                                                                                                                                                                                                                                                                                            DGDAT(I,J) = R4DAT(I,J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CALL AGC (NSAMR, NCHANS, RDAT, LENAGC)
                                          DGDAT(I,J) = DGDAT(I + NDT, J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      NFIRST(J) = NFIRST(J + 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         READ (5,*) LENAGC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE (6, *)'Length of AGC to be applied :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 20 I = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          R4DAT(I, J) = R4DAT(I, J + 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    FIRST BREAKS AT NALIGN SAMPLES
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IF (ANS .EQ. 'Y' .OR. ANS .EQ. 'y') GO TO 100
C WRITE(7,129)((I,DGDAT(I,J),I=1,NSAMR),J=1,NRECS)
C 129 FORMAT(5(14,1X,F5.2,2X))
                                                                                                                  O
                                                                       a
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 C Pad with zeros
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                130
  150
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          140 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               120
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            110
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   100 PRINT *, 'APPLYING MEDIAN FILTER ....'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DISPLAY
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Apply median filter across traces
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  90 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     80 CONTINUE
                                                                                                                                                                                                               Shift back the traces
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          MUTE before first arrivals
                                                                                                                                                                                                                                                                                                                                                                                                                        IF (ANS .EQ. 'Y' .OR. ANS .EQ. 'Y') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DO 140 I = LN + 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IF (ANS .EQ. 'Y' .OR. ANS .EQ. 'y') THEN
                                                                                                                                         DO 170 J = 1, NRECS
                                                                                                                                                                                                                                                                                                                                                      PRINT *, 'RE-APPLY MEDIAN FILTER (Y/N)?'
                                                                                                                                                                                                                                                                                                                                                                                 END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                   READ (5,10) ANS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   READ (5, 10) ANS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       PRINT *, 'TRACES ALIGNED ... PLOT (Y/N)? '
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DO 90 J = 1, NRECS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IN - NALIGN - 5
                                                                                                                                                                PRINT *, 'SHIFTING BACK TRACES ...'
                                                                                                                                                                                                                                                                                                                                READ (5, 10) ANS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                           PRINT *, 'TRACES STILL ALIGNED ... PLOT (Y/N)? '
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                               CALL MENPL1 (NSAMR, NRECS, DGDAT, NFIRST)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL MENPL1 (NSAMR, NRECS, DGDAT, NFIRST)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL ZERO(LN, DGDAT(1,J))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CONTINUE
CONTINUE
                                                                   WRITE(7,*)NDT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 130 J = 1, NRECS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      DO 110 J = 1 - LENFIL / 2, NRECS + LENFIL / 2
                                             DO 150 I = NSAMR, NALIGN, -1
                                                                                            NDT = NFIRST(J) - NALIGN
                                                                                                                  WRITE (7, *) NFIRST
                    DGDAT(I, J) = DGDAT(I - NDT, J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CALL MDIAN1(Y(J), LENFIL, DGDAT(I,J))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DO 120 LL = 1, 48
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IF (J .LT. 1 .OR. J .GT. NRECS) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DGDAT(I,J) = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     X(J + LENFIL/2) = DGDAT(I, J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    X(J + LENFIL/2) = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    Y(LL) = X(LL)
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           200
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          180
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       220
230
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  170 CONTINUE
                                                       SOURCE: Numerical recipes
                                                                                                                                                                                                                                                                                                                                                                               SOURCE: Numerical recipes
                                                                                                                                                                                                                                                                                                                                                                                                                     Subroutine to obtain median value of array X(N) (XMED)
                                                                                                                                                                                                                                                                                                                                                                                                  The array X is left sorted on exiting
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ELSE IF (ANS .EQ. 'D' .OR. ANS .EQ. 'd') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            PRINT *, 'COPY WAVEFIELD TO R4DAT (Up/Down/No) ?'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         PRINT *, 'DISPLAY UPGOING WAVEFIELD (Y/N)?'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 IF (ANS .EQ. 'Y' .OR. ANS .EQ. 'y') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       PRINT *, 'TRACES SHIFTED BACK ... PLOT (Y/N)?'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         READ (5, 10) ANS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IF (ANS .EQ. 'Y' .OR. ANS .EQ. 'y') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        READ (5, 10) ANS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         READ (5, 10) ANS
                  DIMENSION ARR(N)
                                                                                                                                                                               END IF
                                                                                                                                                                                                                                                                                                 CALL PIKSRT(N, X)
                                                                                                                                                                                                                                                                                                                      DIMENSION X(N)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                               RETURN
DO 30 J = 2, N
                                                                                                SUBROUTINE PIKSRT(N, ARR)
                                                                                                                                                           RETURN
                                                                                                                                                                                                                       ELSE
                                                                                                                                                                                                                                                           IF (2*N2 .EQ. N) THEN
                                                                                                                                                                                                                                                                                N2 = N / 2
                                                                                                                                                                                                                                                                                                                                         SUBROUTINE MDIAN1 (X, N, XMED)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IF (ANS .EQ. 'U' .OR. ANS .EQ. 'u') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CALL MENPL1 (NSAMR, NRECS, DGDAT, NFIRST)
                                                                                                                                                                                                                                     XMED = 0.5 * (X(N2) + X(N2 + 1))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      DO 210 J = 1, NRECS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    DO 190 J = 1, NRECS
                                                                                                                                                                                                 XMED = X(N2 + 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 230 J = 1, NRECS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CALL MENPLI (NSAMR, NRECS, UGDAT, NFIRST)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DO 200 I = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DO 180 I = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DO 220 I = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           R4DAT(I,J) = DGDAT(I,J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             R4DAT(I,J) = UGDAT(I,J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            UGDAT(I, J) = R4DAT(I, J) - DGDAT(I, J)
```

160

CONTINUE

DO 160 I = 1, NALIGN - 1

DGDAT(I, J) = 0.0

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000
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                റ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                იი
                                                                                                                                                                                                                                                                                                                                                                                            O
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        20
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      30 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                             10 CONTINUE
                                                                 20 WRITE (6,*) WRITE (6,*)
                                                                                                                                                                                                                                                                                                                                                                                                               DEFAULTS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     Routine to apply waveshaping filters to dataset.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           Version 2.0 -- Menu-driven waveshaping code
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          and as amplitude spectra.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 Displays input, desired output, filter and filter output as time seies
                                                                                                                                                           IDD = NCR(1)

IDB = NCR(2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          FNYQ = .5E6 / DT
DF = FNYQ / REAL(NSAMS/2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         REAL D(NS1), P1(NS3), P2(NS3), P3(NS3), P4(NS3)
COMPLEX CMPB(NS1), CBUTT(NS1), C1(NS1), C2(NS1), C3(NS1), C4(NS1)
COMPLEX CXA(NS1), CXB(NS1), CXC(NS1), CXD(NS1), CTEMP(NS1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             END
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           NSAMS = NSAMP2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CALL POWER2 (NSAMR, NSAMP2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  REAL TEMP(NS1), X(NS1), ACF(NS1), TEMP2(NS1), BUTT(NS1),
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           REAL S1(NS1), S2(NS1), S3(NS1), A(NS1), B(NS1), RDAT(NS1)
REAL C(NS2), ER(NS3), REF(NS1), XPOSNS(NS1), DSERIS(NS1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      SUBROUTINE WVSHAP (NSAMR, NCHR, R4DAT, NFIRST, NCR, DT)
WRITE (6,*)
WRITE (6,30)
                                         WRITE (6,*)
                                                                                                                                     REPLY = 'YES
                                                                                                                                                                                                        WEIGHT = 'NO'
IFJ = 0
                                                                                                                                                                                                                                                    RFC = 0.01
                                                                                                                                                                                                                                                                                                 NL = 5
                                                                                                                                                                                                                                                                                                                       LA = 64
                                                                                                                                                                                                                                                                                                                                            NFILTS = 1
                                                                                                                                                                                                                                                                                                                                                                    FILTER = .FALSE.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      DO 10 I = 1, NSAMS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          LOGICAL FILTER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CHARACTER WEIGHT*3, ANS*1, REPLY*3
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         INTEGER NOPT(6), NDO(64)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        REAL BSERIS (NS1), S4 (NS1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DIMENSION R4DAT (NSAMR, NCHR), NFIRST (NCHR), NCR(2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 RETURN
                                                                                                                                                                                                                                                                         LAG1 = -2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              PARAMETER (NS1=1024, NS2=2048, NS3=513)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                XPOSNS(I) = REAL(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          ARR(I + 1) = A
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                I ■ 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    DO 10 I = J - 1, 1, -1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          A = ARR(J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                BUTT2 (NS1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ARR(I + 1) = ARR(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IF (ARR(I) .LE. A) GO TO 20
                                                                  WAVESHAPING FILTER MENU
                                                                  (0 to EXIT)'
```

```
WRITE (6,70)
70 FORMAT (/' 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    60 FORMAT (/' 4
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                50 FORMAT (/' 3
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    FORMAT (/' 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE (6,60)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,50
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             WRITE (6,40)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              IF (IANS .EQ. 1) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       READ (5, *) IANS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             ELSE IF (IOPT .EQ. 2) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 FORMAT (/' 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE (6,110)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE (6,90)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE (6, *)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           WRITE (6, *)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IF (IOPT .EQ. 1) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  READ (5,*) IOPT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6, 120)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 FORMAT (/' 3
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       FORMAT (/' 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WRITE (6,*)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           FORMAT (/' 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE (6,100)
                                                                                                                                                                                                                                                                             CALL ZERO (NSAMS, TEMP2)
                                                                                                                                                                                                                                                                                                    END IF
                                                                                                                                                                    DO 160 J = 1, NAV
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE (6,*)'Enter l=same window 0=selection for channels :
                                                                                                                                                                                           END IF
                                                                                                                                                                                                                                                      IF (IREP .NE. 1) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                LB = NSAMS / 2 + NWTDIF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CALL NORMAN (NSAMS, ACF)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CALL ZERO(NSAMS, ACF)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE (6, *)' ENTER window on trace in samples :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 READ (5,*) NTRACE
                                                                                                                                                                                                                                                                                                                                                                                                                                                         IF (IREP .EQ. 1) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                READ (5,*) IREP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      DO 130 I = 1, NWTDIF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  NWTDIF = NWT2 - NWT1 + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     READ (5,*) NNT1, NWT2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                WRITE (6, *)' Enter trace number :'
                                                                                                                                                                                                        READ (5,*) NAV
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ACF(I + NSAMS/2) = R4DAT(I + NWT1 - 1, NTRACE)
                                                                                                                  IF (IREP .NE. 1) THEN
                                                                                                                                       CALL ZERO (NSAMS, TEMP)
                                                                                                                                                                                                                           WRITE (6,*)' Average over N traces ENTER N :'
                                                                                                                                                                                                                                                                                                                                                                                  WRITE (6, *)'ENTER NUMBER OF CHANNELS :'
               END IF
                                                                                                                                                                                                                                                                                                                       READ (5, *) NCHANN
                                                                                                                                                                                                                                                                                                                                            WRITE (6, *)'ENTER FIRST CHANNEL :'
                                                                                                                                                                                                                                                                                                                                                                   READ (5, *) NAV
                                                                                                                                                                                                                                                                                                                                                                                                               READ (5, *) IW1, IW2
                                                                                                                                                                                                                                                                                                                                                                                                                                WRITE (6,*)'ENTER window on traces:'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          Exit ')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                Apply filter')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            Calculate filter ')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Select "desired output" wavelet')
                                               WRITE (6,*)'Enter window on trace :'
                                                                                           WRITE (6,*)'Enter channel number (', J, ') :'
                              READ (5, *) IW1, IW2
                                                                          READ (5, *) NCHANN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               Window of single trace ')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       Exit ')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               Plot input wavelet ')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       Extract Minimum phase wavelet ')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                "Input" wavelet selection '
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            C NORMALISE INPUT WAVELET
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     170
                                               200
                                                                                         190
                                                                                                                                                            180
     210
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      160
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               140
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      150
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         Do minimum phase conversion
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Shift so origin is at sample NSAMS/2
                                                                                                                                                                               ELSE IF (IANS .EQ.
                                                                                                                                WRITE (6,*)'
                                                                                                                                                                                                      END IF
                                                                                                                                                                                                                                                                     END IF
                      WRITE (6,210)
                                           FORMAT (/, ' 2
                                                                WRITE (6,200)
                                                                                       FORMAT (/, ' 1
                                                                                                            WRITE (6, 190)
                                                                                                                                                        WRITE (6, *)
                                                                                                                                                                                                                                              IF (IOPT .NE. 0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          ELSE IF (IOPT .EQ. 3) THEN
FORMAT (/, '
                                                                                                                                                                                                                         GO TO 80
                                                                                                                                                                                                                                                                                                          CALL PIJOIN (XPOSNS, ACF, 1, NSAMS, 1)
                                                                                                                                                                                                                                                                                                                                                       CALL YAXISI(1.0)
                                                                                                                                                                                                                                                                                                                                                                                                   CALL CTRMAG(20)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL MAP (RXO, RX1, -SCALE, SCALE)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CALL PSPACE(0.05, 0.95, 0.05, 0.95)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CALL MAXSN (NSAMS, ACF, ACFMAX, II)
CALL MINSN (NSAMS, ACF, ACFMIN, II)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                LB = LB + NSAMS / 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DO 170 I = 1, NSAMS / 2
                                                                                                                                                                                                                                                                                        CALL FRAME
                                                                                                                                                                                                                                                                                                                                    CALL CTRMAG(10)
                                                                                                                                                                                                                                                                                                                                                                            CALL XAXISI(20.0)
                                                                                                                                                                                                                                                                                                                                                                                                                        CALL XGRATI(20.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                             CALL AXORIG(513.0, ~2.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL BORDER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            RX1 = RX0 + 4.0 * REAL(NWT2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 RX0 = RX / 2 - 2.0 * REAL(NWT2) + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  SCALE = SCALE * 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF (ABS (ACFMIN) .GT. ACFMAX) SCALE = ABS (ACFMIN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CALL NORMAN (NSAMS, ACF)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     READ (5,*) NWT1, NWT2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (6,*)'Enter taper start and end for wavelet :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        RX = REAL(NSAMS)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              SCALE = ACFMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CALL LINTAP (NSAMS, TEMP2, 0, 0, NWT1, NWT2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   LB = NWT2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CALL MINPH (TEMP2, NSAMS)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        ACF(I + NSAMS/2) = TEMP2(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     ACF(I) = TEMP2(NSAMS/2 + I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IF (IREP .EQ. 1) NCHANN = NCHANN + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IF (ACF(1) .NE. 0.0) THEN DO 150 I = 1, NSAMS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CALL CROSS (NSAMS, TEMP, NSAMS, TEMP, NSAMS, ACF)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   DO 140 I - IW1, IW2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              TEMP(I) = R4DAT(I, NCHANN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CONTINUE
 ω
                                                                                                                                                                             THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   TEMP2(I) = TEMP2(I) + (ACF(I)/ACF(I))
Plot output wavelet ')
                                           Trace in record
                                                                                     Butterworth wavelet ')
                                                                                                                                                   Desired output wavelet '
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130

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120 110 100 90

80

6

30 FORMAT (/' 1

Select "input" wavelet')

CALL NORMAN (NSAMS, BUTT2)  LD = NSAMS  ELSE IF (IOPT = EQ. 2) THEN  WRITE (6,*)'Enter trace i.d. number :'  READ (5,*) NTRACE  WRITE (6,*)'Enter taper points (4) :'  READ (5,*) NTAPO, NTAP1, NTAP2, NTAP3  DO 300 I = 1, NSAMS  BUTT2(I) = R4DAT(I,NTRACE)  CONTINUE  CONTINUE  300 CALL LINTAP (NSAMS, BUTT2, NTAP0, NTAP1, NTAP2, NTAP3)	) 1.) 1.) REAL(CB) TT(1 + NS.	8 8 6 (n	24	WRITE (6,220)  220 FORMAT (/, ' 4 MINIMUM PHASE extracted wavelet ')  WRITE (6,230)  230 FORWAT (/, ' 0 EXIT')  READ (5,*) IOPT  IF (IOPT .EQ. 1) THEN  WRITE (6,*)'Enter low-cut, slope, high-cut, slope '  READ (5,*) BUT1, BUT2, BUT3, BUT4  C HIGH CUT
340 350	•	1, ET2	ST3	310 320

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CALL FRAME
LSE IF (IOPT .EQ. 4) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 SE IF (IOPT .EQ. 3) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE (6,*)'Enter 1=same window 0=selection for channels :
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CALL PTJOIN(XPOSNS, BUTT2, 1, NSAMS, 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CALL XGRATI(20.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CALL AXORIG(513.0, 0.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CALL BORDER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CALL MAP (RX0, RX1, -SCALE, SCALE)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  RX = REAL(NSAMS)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CALL PSPACE(0.05, 0.95, 0.05, 0.95)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               SCALE = SCALE * 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF (ABS (BMIN) .GT. BMAX) SCALE = ABS (BMIN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CALL MAXSN(NSAMS, BUTT2, BMAX, II)
CALL MINSN(NSAMS, BUTT2, BMIN, II)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CALL NORMAN (NSAMS, BUTT2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    DO 330 I - NTAP3 + 1 + NSAMS / 2, NSAMS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DO 320 I = 1, NSAMS / 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DO 310 I = NTAPO, NTAP3
                                                                                                                                                                                                                                                                                                                                                                                                   DO 360 J = 1, NAV
                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IF (IREP .NE. 1) THEN WRITE (6,*)' Average over N traces ENTER N :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL ZERO(NSAMS, TEMP2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         READ (5,*) IREP
IF (IREP .EQ. 1) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   SCALE - BMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE (6, *)'NORMALISED OK'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  LD = NSAMS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   BUTT2(I) = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      BUTT2(I - NTAPO + NSAMS/2 + 1) = BUTT2(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (6,*)'ENTER window on traces:'
READ (5,*) IW1, IW2
WRITE (6,*)'ENTER NUMBER OF CHANNELS:'
READ (5,*) NAV
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            BUTT2(I) = 0.0
                                                                                                                                                                                                                                                                    IF (IREP .NE. 1) THEN
WRITE (6,*)'Enter channel number (', J, ') :'
READ (5,*) NCHANN
WRITE (6,*)'Enter window on trace :'
                                                                                                                                                                                                                                                                                                                                                                                                                                              READ (5,*) NAV
                                                                  CALL CROSS (NSAMS, TEMP, NSAMS, TEMP, NSAMS, BUTT2)

IF (BUTT2(1) .NE. 0.0) THEN

DO 350 I = 1, NSAMS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,*)'ENTER FIRST CHANNEL :'
END IF
                                                                                                                                                  CONTINUE
                                                                                                                                                                                               DO 340 I = IW1, IW2
                                                                                                                                                                                                                                                                                                                                                                         CALL ZERO (NSAMS, TEMP)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           READ (5,*) NCHANN
                                                                                                                                                                       TEMP(I) = R4DAT(I, NCHANN)
                                                                                                                                                                                                                                            READ (5,*) IW1, IW2
                     CONTINUE
                                           TEMP2(I) = TEMP2(I) + (BUTT2(I)/BUTT2(I))
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0 0 0
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                                                                                                                                                                       380
                                                                                                                      Get ACF of input trace ---> S1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CALL LINTAP(NSAMS, TEMP2, 0, 0, NWT1, NWT2)
Shift so origin is at sample NSAMS/2
DO 370 I = 1, NSAMS / 2
                                                                                                                                                                                                                                   INPUT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            NORMALISE INPUT WAVELET
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            Do minimum phase conversion
                                        Loop over specified range of lags
                                                                                                                                                                                           TUMINO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     Calculating the filter coefficients
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        ELSE IF (IANS .EQ. 3) THEN
                                                                                                                                                                                                                                                                                          CALL ZERO(NSAMS, S1)
CALL ZERO(NSAMS, S2)
CALL ZERO(NSAMS, S3)
CALL ZERO(NSAMS, A)
                                                                                                                                                                     CONTINUE
DO 480 L = 1, NL
                                                                                 S1(1) = S1(1) * (1. + RFC)
                                                                                                  CALL CROSS (LB, B, LB, B, LA, S1)
                                                                                                                                                                                                                                                                                                                                                                                                                         RFC = 0.02
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                WRITE (6, *)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE (6,*)'LD ='', LD WRITE (6,*)'LB = ', LB
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             WRITE (6,*)'
WRITE (6,*)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     WRITE (6,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IF (IOPT .NE. 0) GO TO 180
                                                                                                                                                                                                                                                                         DO 380 I = 1, NSAMS
                                                                                                                                                                                                                                                                                                                                                                                 CALL ZERO(NS2, C)
                                                                                                                                                                                                                                                                                                                                                                                                                                             READ (5, *) LAG1
                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6,*)' Enter 1st lag to try (-ve == OP leads IP) :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    READ (5,*) LA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE (6,*)' Enter filter length in samples :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           LL = LD + NL / 2 + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               READ (5,*) NL
                                                                                                                                                                                                                                                                                                                                                                                                         IFJ = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       LL = 2048
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 LD = 1024
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     LB = 1024
                                                                                                                                                                                                           D(I) = BUTT2(I)
                                                                                                                                                                                                                                                     B(I) = ACF(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       LD = LD + NSAMS / 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL NORMAN (NSAMS, BUTT2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            READ (5,*) NWT1, NWT2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                WRITE (6,*)'Enter taper start and end for wavelet :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CALL MINPH (TEMP2, NSAMS)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              LD = NWT2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        BUTT2(I + NSAMS/2) = TEMP2(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      BUTT2(I) = TEMP2(NSAMS/2 + I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 Enter no. of lags to try :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                Calculating filter '
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360

IF (IREP .EQ. 1) NCHANN = NCHANN + 1

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C Calculate ERROR
                                                                                                                                                                                                                                       C Test filter
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                0 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     O
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   C GET XCF OF B & Desired OP CALL ZERO(NS1, S2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               C TAPER FILTER
                                                                                                                                                                    450
                                                                                                                                                                                                                                                                           440
                                                                                            460
                                                                                                                                                                                                                                                                                                                                                                                                                        430
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            410
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           400
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               390
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Solve Normal equations
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            Move shifted desired output to C
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                TRANSFORM FILTER AND INPUT
                                                                                                                                                                                                                                                                                                                                                            CALL FORK (NS1, CXA, -1.0)
CALL FORK (NS1, CXB, -1.0)
CALL FORK (NS1, CXC, -1.0)
CALL NORMAN (NS1, TEMP)
                  CALL NORMAN (NS1, C)
                                                                                                                                            CALL FORK (NS1, CTEMP, +1.0)
                                                                                                                                                                                                                                                                                                                                             CALL FORK(NS1, CXD, -1.0)
                                       ER(I) = 0.0
                                                                                          CONTINUE
                                                                                                                              DO 460 I = 1, NS1
                                                                                                                                                                 CONTINUE
                                                                                                                                                                                                                    DO 450 I = 1, NS1
                                                                                                                                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                              DO 440 I = 1, NS1 / 2 + 1
                                                                                                                                                                                                                                                                                                                                                                                                                        CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DO 430 I = 1, NS1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DO 420 I = 1, LA2

A(NS1 - I + 1) = A(LA - I + 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         LA1 = LA * 7 / 8
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 410 I = LA + 1, NS1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE (6,*)'LA = ', LA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CALL EUREKA(LA, S1, S2, A, S3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL CROSS(LL, C, LB, B, LA, S2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DO 400 \text{ J} = \text{LAG} + 1, LD
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 390 J = 1, LAG
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6,*)'LAG NO. :', LAG
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        LA2 = LA / 8
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CALL ZERO (2048, C)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   LAG = LAG1 + (L - 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        A(I) = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            C(J) = D(LD - LAG +
                                                                                                                                                                                                                                                                                                         S4(I) = CABS(CXA(I))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          C(J) = D(J - LAG)
                                                                                                          TEMP(I) = REAL(CTEMP(I))
                                                                                                                                                                               S4(I) = CABS(CTEMP(I))
                                                                                                                                                                                                   CTEMP(I) = CXA(I) * CXB(I)
                                                                                                                                                                                                                                                                                           S2(I) = CABS(CXB(I))
                                                                                                                                                                                                                                                                                                                                                                                                                                                       CXB(I) = CMPLX(B(I), 0.0)

CXD(I) = CMPLX(D(I), 0.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CXA(I) = CMPLX(A(I), 0.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    A(LA - I + 1) = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                       CXC(I) = CMPLX(C(I), 0.0)
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         470
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             500
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                                                                     520
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        Get
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     Find
                                                                                                                                                                                                                                                                                                                                                                                                 GET
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        Now
                                                                                                                                                                                                                                                     TAPER FILTER
                                                                                                                                                                                                                                                                                                                                            Solve Normal equations
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    Move shifted desired output to C
                                                                                                                                                                                                                                                                                         TRANSFORM FILTER AND INPUT
                                                                                                                                                                                                                                                                                                                                                                                               XCF OF B & Desired OP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      ACF of B
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      repeat filter calculation for a length of 1024 with optimum lag
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 optimum lag
ERMIN = 1.E10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    WRITE (6,*)'MEAN SQUARE ENERGIES :', (ER(I), I=1, NL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL ZERO(NS1, S1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CALL ZERO(2048, C)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     WRITE (6,*)'Minimum energy : ', ERMIN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         NLAGOP = IND + LAG1 - 1
                                                                                                                                                                                                              L2 = 3 * NS1 / 4
                                                                                                                                                                                                                                                                                                                        CALL EUREKA (LA, S1, S2, A, S3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                   CALL CROSS (LB, B, LB, B, LA, S1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DO 500 J = 1, NLAGOP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  LL = 2048
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE (6,*)'OPTIMUM LAG :', NLAGOP, '(', IND, ')'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 490 I = 1, NL
                                                                                                                                                                                                                                                                                                                                                            CALL CROSS (LL, C, LB, B, LA,
                                                                                                                                                                                                                                                                                                                                                                              CALL ZERO(NS1, S2)
                                                                                                                                                                                                                                                                                                                                                                                                                                  S1(1) = S1(1) * (1. + RFC)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 510 J = NLAGOP + 1, LD
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    LA = 1024
             CALL FORK(NS1, CXC, -1.0)
                                CALL FORK(NS1, CXA, -1.0)
CALL FORK(NS1, CXB, -1.0)
                                                                       CONTINUE
                                                                                                                                                            DO 520 I = 1, NS1
                                                                                                                                                                            R2 = REAL(L2)
                                                                                                                                                                                               R1 = REAL(L1)
                                                                                                                                                                                                                                  L1 = NS1 / 4
CALL FORK(NS1, CXD,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               C(J) = D(LD - NLAGOP + J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          C(J) = D(J - NLAGOP)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (ER(I) .LE. ERMIN) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     ER(I) = SQRT(ER(I)/REAL(NS1))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        DO 470 I = 1, NS1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              END IF
                                                                                                      CXB(I) = CMPLX(B(I), 0.0)

CXD(I) = CMPLX(D(I), 0.0)
                                                                                       CXC(I) = CMPLX(C(I), 0.0)
                                                                                                                                           CXA(I) = CMPLX(A(I), 0.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        ER(I) = ER(I) + ((C(I) - TEMP(I))**2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IND = I
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 ERMIN = ER(I)
-1.0)
```

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იი
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            C Calculate ERROR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      იი
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              C Rotate filter trace A
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              530
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                560
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           550
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           Test filter
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Shift filter so that t=0 is at sample 513
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 540 I = 1, NS1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     DO 530 I = 1, NS1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CALL NORMAN (NS1, C)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CALL FORK (NS1, CTEMP, +1.0)
                                                                                                                                                                                                                                                                                                                CALL PSPACE(0.05, 0.95, 0.8, 0.99)
                                                                                                                                                                                                                                                                                                                                                             CALL AXORIG(513.0, 0.0)
                                                                                                                                                                                                                                                                                                                                                                                                        CALL PSPACE(0.05, 0.95, 0.0, 1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                        R1 = REAL(L1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                             L1 = NS1 / 3

L2 = 3 * NS1 / 4
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   DO 580 I = 1, NS1 / 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL ZERO (NS1, S4)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DO 570 I = 1, NS1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  LA2 = LA / 8
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     LA1 = LA * 7 / 8
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    WRITE (6,*)'MEAN SQUARE ENERGY:', ERMIN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   ERMIN = SQRT(ERMIN/REAL(NS1))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DO 550 I = 1, NS1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CALL NORMAN (NS1, TEMP)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     ERMIN = 0.0
               CALL PSPACE(0.05, 0.95, 0.0, 0.2)
CALL MAP(R1, R2, -1.0, 1.0)
                                                                                                                               CALL PTJOIN (XPOSNS, S4, L1, L2, 1)
                                                                                                                                                                            CALL PTJOIN (XPOSNS, D, L1, L2, 1) CALL PSPACE (0.05, 0.95, 0.4, .60)
                                                                                                                                                                                                                        CALL MAP (R1, R2, -1.0, 1.0)
                                                                                                                                                                                                                                               CALL PSPACE(0.05, 0.95, 0.60, 0.8)
                                                                                                                                                                                                                                                                 CALL PTJOIN (XPOSNS, B, L1, L2, 1)
                                                                                                                                                                                                                                                                                              CALL MAP(R1, R2, -1.0, 1.0)
                                                                                                                                                                                                                                                                                                                                          CALL XGRATI (64.0)
                                                                                                                                                                                                                                                                                                                                                                                       CALL MAP(R1, R2, -1.0, 1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                  R2 = REAL(L2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE (6,*)'NSAMS = ', NSAMS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           RX = REAL (NSAMS)
                                                              CALL PTJOIN(XPOSNS, C, L1, L2, 1)
                                                                                    CALL PSPACE (0.05, 0.95, 0.2, 0.4)
CALL MAP (R1, R2, -1.0, 1.0)
                                                                                                                                                           CALL MAP (R1, R2, -1.0, 1.0)
CALL PTJOIN (XPOSNS, TEMP, L1, L2, 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CTEMP(I) = CXA(I) * CXB(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           XPOSNS(I) = REAL(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ERMIN = ERMIN + ((C(I) - TEMP(I))**2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         TEMP(I) = REAL(CTEMP(I))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      S4(I) = A(I + NS1/2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         S4(I + NS1/2) = A(I)
```

FRAME

```
610
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             600
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               590
                                                                                                                                                                                               ELSE IF (IANS .EQ. 4) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL FORK (NSAMS, C1, -1.0)
CALL FORK (NSAMS, C2, -1.0)
CALL FORK (NSAMS, C3, -1.0)
CALL FORK (NSAMS, C4, -1.0)
                                            WRITE
                                                                                                                                WRITE
                                                                                                                                                                         WRITE (6,*)
                                                                                                                                                                                                                   CALL FRAME
                                                                                                                                                                                                                                      CALL PTJOIN(XPOSNS, P4, L1, L2, 1)
                                                                                                                                                                                                                                                            CALL PSPACE(0.05, 0.95, 0.09, 0.315)
CALL MAP(R1, R2, 0.0, 1.0)
                                                                                                                                                                                                                                                                                                   CALL PTJOIN (XPOSNS, P3, L1, L2, 1)
                                                                                                                                                                                                                                                                                                                        CALL MAP (R1, R2, 0.0, 1.0)
                                                                                                                                                                                                                                                                                                                                              CALL PSPACE(0.05, 0.95, 0.315, .54)
                                                                                                                                                                                                                                                                                                                                                                 CALL PTJOIN (XPOSNS, P2, L1, L2, 1)
                                                                                                                                                                                                                                                                                                                                                                                       CALL MAP(R1, R2, 0.0, 1.0)
                                                                                                                                                                                                                                                                                                                                                                                                             CALL PSPACE(0.05, 0.95, 0.54, 0.765)
                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL PTJOIN(XPOSNS, P1, L1, L2, 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CALL MAP(R1, R2, '0.0, 1.0)
CALL AXORIG(0.0, 0.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CALL NORMAN (NSFT, P4)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CALL NORMAN (NSFT, P2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DO 590 I = 1, NSAMS
                          WRITE
                                                                                         WRITE
                                                                                                             WRITE (6, *)
                                                                                                                                                      WRITE (6,*)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL MAP (R1, R2, 0.0, 1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CALL PSPACE(0.05, 0.95, 0.765, 0.99)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    R1 = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CALL CTRMAG(10)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CALL XAXISI(200.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CALL CTRMAG(20)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL XGRATI(100.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CALL PSPACE(0.05, 0.95, 0.09, 0.99)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                R2 = REAL(NSFT) * DF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     R1 = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CALL NORMAN (NSFT, P3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CALL NORMAN (NSFT, P1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   DO 600 I = 1, NSFT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      NSFT = NSAMS / 2 + 1
                                                                  WRITE (6, *)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            R2 = REAL(NSFT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       L2 = NSFT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     L2 = REAL(L2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       L1 = REAL(R1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           C4(I) = CMPLX(CTEMP(I))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        C1(I) = CMPLX(B(I), 0.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               P4(I) = CABS(C4(I))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    P2(I) = CABS(C2(I))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       C2(I) = CMPLX(D(I), 0.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    P3(I) = CABS(C3(I))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             P1(I) = CABS(C1(I))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   C3(I) = CMPLX(A(I), 0.0)
                                                                                                                            (6, *)
                                                                                   (6,*)' 1 Select channels to apply filter '
   (6,*)' 0 EXIT'
                        (6, *)
                                          (6,*)' 2 Apply filter to channels '
                                                                                                                                                    FILTER APPLICATION'
0
                                          a
```

C Now plot transforms

```
690
700
                                                                                                                                                                                                                                                                       680
                                                                                                                                                                                                                                                                                                                                                        670
                                                                                                                                                                                                                                                                                                                                                                                                                                                            660
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         650
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      640
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    630
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 620
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      : (
                     END IF
                                                                                  END IF
RETURN
                                                            IF (IANS .NE. 0) THEN
                                       GO TO 20
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IF (IOPT .EQ. 1) THEN
WRITE (6,*)'Enter "1" if you want to apply to all :'
                                                                                                  IF (IOPT .NE. 0) GO TO 610
                                                                                                                        END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          ELSE IF (IOPT .EQ. 2) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            READ (5,*) IOPT
                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       DO 700 I = 1, NAPPLY
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IF (IREPL .EQ. 1) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               READ (5,*) IREPL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   DO 620 I = 1, NAPPLY
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CALL RMSERR(NSAMR, R4DAT(1, II), RMS0)
                                                                                                                                                                                                                                                                                                                                                                                                                                 CALL FORK (NSAMS, CXB, +1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL FORK (NSAMS, CXB, -1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DO 640 J = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (6,*)' Enter number of channels to apply filter
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           NAPPLY - NCHR
                                                                                                                                                                 CONTINUE
                                                                                                                                                                                                        DO 690 J = 1, NSAMR
                                                                                                                                                                                                                            SCALE = RMS0 / RMS1
                                                                                                                                                                                                                                                CALL RMSERR(NSAMR, R4DAT(1, II), RMS1)
                                                                                                                                                                                                                                                                     CONTINUE
                                                                                                                                                                                                                                                                                                                                DO 680 J = NLAGOP + 1, NSAMS
                                                                                                                                                                                                                                                                                                                                                        CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                               DO 670 J = 1, NLAGOP
                                                                                                                                                                                                                                                                                                                                                                                                                                                        CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DO 660 J = 1, NSAMS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DO 650 J = NSAMR + 1, NSAMS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   II = NDO(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 630 I = 1, NAPPLY
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 READ (5, *) NAPPLY
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CXB(J) = 0.0
                                                                                                                                                                                                                                                                                  R4DAT(J - NLAGOP, II) = REAL(CXB(J))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CXB(J) = CMPLX(R4DAT(J, II))
                                                                                                                                                                                   R4DAT(J,II) = R4DAT(J,II) * SCALE
                                                                                                                                                                                                                                                                                                                                                                      IF (NSAMS - NLAGOP + J .GT. NSAMR) GO TO 670 R4DAT (NSAMS - NLAGOP + J, II) = REAL (CXB (J))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CXB(J) = CXB(J) * C3(J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      READ (5, *) NDO(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE (6, *)'Enter channel #', I
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  NDO(I) = I
                                                                                                                                                                                                                                                                                                             IF (J - NLAGOP .GT. NSAMR) GO TO 680
```

SUBROUTINE LINTAP (NX, X, N1, N2, N3, N4)

```
DIMENSION X(NX)
DO 10 I = 1, N1
    X(I) = 0.0

10 CONTINUE
    DO 30 I = N1 + 1, N2 - 1
    X(I) = REAL(I - N1) * X(I) / REAL(N2 - N1)

20 CONTINUE
    DO 30 I = N3 + 1, N4 - 1
    X(I) = REAL(N4 - I) * X(I) / REAL(N4 - N3)

30 CONTINUE
    DO 40 I = N4, NX
    X(I) = 0.0

40 CONTINUE
    RETURN

FRETURN
                                                                                                                                                                                                                                                                                                                                     C Applies linear taper to both sides of time series \ensuremath{\mathsf{C}}
```

#### Appendix A.2

#### The reflection point loci program

#### **REFLOC**

The program REFLOC takes a given model with layer velocities and source and receiver coordinates and calculates the locus of reflection points for each source and receiver pairing. The loci are output to a file which is attached as unit 7 at run-time and these loci are then used by the VSP-CDP mapping program XHRMAP in Appendix A.3.

```
0 0 0 0 0 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 ററ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          00000000000000
                                                                                                                                                                                                                                                                                                                                         10 FORMAT (A1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         Modified to include anisotropy in raytracing by Ed Kragh 1989
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    initial ray parameters from the source and repeating with the same ray parameter from the receiver. The intersection of the 2 raypaths {\sf ray}
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             two sided survey is being processed then -ve x comes first.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          Space to the right is -ve x and space to the right is +ve x. If a single sided survey is being processed then -ve x must be used. If a
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                Modified to handle Hole-to-surface geometry as well as crosshole
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           Written by M J Findlay 1988
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           Program output used by XHRMAP program
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 Subroutines called : MAXSN, MINSN, ZERO from REAL*4 TSAR4_1 Lib
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         at XR(i), ZR(i); Locus for each source/receiver pair will be contained in the arrays X(i), Z(i) : output to disc for later
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  homogeneous layered model with source at position XS, ZS; receiver
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               Program to find loci of reflection points for a plane parallel
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      The following convention should be used: The borehole is at x=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               yields the reflector locus.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    interpolation.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      PRINT *, 'Enter R for common receiver gathers or S for common shot
                                                                                                                                                    PRINT *, 'Enter TOTAL no of loci to be calulated
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         REAL XINTR(31), XINTS(31), THICK(30), VV(30), VH(30), THET(31)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     REAL XS, ZS, XR(24), ZR(24), X(52000), Z(52000), T(52000)
                               IF (NLAMAX .GT. 30) THEN
                                                                   READ (1, *) NLAMAX
                                                                                                                            READ (1, *) NLOCI
                                                                                                                                                                                                                     READ (1, 10) GATHER
                                                                                                                                                                                                                                                                                                                                                                      READ (1,10) HSTYPE
                                                                                                                                                                                                                                                                                                                                                                                             PRINT *, 'Enter F for full two sided survey else single sided
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            KOUNT = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   PI = ACOS(-1.)
PI2 = PI / 2.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CHARACTER MODE*1, HSTYPE*1, WAVFLD*1, GATHER*1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       REAL DEPTH(31), TIME(31)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            PROGRAM REFLOC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             LOGICAL RECLAY
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   read in the survey type.... F=full two sided .... else single
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                attached to unit 1 Output goes to unit 7
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            parameterise the velocity structure layer i ; thickness THICK(i),
WRITE (6,*)' MAXIMUM NO. OF LAYERS = 30 : PLEASE MODIFY UNIT 1'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             The method involves raytracing by iterating over different
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    May be necessary to play around with DTHETA (step angle)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   DIST(31)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          Routines from *ghost80
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          ; velocity V(i)
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     20 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 40 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DO 30 I = 1, NLAMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DO 20 I = 1, NLAMAX
                                                                                                                                                              END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   IF (GATHER .EQ. 'R' .OR. GATHER .EQ. 'r') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              Read in stepping angle for raysearch READ (1,*) DTHETA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           READ (1,10) MODE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               READ (1,10) WAVFLD
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           READ (1,*) PHI1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        READ (1,*) ANISO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DEPMAX = DEPTH (NLAMAX + 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DEPTH(1) = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 READ (1,*) MAXLOP, NLP10, NLP100
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IF (GATHER .EQ. 'S'
                                                                               IF (GATHER .EQ. 'S' .OR. GATHER .EQ. 's') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                PHI = angle of dip
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         If a full survey is being processed do the -ve half first.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         The borehole is at x=0 and -ve values are to the left
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             Read in source and receiver positions
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 Read in display mode (Full scale/ Optimal fill)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      wavfld is not used in this version of refloci
                                                                                                                                                                                     CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DEPTH(I + 1) = DEPTH(I) + THICK(I)
PRINT *, 'If processing a full survey do the -ve half first' PRINT *, 'Enter XSHOT ZSHOT'
                                               PRINT *, 'Borehole is at x=0
                                                                                                                                                                                                                                                                                                                                                                                                                        PRINT *, 'If processing a full survey do the -ve half first' PRINT *, 'Enter XREC ZREC'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     READ (1,*) THICK(I), VV(I)
                                                                                                                                                                                                                                     DO 50 I = 1, NRECS
                                                                                                                                                                                                                                                                                         READ (1,*) NRECS
                                                                                                                                                                                                                                                                                                               PRINT *, 'Enter the no of downhole shots'
                                                                                                                                                                                                                                                                                                                                                                                          READ (1,*) XS, ZS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                     PRINT *, 'Borehole is at x=0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              Read in max number of takeoff angle spreads \epsilon NUMBERS FOR INCREASE IN DTHETA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      VH(I) = VV(I) + VV(I) * ANISO
                                                                                                                                                                                                                                                                PRINT *, 'Enter XSHOT ZSHOT for every shot'
                                                                                                                                                                                                                                                                                                                                             XSPLOT = XS
                                                                                                                                                                                                                                                                                                                                                                      IF (KOUNT .EQ. 2) XS = -XS
                                                                                                                                                                                                              READ (1,*) XR(I), ZR(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         p +ve for dip UP from borehole to RIGHT
.OR. GATHER .EQ. 's') PHI1 = -PHI1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                          -ve is to the right'
                                                 -ve is to the right'
```

READ (1,\*) XS, ZS

END IF

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C posns
                                                                                                                                                        120 DISTS = SQRT(XS**2 + ZS**2)
IF (XS .EQ. 0.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF (XMIN .LT. 0.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CALL MINSN (NRECS, ZR,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CALL MAXSN (NRECS, ZR,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL MAXSN (NRECS, XR, XMAX, II)
                                                                                                                                                                                                                                                                                                                                                                                                                           IF (ZMIN .LT. 0.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     XSHIFT = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ZMIN = AMIN1(ZMIN, ZS)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        ZMAX = AMAX1(ZMAX, ZS)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CALL MINSN (NRECS, XR, XMIN, II)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           XMAX = AMAX1(XMAX, XS)
                       DZS = DISTS * (SIN(ALPHA) - SIN(ALPHA - PHI))
                                            END IF
                                                                                                                ELSE
                                                                                                                                                                                                                                                                    END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                    END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                ZSHIFT = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     XMAXP = XMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            XMINP = XMIN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   XMIN = AMIN1 (XMIN, XS)
DXS = DISTS * (COS(ALPHA - PHI) - COS(ALPHA))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         Shift axes so that all Xs and Zs are >0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Pick out maximum and minimum values of X & Z
                                                                                                                                                                                                                                                                                                                                      CONTINUE
                                                                                                                                                                                                                        Now apply rotational transformation of PHI to source@receiver
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 80 I = 1, NRECS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               PRINT *, 'Enter XREC ZREC for every receiver' DO 60 I = 1, NRECS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           READ (1,*) NRECS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               PRINT *, 'Enter the no of surface receivers'
                                                                                                                                                                                                                                                                                                                                                                                DO 110 J = 1, NRECS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DO 100 J = 1, NRECS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              XSPLOT = -XXXX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL MAXSN (NRECS, XR, XXXX, II)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 70 I = 1, NRECS
                                                                 ALPHA = ATAN (ALPHA)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                       XMIN = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     XS = XS - XMIN
                                                                                        ALPHA = ZS / XS
                                                                                                                                 ALPHA = PI2
                                                                                                                                                                                                                                                                                           ZMIN = 0.0
                                                                                                                                                                                                                                                                                                                 ZSHIFT = ZMIN
                                                                                                                                                                                                                                                                                                                                                                                                      ZS = ZS - ZMIN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               XSHIFT = XMIN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          PRINT *, ' XR(I) =', XR(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IF (KOUNT .EQ. 1) XR(I) = -XR(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            READ (1,*) XR(I), ZR(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       XR(J) = XR(J) - XMIN
                                                                                                                                                                                                                                                                                                                                                           ZR(J) = ZR(J) - ZMIN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             ZMAX, II)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     ZMIN, II)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  ဂ ဂ
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C Find source layer number
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                                                                                                                                                                                                                                                   160 CONTINUE
                                                                                                                                                                                                                                                                           150 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          COORDINATES
                                                                                                                                                                                                                                                                                                                                                                                                     DO 150 I = 1, NLAMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DO 130 J = 1, NRECS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 PRINT *, 'NEW SOURCE POSN = ', XS, ZS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ZS = ZS - DZS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 XS = XS + DXS
                                                                                                                                               IF (KOUNT .EQ. 1) THEN
                                                                                                                                                                                                                            PRINT *, 'SOURCE LAYER = ', LAYSOR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CALL MINSN (NRECS, ZR,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          ZMAX = AMAX1(ZMAX, Z0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CALL MAXSN (NRECS, ZR,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         XMIN = AMIN1(XMIN, X1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CALL MINSN (NRECS, XR,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CALL MAXSN(NRECS, XR, XMAX = AMAX1(XMAX, X0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                PRINT *, ' Reset = ', RESET
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IF (XS .LT. 0.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              RESET = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ZMIN = AMIN1(ZMIN, Z1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               If new source position is lt zero then shift source + all recs
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DO 140 J = 1, NRECS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             XR(J) = XR(J) + DXR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DISTR = SQRT(XR(J)**2 + ZR(J)**2)
                                                                                                CALL PSPACE(0.1, 0.9, 0.1, 0.9)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 Pick out maximum and minimum values of X & Z IN SHIFTED
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    XS = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  PRINT *, 'NEW RECEIVER POSN', J, ' = ', XR(J), ZR(J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ZR(J) = ZR(J) - DZR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        DXR = DISTR * (COS(ALPHA - PHI) - COS(ALPHA))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DZR = DISTR * (SIN(ALPHA) - SIN(ALPHA - PHI))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IF (XR(J) .EQ. 0.0) THEN
                                                                                                                                                                                                                                                                                                  END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               RESET = XS
                                                                          IF (HSTYPE .EQ. 'F' .OR. HSTYPE .EQ. 'f') THEN
                                                                                                                            CALL PAPER(1)
                                                                                                                                                                                                                                                                                                                                                                           IF (DEPTH(I + 1) .GE. ZS) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             ALPHA - ATAN (ALPHA)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ALPHA = ZR(J) / XR(J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      ALPHA = PI2
CALL MAP (0.0, XSPLOT, DEPMAX, 0.0)
                                                 CALL MAP (-XSPLOT, XSPLOT, DEPMAX, 0.0)
                                                                                                                                                                                                                                                                                                                            GO TO 160
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       XR(J) = XR(J) - RESET
                                                                                                                                                                                                                                                                                                                                                   LAYSOR = I
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              x0, II)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   Z1, II)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 X1, II)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Z0, II)
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230

CONTINUE

C Loop over C horizontal C റ 190 210 220 200 Find receiver layer

DO 180 NL = 1, NLAMAX

IF (DEPTH(NL + 1) .GE. ZR(J)) THEN Loop over takeoff angles (Lay parameters) Loop over each receiver ; THETAO is initial takeoff angle to DO 370 J = 1, NRECS IF (KOUNT .EQ. 1) WRITE (7,\*) NLOCI DTHETA = ABS (DTHETA) IF (VH(LAYREC) .LE: VH(LAYREC - 1)) THEN CONTINUE CONTINUE PRINT \*, 'RECEIVER no.: ', J, ' At depth ', ZR(J) DO 320 I = 1, MAXLOP END IF ELSE END IF DTHETO = DTHETA IF (LAYREC .EQ. LAYSOR .OR. LAYREC .EQ. 1) THEN LOOP = 1 THETAO = THETAO - DTHETA + DTHETA / 100. THETA0 = ATAN(SQRT(TEM3/TEM2))TEM3 = VH(LAYREC - 1) \*\* 4 TEM2 = TEM1 \* VV(LAYREC - 1) \*\* 2THETAO = 0.0GO TO 200 CALL ZERO(31, XINTR) CALL ZERO(31, DIST) THETAO = PI2 - THETAO TEM1 = VH(LAYREC) \*\* 2 - VH(LAYREC - 1) \*\*THETA0 = 0.0END IF CONTINUE DO 220 JJ = 1, 31 RECLAY = .FALSE. NLAYER = LAYSOR THETA = THETAO IF (I .GT. NLP100) DTHETA = 100. \* DTHETO IF (I .GT. NLP10) DTHETA = 10. \* DTHETO ZPO = ZSXPO = XSIF (ABS(THETAO) .GE. PI2) GO TO 320 IF (THETAO .EQ. 0.0) THETAO = THETAO + DTHETA THETAO = THETAO + DTHETA GO TO 190 LAYREC = NL XINTS(JJ) = -1000-ve ==> upwards

Now start raytracing loop

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C \*\*\*\*\*\*\* RAY OUT BOTTOM =====> STOP THIS RAY AND START RAY FRO C RECEIVER C \*\*\*\*\*\*\*\*\*\* RAY BEYOND RECEIVER ===> STOP THIS RAY & START FROM C RECEIVER ററ 00 C\*\*\*\*\*\*\* RAY OUT TOP =====> STOP THIS RAY AND START FROM RECEIVER Check for critical reflection Check for ray passing beyond receiver or out top THETA<0) Ensure ray goes deeper than rec (FOR THETA>0 :: SHALLOWER FOR IF (NLAYER .EQ. LAYREC) THEN ELSE FAC = (ZR(J) - ZPO)ELSE IF (THETA .GE. 0.0 .AND. NLAYER .EQ. NLAMAX) ELSE END IF XPO = XPO + DX
IF (THETA .LT. 0.0) THEN TEMP3 = TEMP1 \* COS(THETA) \*\* 2 TEMP4 = TEMP2 \* SIN(THETA) \*\* 2 TEMP2 = VH(NLAYER) \*\* 2THET (NLAYER) = THETA END IF IF (ABS (THETA) .EQ. PI2) THEN END IF IF (THETA .LT. 0) THEN ELSE IF (THETA .LT. 0.0 .AND. NLAYER .EQ. 1) THEN IF (XPO .GT. XR(J)) THEN END IF TIME (NLAYER) = DIST (NLAYER) / VTHETA VTHETA = SQRT(TEMP1\*TEMP2/(TEMP3 + TEMP4)) TEMP1 = VV(NLAYER) \*\* 2 DIST(NLAYER) = DIST(NLAYER) + SQRT(DX\*\*2 + D2\*\*2) DX = 0.0XINTS (NLAYER + 1) = XPO 2PO = DEPTH(NLAYER + 1) DZ = DEPTH(NLAYER + 1) - ZPO ZPO - DEPTH(NLAYER) IF (ABS(TAN(THETA)) .LT. ABS(FAC/(XR(J) - XPO))) XINTS (NLAYER) = XPO DX = DZ / TAN (THETA) DZ = DEPTH(NLAYER) - ZPO GO TO 250 IF ( .NOT. RECLAY) THEN RECLAY - .TRUE. GO TO 250 END IF GO TO 320 IF ((THETA .LT. 0.0 .AND. FAC .LT. 0.0) .OR. (THETA .GT. 0.0 .AND. FAC .GT. 0.0)) GO TO THEN 320

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                                                                                                                                                                                                                                                                                                                                                                                                                                               C
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         000
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        C******** APPLY SNELL'S LAW, UPDATE LAYER NO. 6 RESTART RAYTRACE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  C******* SUPERCRITICAL ===> STOP THIS RAY & START FROM RECEIVER
                                                                                                                                                                                                                                                                                                                               C ******* SUPERCRITICAL ===> STOP THIS RAY & TRY NEXT ONE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             240
                                                                                                                                                                                                                                                                                                          260
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 250
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Code
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 for tracing from receiver
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CRIT = ATAN(SQRT(1./TEM))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (LAYREC .GE. LAYSOR) THETA = THET(LAYREC)
IF (LAYREC .LT. LAYSOR) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CRIT = PI2 - CRIT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   IF (THETA .LT. 0.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               V00 - VV (NLAYER)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 IF (ABS (THETA) .LT. CRIT) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                TEM = V00 ** 2 * (V1**2 - V0**2) / V0 **
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IF (V0 .GE. V1) GO TO 240
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             V1 = VH(NLAYER - 1)
                                                                                                                                                                                                                                                                                                                                                                                 CRIT = ATAN(SQRT(1./TEM))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  GO TO 230
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            THETA = THETA2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       THETA2 = (PI2 - ABS(THETA2)) * SIGN(1.0, THETA)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             TEMC = VH(NLAYER - 1) ** 4 / (TAN(PI2 - ABS(THETA))**2)
TEMD = VH(NLAYER - 1) ** 2 - VH(NLAYER) ** 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    TEMB = VV(NLAYER) ** 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        NLAYER = NLAYER + NINT(SIGN(1.0, THETA))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IF ((ZPO - ZR(J))*SIGN(1.0, THETA) .GT. 0.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      V1 = VH(NLAYER + 1)
                                                                                                                                                                                       TEMC = (1.0/TEMC) * TEMA / TEMB
                                                                                                                                                                                                                      TEMC = (TAN(PI2 - ABS(THET(LAYSOR)))**2)
                                                                                                                                                                                                                                                                                                          CONTINUE
                                                                                                                                                                                                                                                                                                                                                              CRIT = PI2 - CRIT
                                                                                                                                                                                                                                                                                                                                                                                                              TEM = V00 ** 2 * (V1**2 - V0**2) / V0 ** 4
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 V1 = VH(LAYSOR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              V00 = VV(LAYREC)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          V0 = VH(LAYREC)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              THETA2 = ATAN (SQRT (TEMA/TEME))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             TEME = TEMB * (TEMC + TEMDD*TEMD)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        TEMDD = VV(NLAYER - 1) ** 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 TEMA = VH(NLAYER) ** 4 * VV(NLAYER - 1) ** 2
                          THETA = ATAN(SQRT(1.0/TEME))
                                                    TEME = TEME / (VH(LAYREC)**4)
IF (TEME .LT. 0.0) GO TO 320
                                                                                                           TEME = TEMC - TEMDU * TEMD
                                                                                                                                       TEMDD = VV(LAYREC) ** 2
                                                                                                                                                           TEMD = VH(LAYREC) ** 2 - VH(LAYSOR) ** 2
                                                                                                                                                                                                                                                   TEMB = VV(LAYSOR) ** 2
                                                                                                                                                                                                                                                                           TEMA = VH(LAYSOR) ** 4 * VV(LAYREC) ** 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF (V0 .GE. V1) GO TO 260
THETA = (PI2 - ABS(THETA))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                GO TO 320
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     GO TO 250
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          No crit rays
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     PRINT*, 'SUPERCRITICAL AT LAYER ', NLAYER
                                                                                                                                                                                                                                                                                                                                                                                                                                          No ray will reach sor layer
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VO = VH(NLAYER)

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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           C ******* SUPERCRITICAL ===> STOP THIS RAY & TRY NEXT ONE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       270
                                                                                                                                                                                                                                           Check for raypath intersection
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            Now start raytracing code for receiver
                                                               Check for ray passing beyond SOURCE or out top
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   XPO = XR(J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      IF (LAYREC .EQ. LAYSOR) THETA - THETAO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  END IF
                                                                                                              END IF
                                                                                                                                                                                                   IF (THETA .LT. 0.0) THEN
                                                                                                                                                                                                                                                                                            END IF
                                                                                                                                                                                                                                                                                                                                                                                                                         TIME (NLAYER) = DIST(NLAYER) / VTHETA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        TEMP1 = VV(NLAYER) ** 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DIST(NLAYER) = DIST(NLAYER) + SQRT(DX**2 + DZ**2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                FAC = (ZS - ZPO)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ZPO = ZR(J)
                     IF (XPO .LT. XMIN) THEN
                                                                                                                                                                                                                                                                                                                                                                               IF (THETA .LT. 0.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                        XPO = XPO - DX
                                                                                                                                                                                                                                                                                                                                                                                                                                                 VTHETA = SQRT(TEMP1*TEMP2/(TEMP3 + TEMP4))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                        TEMP4 = TEMP2 * SIN(THETA) ** 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             TEMP3 = TEMP1 * COS(THETA) ** 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  TEMP2 = VH(NLAYER) ** 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF (ABS (THETA) .EQ. PI2) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (THETA .LT. 0.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IF (NLAYER .EQ. LAYSOR) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          NLAYER = LAYREC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           RECLAY = .FALSE.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      DX = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IF (ABS (TAN (THETA)) .LT. ABS (FAC/(XS - XPO))) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          END IF
                                                                                                                                                                          IF (XINTR(NLAYER) .LE. XINTS(NLAYER)) GO TO 290
                                                                                                                                                                                                                                                                                                                                                            XINTR(NLAYER) = XPO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       DX = DZ / TAN(THETA)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         END IF
GO TO 320
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ZPO = DEPTH(NLAYER + 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       DZ = DEPTH(NLAYER + 1) - ZPO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DZ = DEPTH(NLAYER) - ZPO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IF (ABS (THETA) .LT. CRIT) THEN
                                                                                                                               IF (XINTR(NLAYER + 1) .LE. XINTS(NLAYER + 1)) GO TO 290
                                                                                                                                                                                                                                                                                                               XINTR(NLAYER + 1) = XPO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ZPO = DEPTH(NLAYER)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              GO TO 320
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                GO TO 320
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      PRINT *,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  ' CRIT RAY ... FOR REC CODE'
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C\*\*\*\*\*\*\*\* \*\*\* RAY BEYOND RECEIVER ===> STOP THIS RAY & TRY NEXT ONE

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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     C ******* SUPERCRITICAL ===> STOP THIS RAY & TRY NEXT ONE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          C******* APPLY SNELL'S LAW, UPDATE LAYER NO. & RESTART RAYTRACE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       C******* RAY OUT BOTTOM =====> STOP THIS RAY AND TRY NEXT ONE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            C****** RAY OUT TOP ====> STOP THIS RAY AND TRY NEXT ONE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              290
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           280
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Now establish point of intersection of the rays
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ELSE IF (THETA .GE. 0.0 .AND. NLAYER .EQ. NLAMAX)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CRIT = PI2 - CRIT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CRIT = ATAN (SQRT (1./TEM))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF (THETA .LT. 0.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  V00 = VV (NLAYER)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              IF (THETA .LT. 0.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (ABS (THETA) .LT. CRIT) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        TEM = V00 ** 2 * (V1**2 - V0**2) / V0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IF (V0 .GE. V1) GO TO 280
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  VO = VH(NLAYER)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               GO TO 320
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                V1 = VH(NLAYER + 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          V1 = VH(NLAYER - 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       GO TO 320
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                TEMD = VH (NLAYER - 1) ** 2 - VH (NLAYER) ** 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   GO TO 320
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   GO TO 270
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              THETA2 = (PI2 - ABS(THETA2)) * SIGN(1.0, THETA)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                TEMC = VH(NLAYER - 1) ** 4 / (TAN(PI2 - ABS(THETA))**2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              TEMB = VV(NLAYER) ** 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              TEMA = VH(NLAYER) ** 4 * VV(NLAYER - 1) ** 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           NLAYER = NLAYER + NINT(SIGN(1.0, THETA))
                                                                                                                                                                                                                                                                                  ELSE
                                                                                                                                                                                                                                                                                                                                                                                                       Z (LOOP) = DEPTH (NLAYER) + DZ
                                                                                                                                                                                                                                                                                                                                                                                                                                    DZ = (X(LOOP) - XINTS(NLAYER)) * TAN(THETA)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IF (X(LOOP) .LT. 0.0) WRITE (6,*)'XINTS(NL),XINTR(NL) = ',
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            X(LOOP) = 0.5 * (XINTS(NLAYER) + XINTR(NLAYER))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 THETA = THETA2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           THETA2 = ATAN (SQRT (TEMA/TEME))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           TEME = TEMB * (TEMC + TEMDD*TEMD)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      TEMDD = VV(NLAYER - 1) ** 2
                                                                                                                                                                                                                                                                                                                                                                       IF (NLAYER .EQ. LAYSOR) THEN
                                                                                                                                                       IF (NLAYER .EQ. LAYREC) THEN
                                                                                                                                                                                       END IF
Z2DASH = DEPTH (NLAYER + 1)
                          X2DASH = XINTR(NLAYER + 1)
                                                                                                                                                                                                                    ZIDASH = DEPTH(NLAYER + 1)
                                                                                                                                                                                                                                                  X1DASH = XINTS (NLAYER + 1)
                                                                                          22DASH = ZR(J)
                                                                                                                                                                                                                                                                                                               Z1DASH = ZS
                                                                                                                                                                                                                                                                                                                                          X1DASH = XS
                                                                                                                          X2DASH = XR(J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                            XINTS (NLAYER), XINTR (NLAYER)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        No crit rays
```

ELSE IF (THETA .LT. 0.0 .AND. NLAYER .EQ. 1) THEN

```
C apply rotational transformation of minus PHI to source&receiver posns
                         C Now map X, Z coordinates back to dipping space
                                                                                                                                                                                                    C Next ray
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       300
                                                                                                                                                                                                                                                                                                                        310
                                                                                                                                               CONTINUE
                                                                                                              DTHETA = DTHETO
                                                                                     IF (LOOP .LE. 1) GO TO
                                                                                                                                                                                                                                                              LOOP = LOOP + 1
                                                                                                                                                                                                                                                                                          END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CONTINUE
                                                                                                                                                                                                                                                                                                                   CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IF (X(LOOP) .LT. 0.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    T(LOOP) = SQRT((X2DASH - X1DASH)**2 + (2*Z(LOOP) - Z1DASH -
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               VTHETA = SQRT(TEMP1*TEMP2/(TEMP3 + TEMP4))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         TEMP3 = TEMP1 * COS(THETA) ** 2
TEMP4 = TEMP2 * SIN(THETA) ** 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              TEMP2 = VH(NLAYER) ** 2
                                                                                                                                                                                                                                                                                                                                                                                DO 310 M = NLAYER - 1, 1, -1
                                                                                                                                                                                                                                                                                                                                                                                                      Z2DASH) **2) / VTHETA
                                                                                                                                                                                                                                                                                                                                                                                                                                       T(LOOP) = SQRT((X2DASH - X1DASH)**2 + (2*Z(LOOP) - Z1DASH -
                                                                                                                                                                                                                                                                                                                                                                                                                                                                   VTHETA = SQRT(TEMP1*TEMP2/(TEMP3 + TEMP4))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 TEMP4 = TEMP2 * SIN(THETA) ** 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          TEMP3 = TEMP1 * COS(THETA) ** 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         TEMP2 = VH(NLAYER) ** 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          Z(LOOP) = DEPTH(NLAYER + 1) + DZ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        DZ = (X(LOOP) - XINTS(NLAYER + 1)) * TAN(THETA)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             X(LOOP) = 0.5 * (XINTS(NLAYER + 1) + XINTR(NLAYER + 1))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 300 M = NLAYER + 1, NLAMAX, 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          22DASH) **2) / VTHETA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         TEMP1 = VV(NLAYER) ** 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       TEMP1 = VV(NLAYER) ** 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (NLAYER .EQ. LAYSOR) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IF (NLAYER .EQ. LAYREC) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                T(LOOP) = T(LOOP) + TIME(M)
                                                                                                                                                                                                                                                                                                                                                    T(LOOP) = T(LOOP) + TIME(M)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              Z2DASH = DEPTH(NLAYER)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          X2DASH = XINTR (NLAYER)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    Z2DASH = ZR(J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             X2DASH = XR(J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Z1DASH = DEPTH (NLAYER)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               XIDASH = XINTS (NLAYER)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         Z1DASH = ZS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  X1DASH = XS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             WRITE (6, *)'LAYREC=', LAYREC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           WRITE (6, *)'RECEIVER=', J
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    WRITE (6,*)'THETA=', THETA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE (6, *)'NLAYER = ', NLAYER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE (6,*)'XINTS = ', XINTS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,*)'XINTS(NL+1), XINTR(NL+1)=', XINTS(NLAYER + 1),
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            XINTR(NLAYER + 1)
```

```
350 CONTINUE
360 CONTINUE
370 CONTINUE
                                                                                                                                                                                                                                                                                                                                                 340
CALL GREND
END
                                     END IF
                                                                                                                                                          IF (KOUNT .EQ. 1) THEN
                                                                                                                                                                                                     CONTINUE
                                                                                                                                                                                                                                                                                                                                                CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DO 340 K = 1, LOOP - 1
DISTP = SQRT(X(K)**2 + Z(K)**2)
IF (X(K) .EQ. 0.0) THEN
                                                                          IF (HSTYPE .EQ. 'F' .OR. HSTYPE .EQ. 'f') THEN
KOUNT = 2
PHI = -PHI1
GO TO 40
                                                                                                                                                                                                                                        CALL PTJOIN(X, Z, 1, LOOP - 1, 1)
WRITE (7,*) (LOOP - 1)
DO 350 M = 1, LOOP - 1
WRITE (7,*) T(M), -X(M), Z(M)
                                                            END IF
                                                                                                                                                                                                                                                                                                                              PHI = -PHI
                                                                                                                                                                                                                                                                                                                                                                                                                          DZP = DISTP * (SIN(ALPHA) - SIN(ALPHA - PHI))
DXP = DISTP * (COS(ALPHA - PHI) - COS(ALPHA))
X(K) = X(K) + DXP + XSHIFT
Z(K) = Z(K) - DZP + ZSHIFT
                                                                                                                                                                                                                                                                                                                                                                IF (GATHER .EQ. 'S' .OR. GATHER .EQ. 's') X(K) = -X(K) IF (KOUNT .EQ. 2) X(K) = -X(K)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                First reset the x position before the rotation The x position was shifted if after the rotation the source had -ve x value

IF (RESET .LT. 0.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              X(K) = X(K) + RESET
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 ALPHA = Z(K) / X(K)
ALPHA = ATAN (ALPHA)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ALPHA = PI2
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#### Appendix A.3

# The VSP-CDP transform program

#### **XHRMAP**

The program XHRMAP takes upgoing or downgoing reflection data and transforms it on to reflection point loci calculated by the program REFLOC. Mapped data are subsequently binned on to a rectangular grid and then plotted.

# PROGRAM XHRMAP

```
C source/receiver
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 file
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    10 WRITE (6,*)
                                           20
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           WRITTEN BY M J FINDLAY 1988
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                Program to map XHR reflection data to correct CDP position
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       Subroutines required:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CALL PAPER (2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    N3 = 24
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          REAL TT (1500, 24), XX (1500, 24), ZZ (1500, 24), NPOINT (24),
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Option allows user to stack individual CDP sections in unformatte
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           MUST first run REFLOCI 'to calculate reflection locus for
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE (6,*)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE (6,*)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                XOFF = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            N1 = 300
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              REAL CSGS(300,40,24), CDP(300,24), SECTN(300,40), RNORM(24)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 REAL NSTACK (300, 40)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  REAL X(1024), Z(1024), X0(1024), WT(300,40), REF0(300,40)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          REAL R4DAT(1024,40), RECDEP(24), DBGAIN(24), GCMSCL(24),
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DIMENSION A1 (9)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CHARACTER FNAME*16, A1*20, ANS*1, INSTAK*16, ANSWR*1
                                                                                                                       IF (IANS .EQ. 1 .OR. IANS .EQ. 5) THEN WRITE (6,*)'True scale plot (Y/N)?'
                                                                                                                                                                                           WRITE (6,*)
                                                                                                                                                                                                             WRITE (6, *)'
                                                                                                                                                                                                                                 WRITE (6,*)
                                                                                                                                                                                                                                                       WRITE
                                                                                                                                                                                                                                                                            WRITE
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                INTEGER NFIRST(24), IDPROC(4,24), NCR(2)
                                                                                                                                                                     READ (5,*) IANS
READ (5, *) NSHOT
                     WRITE (6, *)'Enter shot ID number :'
                                         FORMAT (A16)
                                                             READ (5,20) FNAME
                                                                                   WRITE (6, *)'Enter data file name :'
                                                                                                       READ (5,100) ANSWR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WT0 (300, 40)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         REFL (300, 40)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              Initially for upgoing wavefield only
                                                                                                                                                                                                                                                                         (6, *)
                                                                                                                                                                                                                                                                                                                                                                                                                                              (6, *)
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                                                                                                                                                                                                                                                     (6,*)'
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                                                                                                                                                                                                                                                                                                                                                                                                                        Output binned traces
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          Plot binned traces
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Put reflectors on loci, plot and bin '
                                                                                                                                                                                                                                                     Apply AGC to binned record
                                                                                                                                                                                                                                                                                             Bandpass filter binned data
                                                                                                                                                                                                                                                                                                                                        Selective CDP stacking
                                                                                                                                                                                                                                                                                                                                                                                                                                                                    Stack binned traces
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      *ghost80 and TimeSeriesAnalysis(REAL*4) libs
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  SAMNOR (included in this file)
                                                                                                                                                                                                                                                                                                                                                                               OPTION 1 but for headerless files '
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  XHRMAP
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                                                                                                                                                                                                            60
                                                                                       Normalise so that Peak RMS amplitude over all traces is 1.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,*)'Enter Maximum depth to be plotted :'
DO 80 J = 1, NRECS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL ZERO(NN, WT(1,1))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CALL ZERO (NN,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CALL ZERO(NN, REFO(1,1))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE (6,*)'Enter polarity (-1=SEG-normal +1=SEG-reverse):'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      READ (5,*) AMPSCL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                WRITE (6,*)'ENTER amplitude scaling factor:'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     READ (5,*) XOFF
                              RMSMAX = 0.0
                                                                                                                                                 END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (IANS .EQ. 1) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IDCODE = (NSHOT - 1) * 25 + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        NRECS = 24
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    NSAMR = 1024
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                LEN = 4104
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      NN = 300 * 40
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE (6,*)'NTRCEX,NDIMZ = ', NTRCEX, NDIMZ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         NDIMZ = INT (DMAX/DELTAZ) +
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     NTRCEX = INT(XOFF/DELTAD) + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               READ (5,*) DELTAD
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           WRITE (6,*)'Enter vertical trace spacing in metres :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       READ (5,*) DELTAZ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,*)'Enter vertical sampling in metres :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IF (ABS (IPOLAR) .NE. 1) GO TO 30
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              READ (5,*) IPOLAR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            READ (5,*) DMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6,*)'Enter source offset :'
                                                                                                                                                                                                            CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CLOSE (10)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DO 40 J = 1, NRECS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    READ (10, REC=IDCODE) A1, SORPOS, NRECS, RECDEP, DBGAIN, GCMSCI, NFIRST, NCR, NPROCS, IDPROC, DT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              OPEN (10, FILE=FNAME, STATUS='OLD', ACCESS='DIRECT', RECL=LEN)
                                                                                                                                                                           CLOSE (11)
                                                                                                                                                                                                                                                                                                                                                                                        DO 60 J = 1, NRECS
                                                                                                                                                                                                                                                                                                                                                                                                                 OPEN (11, FILE=FNAME, STATUS='OLD', FORM='FORMATTED')
                                                                                                                                                                                                                                                                                                                                                                                                                                                   FORMAT (8F10.4)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DT = 200E-6
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       READ (5,*) ZMINR, DZR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6, *)'ENTER source depth (metres):'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          READ (5,*) VFLAT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DT = 200.0 * 1E-6
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ZRECS = ZMINR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,*)'Enter shallowest receiver & receiver sepn:'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  READ (5,*) SORDEP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    WRITE (6,*)'Enter (uniform) velocity field in metres/sec:'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IF (DT .EQ. 0.0) PRINT *, 'DT = 0'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        NREC = IDCODE + J
                                                                                                                                                                                                                                                                                                                                                    READ (11, *) JDUM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         READ (10, REC=NREC) (R4DAT(I, J), I=1, NSAMR)
                                                                                                                                                                                                                                        ZRECS = ZRECS + DZR
                                                                                                                                                                                                                                                                     NFIRST(J) = 1
                                                                                                                                                                                                                                                                                                 TD = SQRT(XOFF**2 + (SORDEP - ZRECS)**2) / VFLAT
                                                                                                                                                                                                                                                                                                                             READ (11,50) (R4DAT(I,J), I=1, NSAMR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      REFL (1, 1))
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120
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      140
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           130
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            100
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   90
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   80
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           70
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       PLOT REFLECTORS ON LOCI
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      OPEN (1, FILE=FNAME, STATUS='OLD')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DO 90 J = 1, NRECS
                                                                                                                                                                                                                                                                                                                                                                                                         CALL AXES
                                                                                                                                                                                                                                                                                                                                                                                                                              CALL MAP (0.0, XOFF, DMAX, 0.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL PSPACE(POX, PIX, 0.1, 0.9)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CLOSE (1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DO 140 JJ = 1, NRECS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   READ (1,*) NRECS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     READ (5,20) FNAME
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE (6,*)'Enter name of file of reflection loci :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IF (ANS .EQ. 'y' .OR. ANS .EQ. 'Y') THEN DO 120 J = 1, NRECS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       FORMAT (A1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 READ (5,100) ANS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE (6, *)'Apply T-squared ramp (Y/N) ?'
                                                                                                                                                                                                                                                                                                                                                       TTRMS = 0.0
                                                                                                                                                                                                                                                                                                                                                                                 CALL BORDER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      IF (ANSWR .EQ. 'Y' .OR. ANS .EQ. 'y') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    P1X = 0.9
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            P0X = 0.1
                                                                                                                                                                                                                                                                                                                             DO 200 J = 1, NRECS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 90 I = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DO 130 II = I', NPOINT(JJ)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DO 70 I = 1, NSAMR
                   WRITE (6,*) NFIRST(J), NSAMR
                                                                                             WRITE (4,*)'RECEIVER', J,' TTERR = ', TTERR
                                                                                                                                                                                                                             WRITE (4, *)'First break time = ',
                                                                                                                                                                                                                                                   TG = (NFIRST(J) - 1) * DT
                                                                                                                                                                                                                                                                        WRITE (4,*)'RECEIVER #', J
                                                                                                                                                                                                                                                                                                     PRINT *, 'CHANNEL = ', J
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          P1X = P0X + 0.8 * DPX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DPX = XOFF / DMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   READ (1, *) NPOINT (JJ)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF (RMS .GT. RMSMAX) RMSMAX = RMS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 RMS - SQRT (RMS/NSAMR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                RMS = 0.0
DO 160 I = NFIRST(J), NSAMR
                                                                     IF (ABS (TTERR) .GT. 0.001) WRITE (6,*) J, 'TTERR = ',
                                                                                                                           TTRMS = TTRMS + TTERR ** 2
                                                                                                                                                 TTERR = TG - TT(1,J)
                                                                                                                                                                             NO = 0
                                                                                                                                                                                                     INDT = 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 READ (1,*) TT(II,JJ), XX(II,JJ), ZZ(II,JJ)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DO 110 I = 1, NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         R4DAT(I,J) = R4DAT(I,J) / RMSMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              RMS = RMS + R4DAT(I, J) * R4DAT(I, J)
                                                 TTERR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          R4DAT(I,J) = R4DAT(I,J) * (I - 1) ** 2 / 10000
                                                                                                                                                                                                                             ïG
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       C
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                150
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   170
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  160
190
200
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            180
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       Now calculate array REFL(300,40) of binned traces for surface refletn
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            Simple plot of repositioned traces
CONTINUE
                       CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        DO 190 I = NFIRST(J), NSAMR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 180 I = NFIRST(J) + NO, LEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CALL PIJOIN(X, Z, NFIRST(J) + NO, LEN, 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   LEN = INDI - 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CONTINUE
                                                                   WT(NVERT,NHORI + 1) = F1 * G2 + WT(NVERT,NHORI + 1)
WT(NVERT + 1,NHORI) = F2 * G1 + WT(NVERT + 1,NHORI)
WT(NVERT + 1,NHORI + 1) = F2 * G2 + WT(NVERT + 1,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           NHORI = INT(X0(I)/DELTAD) + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                1,J))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Z(I) = ZZ(INDT - 1, J) + FAC * (ZZ(INDT, J) - ZZ(INDT -
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     DELTAT = TT(INDT, J) - TT(INDT - 1, J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IF (TSAMP .GT. TT(NPJ, J)) GO TO 170
IF (TSAMP .GT. TT(INDT, J)) THEN
INDT = INDT + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  NPJ = NPOINT (J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            INDI - I
                                                 NHORI + 1)
                                                                                                                                                                                                                                                                                                                                                                          F1 = 1.0 - F2
                                                                                                                                                                                                                                                                                                                                                                                                                          G1 = 1.0 - G2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        NVERT = INT(Z(I)/DELTAZ) + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IF (R4DAT(I,J)*IPOLAR .LT. - 0.01) THEN
   CALL POSITN(X0(I), Z(I))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          X(I) = XO(I) + AMPSCL * R4DAT(I, J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        XO(I) = XX(INDT - 1, J) + FAC * (XX(INDT, J) - XX(INDT -
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IF (INDT .GT. NPOINT(J)) GO TO 170
IF (TSAMP .LT. TT(1,J)) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      TSAMP = (I - 1) * DT
                                                                                                                                                                     REFL(NVERT + 1, NHORI + 1)
                                                                                                                                                                                                                                                                        NVERT, NHORI + 1)
                                                                                                                                                                                                                                                                                                                                                  REFL(NVERT, NHORI) = R4DAT(I, J) * F1 * G1 + REFL(NVERT,
                                                                                                                                                                                                                                                                                                                                                                                                                                                      G2 = (X0(I) - (NHORI - 1)*DELTAD) / DELTAD
                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IF (NHORI .LE. 0 .OR. NVERT .LE. 0) GO TO 190
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (NHORI .GT. NTRCEX .OR. NVERT .GT. NDIMZ)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  FAC = (TSAMP - TT(INDT - 1, J)) / DELTAT
                                                                                                                                                 WT (NVERT, NHORI) = F1 * G1 + WT (NVERT, NHORI)
                                                                                                                                                                                                   REFL(NVERT + 1, NHORI + 1) = R4DAT(I, J) * F2 * G2 +
                                                                                                                                                                                                                           NVERT + 1, NHORI)
                                                                                                                                                                                                                                                   REFL(NVERT + 1, NHORI) = R4DAT(I, J) * F2 * G1 + REFL(
                                                                                                                                                                                                                                                                                                     REFL(NVERT, NHORI + 1) = R4DAT(I, J) * F1 * G2 + REFL(
                                                                                                                                                                                                                                                                                                                               NHORI)
                                                                                                                                                                                                                                                                                                                                                                                                    F2 = (Z(I) - (NVERT - 1)*DELTAZ) / DELTAZ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      GO TO 190
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              NO = NO + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         GO TO 160
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CALL JOIN(X(I), Z(I))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         GO TO 150
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   იიი
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240
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         210
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     No longer need record of weighting
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ELSE IF (IANS .EQ. 2) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               Plot binned traces
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            End of option 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE (6,*)'Enter polarity (-1=SEG-normal +1=SEG-reverse):'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     Ħ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 220 JJ = 1, NTRCEX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE (6,*)'NTRCEX, NDIMZ', NTRCEX, NDIMZ
                                                                                                                                                                                                                                                                                                                                                                             PEAKMX = 1.0
                                                                                                                                                                                                                                                                                                                                                                                                   READ (5,*) IVAL
                                                                                                                                                                                                                                                                                                                                                                                                                     WRITE (6,*)'Normalise traces by RMS(1), PEAK(2), None(0):
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CALL FRAME
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE (4,*)'RMS TIERROR = ', TIRMS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   TTRMS = SQRT(TTRMS/NRECS)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          REFMAX = 0.0
                                                                                                                                                                                                                                                                                                                                                    IF (IVAL .EQ. 1) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                               IF (ABS(IPOLAR) .NE. 1) GO TO 230
                                                                                                                                                                                                                                                                                                                                                                                                                                                                       READ (5,*) IPOLAR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     (XOFF .EQ. 0.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    DO 210 II = 1, NDIMZ
                                                                                                                                                                                                                                                                                                                        WRITE (6,*)'Enter depth range for RMS calculation :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE (6,*)'Enter vertical trace spacing in metres :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6, *)'ENTER amplitude scaling factor:'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CONTINUE
                                                                                                                                                                                                           DO 250 I = 1, N2
                                                                                                                                                                                                                                                          NZ1 = INT(Z1/DELTAZ) + 1
                                                                                                                                                                                                                                                                                  NZO = INT(ZO/DELTAZ) + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  NTRCEX = INT(XOFF/DELTAD) + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        READ (5,*) DELTAD
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE (6,*)'Enter vertical sampling in metres :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 READ (5, *) AMPSCL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            READ (5,*) DMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                WRITE (6, *)'Enter Maximum depth to be plotted :'
                                                                                                                                                                                                                                                                                                          READ (5,*) Z0, Z1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE (6, *) NTRCEX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     READ (5,*) DELTAZ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          READ (5, *) XOFF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6,*)'Enter source offset :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      READ (5,100) ANSWR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE (6,*)'True scale plot (Y/N) ?'
                                                                                                                                                                                                                                   PEAKMX = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 REFMAX = AMAX1(REFMAX, ABS(REFL(II, JJ)))
                                                                                                                                       DO 240 J = NZ0, NZ1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF (WT(II,JJ) .EQ. 0.0) WT(II,JJ) = 1.0
REFL(II,JJ) = REFL(II,JJ) / WT(II,JJ)
RMS = SQRT (RMS)
                      RMS = RMS / REAL(N1)
                                              CONTINUE
                                                                                                                                                                 PEAK = 0.0
                                                                                                                                                                                       RMS = 0.0
                                                                                        IF (ABS(REFL(J,I)) .GT. PEAK) PEAK = ABS(REFL(J,I)
                                                                                                                RMS = RMS + REFL(J, I) ** 2
300
310
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             270
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  250
                                                                                                                                                                                     290
                                                                                                                                                                                                                                                                                                                                                    280
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                260
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CALL MAXSN (NREFL, REFL(1,1), REFMAX, IND)
CALL MINSN (NREFL, REFL(1,1), REFMIN, IND)
                                                                                                                                                                                                                                                                                                                          DO 310 I = 1, NTRCEX
                                                                                                                                                                                                                                                                                                                                                    CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                 WRITE (6,*)'NDIMZ = ', NDIMZ
                                                                                                                                                                                                                                                                                                                                                                                                                                         NDIMZ = INT(DMAX/DELTAZ) + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CALL AXES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL PSPACE(POX, PIX, 0.1, 0.9)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         PlX = 0.9
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IF (AMPSCL .EQ. 0.0) AMPSCL = DELTAD / REFMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            NREFL = N1 * N2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 ELSE IF (IVAL .EQ. 2) THEN
CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                               DO 280 J = 1, NDIMZ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL BORDER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CALL MAP (0.0, XOFF, DMAX, 0.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 IF (ANSWR .EQ. 'Y' .OR. ANS .EQ. 'y') THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               P0X = 0.1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IF (ABS (REFMIN) .GT. REFMAX) REFMAX = ABS (REFMIN)
                                                                                                                                                                                                                                                                                                                                                                         Z(J) = (J - 1) * DELTAZ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  P1X = P0X + 0.8 * DPX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CALL MINSN(N12, REFL(1,1), PEAKO, IND)
                    CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DPX = XOFF / DMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CALL MAXSN(N12, REFL(1,1), PEAK, IND)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  N12 = N1 * N2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         PEAKMX - PEAKMX / 1.4
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CONTINUE
                                                                                                                                                         CALL PTJOIN(X, Z, 1, NDIMZ, 0)
                                                                                                                                                                                     CONTINUE
                                                                                                                                                                                                                                 DO 290 J = 1, NDIMZ
                                                                                                                                                                                                                                                      IF (RNORM(I) .EQ. 0.0) RNORM(I) = 1.0 IF (RNORM(I) .NE. 1.0) AMPSCL = DELTAD / (RNORM(I) *PEAKMX)
                                                                                                                                                                                                                                                                                                    X1 = (I - 1) * DELTAD
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       DO 270 I = 1, N2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IF (ABS (PEAKO) .GT. PEAK) PEAK = ABS (PEAKO)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 260 I = 1, N2
                                                                                                                                       DO 300 J = 1, NDIMZ
                                                                                                                                                                                                           X(J) = X1 + REFL(J,I) * AMPSCI
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               RNORM(I) = PEAK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CALL MINSN(N1, REFL(1,I), PEAKO, IND)
IF (ABS(PEAKO) .GT. PEAK) PEAK = ABS(PEAKO)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    RNORM(I) = PEAK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CALL MAXSN (N1, REFL(1, I), PEAK, IND)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               Ħ
                                              END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   IF (PEAK .GT. PEAKMX) PEAKMX = PEAK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF (RMS .GT. 0.0) PEAK - PEAK / RMS
                                                                                                              IF (REFL(J, I) *IPOLAR .LT. - 0.01) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               (RMS .GT. 0.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      RNORM(I) = RMS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          RNORM(I) = 1.0
                                                                                    CALL POSITN(X1, Z(J))
                                                                CALL JOIN(X(J), Z(J))
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                                                                                                                                                                                                                                                             output binned traces
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    Stack binned traces
                                                                                                                                                                                                                                                                                                                                               End of option 3
                                                                                                                                                                                                                                                                                                   ELSE IF (IANS .EQ. 4) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ELSE IF (IANS .EQ.
                                                                                  WRITE (6,*)'NTRCEX , NDIMZ = ', NTRCEX, NDIMZ
                                                                                                       OPEN (8, FILE=INSTAK, STATUS='UNKNOWN')
                                                                                                                                                     READ (5,20) INSTAK
                                                                                                                                                                         WRITE (6,*)'Enter OUTPUT filename :'
                                                                                                                                                                                                                                                                                                                                                                                         CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DO 370 J = 1, NTRCEX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 360 II = 1, NSTAK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        DO 320 J = 1, NTRCEX
DO 320 I = 1, NDIMZ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE (6,*) 'Enter no. of common shot records to be stacked' READ (5,*) NSTAK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL ZERO(NN, WT) WRITE (6,*)'Enter dimensions of section (NX,NZ):'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CALL ZERO(NN,
                                                                                                                                 NLEN = NDIMZ * NTRCEX
                                                                                                                                                                                             READ (5, *) NANS
                                                                                                                                                                                                               WRITE (6,*)'Output the section (1=Y)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        READ (5, *) NTRCEX, NDIM2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL ZERO(NN, REFO)
                                                                   IF (NANS .EQ. 0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              NN = 300 * 40
WRITE (8,340) ((SECTN(I,J), I=1, NDIMZ), J=1, NTRCEX)
                                           WRITE (8,340) ((REFL(I,J), I=1, NDIMZ), J=1, NTRCEX)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE (6,*)'NTRCEX , NDIMZ =", NTRCEX, NDIMZ
                                                                                                                                                                                                                                                                                                                                                                                                                                                     DO 370 I = 1, NDIMZ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  READ (8,340) (((REFO(I,J)), I=1, NDIMZ), J=1, NTRCEX)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    WRITE (6,*)'Enter input filename for stack :'
READ (5,20) INSTAK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             FORMAT (16F10.6)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CLOSE (8)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          OPEN (8, FILE=INSTAK, STATUS='OLD')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     DO 350 J = 1, NTRCEX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                      REFL(I,J) = REFL(I,J) / NSTACK(I,J)
                                                                                                                                                                                                                                                                                                                                                                                                                          IF (NSTACK(I, J) .EQ. 0.0) NSTACK(I, J) = 1.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DO 350 I = 1, NDIMZ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      NSTACK(I, J) = NSTAK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   NSTACK(I, J) - 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF (ABS(REFO(I,J)) .LT. 1E-3) NSTACK(I,J) =
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             REFL(I,J) = REFL(I,J) + REFO(I,J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           THEN
                                                                                                                                                                                                                 0=Output bin):'
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End of option 2

CALL FRAME

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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  END OF OPTION 6
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   End option 4
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           OPTION TO USE CDP SELECTIVE STACKING
                          17′
                                                                                                             ELSE IF (IANS .EQ. 8) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ELSE IF (IANS .EQ. 7) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      ELSE IF (IANS .EQ. 6) THEN
                                        WRITE (6,*)'Do you want to apply muting prior to AGC (1=Y 0=N)
                                                                  WRITE (6,*)'Enter sample interval in metres :'
READ (5,*) DELTAZ
                                                                                                                                           CONTINUE
                                                                                                                                                                                                        DO 420 J = 1, NTRCEX
                                                                                                                                                                                                                                                                                                     READ (5,*) NFILT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6,*)'Enter no. of common shot gathers : NY '
READ (5,*) MUTAGO
                                                                                                                                                                                                                                      END IF
                                                                                                                                                                                                                                                        IF (NFILT .EQ. 1) THEN
CALL FILTER(1024, 40, R4DAT, DELTAZ)
                                                                                                                                                                                                                                                                                                                         WRITE (6,*)'Filter traces 1=Y 0=N?'
                                                                                                                                                                                                                                                                                                                                                        END IF
                                                                                                                                                                                                                                                                                                                                                                                                    IF (NPLOT .EQ. 1) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                        READ (5, *) NPLOT
                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE (6,*)'Plot spectra 1=Y 0=N?'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CALL ZERO (NSC, R4DAT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                NSC = 1024 * 40
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     READ (5,*) DELTAZ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     WRITE (6,*)'Enter sample interval in metres :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CALL CDPSTK(N1, N2, NGATH, NDIMZ, NTRCEX, DELTAD, DELTAZ,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         READ (5,*) DELTAD WRITE (6,*) 'Enter vertical sampling interval in metres : DZ '
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE (6,*)'Enter horizontal trace separation in metres : DX:'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 390 KK ≈ 1, NGATH
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      FORMAT (A10)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            READ (5,*) NGATH
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CLOSE (8)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DO 410 J = 1, NTRCEX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           READ (5,*) DELTAZ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       READ (5,*) NTRCEX, NDIMZ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           WRITE (6,*)'Enter dimensions of binned arrays : NX,N2'
                                                                                                                                                                                    DO 420 I = 1, NDIMZ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DO 400 I = 1, NDIMZ
                                                                                                                                                                                                                                                                                                                                                                          CALL FOURPL(1024, 40, R4DAT, DELTAZ)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              OPEN (12, FILE-FNAME, STATUS='OLD')
READ (12, 340) ((CSGS(I, J, KK), I=1, NDIMZ), J=1, NTRCEX)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,*)'Enter name of file containing binned gather #'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CLOSE (12)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           READ (5,380) FNAME
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              NGATH, CSGS, CDP, SECTN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     R4DAT(I,J) = REFL(I,J)
                                                                                                                                                             REFL(I,J) = R4DAT(I,J)
```

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C NORMAL C ARRAY)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        460
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              450
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            440
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         430
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            470 END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          480 GO TO 10
                    30 CONTI
40 CONTINUE
50 RETURN
                                                                                                                                                                      10 CONTI
20 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                               NORMALIZES 2D ARRAY TO PEAK WITHIN REQUIRED RANGE (NORMALISES ENTIR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WRITE (6,*)'NDIMZ,NTRCEX = ', NDIMZ, NTRCEX CALL AGC(N1, N2, REFL, LENAGC)
ELSE IF (IANS .EQ. 0) THEN
                                                                                                    DO 40 J = 1, LY
DO 30 I = 1, LX
                                                                                                                                                                                                                                                                                                                                                                                                                        SUBROUTINE SAMNOR(LX, LY, X, NSAMF, NSAML)
                                                                                                                                                                                                                                                                           DO 20 J = 1, LY
                                                                                                                                                                                                                                                                                                   RMAX = 0.0
                                                                                                                                                                                                                                                                                                                     DIMENSION X (LX, LY)
                                                                                                                                                IF (RMAX .EQ. 0.0) GO TO 50
                                        CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    STOP
                                                                                                                                                                                            CONTINUE
                                                                                                                                                                                                                                                        DO 10 I = NSAMF, NSAML
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DO 460 JMUT = 1, NTRCEX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE (6,*)'Enter length of AGC to be applied in metres :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         ΙF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WRITE (6,*) 'Enter low amplitude cutoff mute :'
READ (5,*) OFF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  LENAGC = NINT(RLEN/DELTAZ)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         READ (5, *) RLEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       (MUTAGC .EQ. 1) THEN

WRITE (6,*)'Enter trace no., start depth, end depth:'

READ (5,*) NTRMUT, ZMUTO, ZMUT1

IF (NTRMUT .EQ. 0) GO TO 450
                                                                                                                                                                                                                                 IF (I .EQ. 7) GO TO 10
                                                                X(I,J) = X(I,J) / RMAX
                                                                            IF (I .EQ. 7) X(I,J) = X(I-1,J) + X(I+1,J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 460 IMUT = 1, NDIMZ

IF (ABS(REFL(IMUT, JMUT)) .LT. OFF) THEN
                                                                                                                                                                                                           IF (ABS(X(I,J)) .GE. RMAX) RMAX = ABS(X(I,J))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      GO TO 430
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     NMUTO = NINT(ZMUTO/DELTAZ) + 1
NMUT1 = NINT(ZMUT1/DELTAZ) + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DO 440 IMUT = NMUTO, NMUT1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              REFL(IMUT, NTRMUT) = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             REFL(IMUT, JMUT) = 0.0
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#### Appendix A.4

#### The raytracing program

#### **TRACER**

The program TRACER carries out two-point raytracing within a velocity model defined at points on a rectangular grid. The algorithm presented by Chang and McMechan (1986) is used. The program traces rays from each source point to each each grid point and then from each receiver point to each grid point, thus providing an image time for all the grid points for each combination of source and receiver positions. The image times can then be used by the reverse-time finite difference migration program.

```
0000
                                                                                                                                                                    10 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 Algorithm from Chang & McMechan (source Lee & Stewart)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        W1 = x ,
                WRITE (6,*)'ENTER image time grid spacing in metres:'
                                                              WRITE (6,*)'Enter velocity grid spacing in metres:'
                                                                                                              WRITE (6,*)'****** SOURCE :', XS(1), ZS(1), '***** WRITE (6,*)'ENTER XMIN,XMAX , ZMIN,ZMAX :'
                                                                                                                                                                                                                                      DO 10 NS = 1, NSOURC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DOUBLE PRECISION XAXIS(N3), ZAXIS(N4), WRK(250000), SMOOTH
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        DOUBLE PRECISION LAMBDA(104), MU(104), FF(N3*N4), W1(50000)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    DOUBLE PRECISION HO, XS(24), ZS(24), SMOTH1, SMOTH2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DOUBLE PRECISION ZOMIN, ZOMAX, V(N1,N2), VO, UXO, UZO
                                             READ (5,*) HO
                                                                                           READ (5,*) XMIN, XMAX, ZMIN, ZMAX
                                                                                                                                                                                                                                                                                                                                    COMMON /DATA/ VO, UXO, UZO
                                                                                                                                                                                                                                                                                                                                                                                      CHARACTER*1 START
                                                                                                                                                                                                                                                                                                                                                                                                                             INTEGER IW2, ADRES(N3*N4), PX, PZ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DOUBLE PRECISION XVALO(N3*N4), ZVALO(N3*N4)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DOUBLE PRECISION XVAL(50000), ZVAL(50000), TVAL(50000)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      DOUBLE PRECISION T, Y(4), X, H, W(4,7), X0, Z0, X0MIN, X0MAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Solve for W1,W2,W3,W4 by 4th order Runge-Kutta algorithm
READ (5,*) HOIM
                                                                                                                                                                                                                                                               READ (5,*) NSOURC
                                                                                                                                                                                                                                                                                      WRITE (6,*)'NUMBER OF SOURCES :'
                                                                                                                                                                                                                                                                                                                                                               EXTERNAL FON
                                                                                                                                                                                                                                                                                                                                                                                                        INTEGER VPOINT (51000), IWRK (50000)
                                                                                                                                                                                                                                                                                                                                                                                                                                                        REAL XCOORD(10000), ZCOORD(10000), FF1(N3,N4), CLEVL(15)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    DOUBLE PRECISION SIGMA, CO(5000), CT(5000), FVAL(50000)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             PARAMETER (N1=64,N2=90,N3=128,N4=180,NVAR=4,PI=3.1415926535)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   Travel time for a ray is calculated by
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      x & z are spatial coordinates ds is along ray.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               These 4 quantities are the initial conditions required to extend
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    At any point along ray there exist 4 quantities :
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        Rewrite ray equation as: dW1/ds = W2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 Define Ux = dU/dx
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 Let U = 1/V be the slowness; velocity=V(x, z)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            the ray by one additional step.
                                                                                                                                                                                      READ (5,*) XS(NS), ZS(NS)
                                                                                                                                                                                                         WRITE (6,*)'ENTER SOURCE POSITION (X,Z) in metres :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      PRECISION XPT(1), ZPT(1), VAL(1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 W2 = dx/ds, W3 = z, W4 = dz/ds, G = Ux*W2 + Uz*W4
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           dx/ds , z , dz/ds
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 Uz = dU/dz
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             dW2/ds = V * (Ux - G*W2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   dW4/ds = V * (Uz - G*W4)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      where Vi is the average velocity on the ith
```

program to raytrace through 2-d velocity model to obtain image times

for reverse time migration.

```
0.0
                                                                                                                                             30 CONTINUE
                                                          WRITE (6,*)'IFAIL = ', IFAIL
                                                                                     IFAIL = 0
                                                                                                                WRITE (6,*)'READ VELOCITIES OK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 30 NL = 1, NLAYER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL ZERO(80, MU)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CDEP = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        VMAX = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (6,*)'Enter fine stepping angle (radians)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              READ (5,*) NANG
DANG = PI / REAL(NANG)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE (6,*)'ENTER NUMBER OF RAYS TO BE TRACED :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             WRITE (6,*)'ENTER RAY STEP LENGTH IN METRES :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 READ (5,*) SMOTH1, SMOTH2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE (6,*)'Enter values of SMOOTH for velocity and time grids:'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL ZERO(40, LAMBDA)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              READ (5,*) NLAYER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (6,*)'Enter NUMBER of layers :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  READ (5, *) FINANG
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       READ (5, *) H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IF (NX .GT. N1 .OR. NZ .GT. N2) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      NZIM = INT((ZMAX - ZMIN)/HOIM)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   NZ = INT((ZMAX - ZMIN)/H0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         NX = INT((XMAX - XMIN)/HO)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DT - DT * 1.E-3
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           WRITE (6,*)'Enter DT in millisecs for SMOOTH estimation :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   IDEPTH = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF (ABS(FINANG) .LT. PI/2.) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              NXIM = INT((XMAX - XMIN)/HOIM)
                                                                                                                                                                                                      CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (6,*)'THICK = ', THICK
                                                                                                                                                                                                                                                                                                                                        WRITE (6, *)'IDEPTH = ', IDEPTH
                                                                                                                                                                                                                                                                                                                                                                                                  NTHICK = NINT (THICK/HO)
                                                                                                                                                                                                                                                                                                                                                                                                                                CDEP = CDEP + THICK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE (6,*)'ENTER THICKNESS OF LAYER', NI,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               WRITE (6,*)'Enter number of rays for fine stepping :'
                                                                                                                                                                        IDEPTH = IDEPTH + NTHICK
                                                                                                                                                                                                                                                                                                                 DO 20 IZ = 1, NTHICK
                                                                                                                                                                                                                                                                                                                                                                     WRITE (6, *)'NTHICK = ', NTHICK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        READ (5, *) THICK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6, *)'VL = ', VL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IF (VL .GT. VMAX) VMAX = VL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 READ (5, *) VIL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE (6,*)'ENTER VELOCITY OF MEDIUM', NL,' (metres / sec)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              NANG = NANG + NRAYFN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         READ (5,*) NRAYFN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               READ (5,*) ANGFAC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                WRITE (6,*)'Enter stepping interval increase (times) :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             WRITE (6,*)' *** WARNING --- ARRAYS TOO SMALL *** '
                                                                                                                                                                                                                                                         DO 20 IX = 1, NX
                                                                                                                                                                                                                                                                               WRITE (6,*)'IZ = ', IZ
                                                                                                                                                                                                                              V(IX, IZ + IDEPTH) = VL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ' (metres)'
```

E02DCF-NAG GIVES LEAST SQUARE BICUBIC SPLINE FIT TO SURFACE ICONTO, PX, PZ, XVALO, ZVALO, LAMBDA, MU, VPOINT, NPOINT AS E02ZAF ABOVE

```
60 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                    70 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       50 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   40 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CO(NC) COEFFICIENTS OF FIT CO((PY-4) * (I-1) + J) IS C(I,J) SMOOTH Smoothing factor for spline accuracy
                                                                                                                                                                                                                                                                                   NOW BEGIN RAYTRACING FROM SOURCE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   FVAL(ICONTO) IS GRID POINT VALUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             contains
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ARRAY FVAL SHOULD CONTAIN VALUES S.T. F (NZ*(Q-1)+R)
                                                                                                                                                                                                                                                                                                                                                                                                         DO 70 I = 1, 104
                                                                                                                                                                                                                                                                                                                                                                                                                            DO 60 IX = 1, NX
                                                                                                                                                                                                                                                                                                                         WRITE (6,*)'IFAIL = ', IFAIL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL E02DCF (START, NX, XAXIS, NZ, ZAXIS, FVAL, SMOOTH, NXEST,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE (6,*)'NX, NZ, NXEST, NZEST, LWRK, LIWRK', NX, NZ, NXEST, NZEST,
                                                                                                                                                                                                                                                                                                                                                IFAIL = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DO 50 IZ = 1, NZ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 40 IX = 1, NX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       NKNOTZ = 8
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              START = 'C'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IFAIL = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  LIWRK = 3 + NX + NZ + NXEST + NZEST
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  NXEST = 50
                                                                                                                                                                                                                                              SCA = (ZMAX - ZMIN) / (XMAX - XMIN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        NKNOTX = 8
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   LIWRK = LIWRK * 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         LWRK = LWRK * 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           LWRK = 4 * (NX + NZ) + 11 * (NXEST + NZEST) + NXEST * NZ + NZ + 54
                                                                                                                                                                                                                          IF (SCA .LT. 1.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      ICOUNT = 0
                                                                           PZ0 = 0.1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          ZAXIS(IZ) = REAL(IZ) * HO
PX1 = PX0 + PXL
                   PX0 = 0.1
                                     PXL = 0.8 / SCA
                                                           PZ1 = 0.9
                                                                                                                       PZ1 = PZ0 + PZL
                                                                                                                                           PZ0 = 0.1
                                                                                                                                                                PZL = 0.8 * SCA
                                                                                                                                                                                   PX1 = 0.9
                                                                                                                                                                                                         PX0 = 0.1
                                                                                                                                                                                                                                                                                                                                                                                         WRITE (12,*) I, LAMBDA(I), MU(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              XAXIS(IX) = REAL(IX) * HO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 40 IZ = 1, NZ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     FVAL(ICOUNT) = V(IX, IZ)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          ICOUNT = ICOUNT + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      NZEST, NKNOTX, LAMBDA, NKNOTZ, MU, CO, SIGMA, WRK, LWRK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   LWRK, LIWRK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         grid point (X(Q), Z(R))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 იიი
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LOOP OVER TAKEOFF ANGLES MEASURED FROM HORIZONTAL (DOWN=+VE)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        STEP ALONG RAY
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          SET UP INITIAL RAY CONDITIONS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DO 200 NS = 1, NSOURC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL MAP (XMIN, XMAX, ZMAX, ZMIN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CALL PSPACE (PXO, PX1, PZO, PZ1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL PAPER(1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       DO 100 I = 1, NANG
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE (6,*)'RAY-TRACING FOR SOURCE #', NS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           WRITE (7,*)'SOURCE NUMBER :', NS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       X0 = XS(NS)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IFIN = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ICOUNT = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     ANG = -PI / 2.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CALL SCALES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  20 - 2S(NS)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   H H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    Y(3) = Z0

Y(4) = SIN(ANG)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Y(1) = X0

Y(2) = COS(ANG)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE (7,*)'RAY NUMBER', I

IF (ANG .GT. FINANG .AND. IFIN .LT. NRAYFN) THEN

ANG = ANG + DANG / ANGFAC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        DO 80 IRAY = 1, 2000
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IFIN = IFIN + 1
                                                                                              NC = (NKNOTX - 4) * (NKNOTZ - 4)
NADRES = (NKNOTX - 7) * (NKNOTZ - 7)
                                                                                                                                                                   NEARZ = NINT(ZPT(1)/H0)
                                                                                                                                                                                                                                                                   ZVAL (ICOUNT) = ZCOORD (IRAY)
                                                                                                                                                                                                                                                                                            XVAL (ICOUNT) = XCOORD (IRAY)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IF (ICOUNT .GT. 50000) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ANG = ANG + DANG
IF (XPT(1) .LT. LAMBDA(4)) XPT(1) = LAMBDA(4)
IF (XPT(1) .GT. LAMBDA(NKNOTX - 3)) XPT(1) = LAMBDA(NKNOTX -
                                                  NPOINT = N + NADRES
                                                                           N = 1
                                                                                                                                                IFAIL = 0
                                                                                                                                                                                              NEARX = NINT(XPT(1)/H0)
                                                                                                                                                                                                                       ZPT(1) = Y(3)
                                                                                                                                                                                                                                            XPT(1) = Y(1)
                                                                                                                                                                                                                                                                                                                     2COORD(IRAY) = REAL(Y(3))
                                                                                                                                                                                                                                                                                                                                          XCOORD(IRAY) = REAL(Y(1))
                                                                                                                                                                                                                                                                                                                                                                   X = X + H
                                                                                                                                                                                                                                                                                                                                                                                            T = T + H
                                                                                                                                                                                                                                                                                                                                                                                                                   END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             ICOUNT = ICOUNT + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                             WRITE (6,*)'STOPPED ... ARRAY TVAL TOO SMALL'
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CALL E02ZAF (NKNOTX, NKNOTZ, LAMBDA, MU, N, XPT, ZPT, VPOINT, NPOINT, ADRES, NADRES, IFAIL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CALL E02ZAF (NKNOTX, NKNOTZ, LAMBDA, MU, N, XPT, ZPT, VPOINT,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IF (ZPT(1) .GT. MU(NKNOTZ - 3)) ZPT(1) = MU(NKNOTZ - 3)
                       UZO = VAL(1)
                                                                                                                                                                                CALL E02ZAF (NKNOTX, NKNOTZ, LAMBDA, MU, N, XPT, ZPT, VPOINT,
                                                                                                                                                                                                               N
= 1
                                                                                                                                                                                                                                                                                                                                               ZPT(1) = Y(3) - H0 / 5.

DELTAZ = H0 * 2. / 5.
                                                                                                                                                                                                                                                                                                                                                                                                                                                        VXO = (VAL(1) - UXO) / (DELTAX)

UXO = -VXO / V0 ** 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL E02DBF(N, NKNOTX, NKNOTZ, XPT, ZPT, VAL, LAMBDA, MU,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IFAIL = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  XPT(1) = XPT(1) + DELTAX
IF (XPT(1) .GT. LAMBDA(NKNOTX = 3)) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IFAIL = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               UX0 = VAL(1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL E02DBF(N, NKNOTX, NKNOTZ, XPT, ZPT, VAL, LAMBDA, MU
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IFAIL = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CALL E02ZAF (NKNOTX, NKNOTZ, LAMBDA, MU, N, XPT, ZPT, VPOINT,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IF (XPT(1) .LT. LAMBDA(4)) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       DELTAX = H0 * .4
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              XPT(1) = XPT(1) - H0 / 5.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IFAIL = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF (VO .LT. 1.0) THEN
WRITE (6,*)'VO = ', VO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     V0 = VAL(1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CALL E02DBF (N, NKNOTX, NKNOTZ, XPT, ZPT, VAL, LAMBDA, MU
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (ZPT(1) . LT. MU(4)) ZPT(1) = MU(4)
                                                                                                                                                                                                                                                                                                                                                                                                    XPT(1) = Y(1)
                                                                                                                                                                                                                                                                                                                                                                                                                                IFAIL = 0
IFAIL = 0
                                                                          CALL E02DBF(N, NKNOTX, NKNOTZ, XPT, ZPT, VAL, LAMBDA, MU
                                                                                                                                IFAIL = 0
                                                                                                                                                                                                                                                                                                                     IF (2PT(1) .LT. MU(4)) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE (6,*)'XPT, ZPT = ', XPT, ZPT
                                                                                                                                                                                                                                                                  DELTAZ = H0 / 5.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DELTAX = HO / 5.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DELTAX = H0 / 5.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    XPT(1) = LAMBDA(4)
                                                                                                                                                                                                                                                                                            2PT(1) = MU(4)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           XPT(1) = LAMBDA(NKNOTX - 3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      VPOINT, NPOINT, CO, NC, IFAIL)
                                                                                                                                                       NPOINT, ADRES, NADRES, IFAIL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             VPOINT, NPOINT, CO, NC, IFAIL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    NPOINT, ADRES, NADRES, IFAIL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               NPOINT, ADRES, NADRES, IFAIL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               VPOINT, NPOINT, CO, NC, IFAIL)
                                                   VPOINT, NPOINT, CO, NC, IFAIL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          0 0 0 0
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DERIVATIVES OF FCNS AND APPLY R-K STEP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CALCULATED INTERPOLATED VELOCITY FIELD AND GRADIENTS NOW FIND
                                                                                                                                                                                                                                                                                                                                              ROUTINE FOR BICUBIC SPLINE CALCULATION
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        RAY TERMINATED !
                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL ZERO(40, LAMBDA)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE (7,*) ICOUNT
                                                                                                                                                         XVAL(ICOUNT) = X0
                                                                                                                                                                                                                                       CONTINUE
                                                                                                                                                                                                                                                                                         DO 110 III = 1, ICOUNT
                                                                                                                                                                                                                                                                                                                                                                                                                                                   NADRES = (PX - 7) * (P2 - 7)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   ₽X = 8
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CONTINUE
WRITE (6,*)'NXEST , NZEST =', NXEST, NZEST
                         NZEST = 40
                                                    NXEST = 20
                                                                           WRITE (6,*)'ICOUNT = ', ICOUNT
                                                                                                       TVAL(ICOUNT) = 0.0D0
                                                                                                                             ZVAL (ICOUNT) = Z0
                                                                                                                                                                                  W1(ICOUNT) = 100.
                                                                                                                                                                                                              ICOUNT = ICOUNT + 1
                                                                                                                                                                                                                                                                                                                                                                                                IFAIL = 0
                                                                                                                                                                                                                                                                                                                                                                                                                            NPOINT = ICOUNT + NADRES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       PZ = 7 + NLAYER * 4
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CALL FRAME
                                                                                                                                                                                                                                                              W1(III) = 1.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL PTJOIN (XCOORD, ZCOORD, 2, LENRAY, 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CALL E02DBF(N, NKNOTX, NKNOTZ, XPT, VPOINT, NPOINT, C0, NC, IFAIL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  VZO = (VAL(1) - UZO) / (DELTAZ)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CALL E022AF (NKNOTX, NKNOTZ, LAMBDA, MU, N, XPT, ZPT, VPOINT,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL DO2YAF(X, H, NVAR, Y, FCN, W, NVAR, IW2)
IF (Y(1) .GT. XMAX .OR. Y(3) .GT. ZMAX .OR. Y(1) .LT. XMIN +
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ZPT(1) = Y(3)
IF (IRAY .EQ. 1) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IFAIL = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (ZPT(1) .GT. MU(NKNOTZ - 3)) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CALL FCN(T, Y, W(1,1))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                UZO = -VZO / VO ** 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         ZPT(1) = ZPT(1) + DELTAZ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               TVAL(ICOUNT) = H / VO + TVALP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  TVALP = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                ZPT(1) = MU(NKNOTX - 3)

DELTAZ = H0 / 5.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               TVALP = TVAL(ICOUNT - 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     GO TO 90
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               LENRAY = IRAY
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         NPOINT, ADRES, NADRES, IFAIL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      HO .OR. Y(3) .LT. ZMIN + HO .OR. (ANG .LT. 0.0 .AND. Y(3) .GT. ZVAL(ICOUNT)) .OR. (ANG .GT. 0.0 .AND. Y(3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 .LT. ZVAL(ICOUNT))) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ZPT,
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                                                                                                                                                                                                                                                                                                                                     140
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               120
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 SETUP GRID POINT ARRAYS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   BICUBIC SPLINE CALCULATION
                                                                                                                                                                                                                                                                                                                                     CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (6,*)'NKNOTX, NKNOTZ', NKNOTX, NKNOTZ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CALL EO2DDF (START, ICOUNT, XVAL, ZVAL, TVAL, W1, SMOOTH, NXEST,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE (6,*)'CALCULATING BICUBIC SPLINE FIT TO TRAVELTIMES '
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  LWRK = (7*IU*IV + 25*IW) * (IW + 1) + 2 * (IU + IV + 4*ICOUNT) +
                                                                               CONTINUE
                                                                                                                                                                                                                                                                                                             DO 150 JJJ = 1, NZIM
                                                                                                                                                                                                                                                                                                                                                                                                                                                              DO 130 IZ = 1, NZIM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ZOMAX = MU(NKNOTZ - 3)
WRITE (6,*) XOMIN, XOMAX, ZOMIN, ZOMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          XOMAX = LAMBDA(NKNOTX - 3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  XOMIN = LAMBDA(4)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 120 III = 1, NKNOTX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  N = NZIM * NXIM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        NADRES = (NKNOTX - .7) * (NKNOTZ - 7)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                NC = (NKNOTX - 4) * (NKNOTZ - 4)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE (6,*)' SIGMA , RANK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WRITE (6,*)'IFAIL1 = ', IFAIL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     WRITE (6, *)'SMOOTH = ', SMOOTH
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (SMOTH2 .LT. 1E-10) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (6,*)'LIWRK = ', LIWRK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            LIWRK = ICOUNT + 2 * (NXEST - 7) * (NZEST -
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (6,*)'LWRK = ', LWRK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IF (IU .GT. IV) IW - IU
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         VI = WI
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IV = NZEST - 4
                                                                                                                                                                                                                                                                                                                                                                                      DO 140 IX = 1, NXIM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    20MIN = MU(4)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IU = NXEST - 4
CALL E02ZAF (NKNOTX, NKNOTZ, LAMBDA, MU, N, XVALO, ZVALO, VPOINT,
                                                    NPOINT = N + NADRES
                            IFAIL = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               23 * IW + 56
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     SMOOTH = SMOTH2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      SMOOTH = DBLE(DT**2*(REAL(ICOUNT) - SQRT(REAL(ICOUNT*2))))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     WRITE (6,*) LAMBDA(III), MU(III)
                                                                                                                                                                                                                                                                                                                                                                                                                                      ZAXIS(IZ) = REAL(IZ) * HOIM
                                                                                                                                                                                                                                                                                   DO 150 III = 1, NXIM
                                                                                                                                                                                                                                                                                                                                                             XAXIS(IX) = REAL(IX) * HOIM
                                                                                                                                                                                                                              INUM = INUM + 1
XVALO(INUM) = XAXIS(III)
                                                                                                   IF (ZVALO(INUM) .GT. ZOMAX) ZVALO(INUM) = ZOMAX
                                                                                                                         IF (ZVALO(INUM) .LT. ZOMIN)
                                                                                                                                                 IF (XVALO(INUM) .GT. XOMAX)
                                                                                                                                                                                                        ZVALO(INUM) = ZAXIS(JJJ)
                                                                                                                                                                             IF (XVALO(INUM) .LT. XOMIN) XVALO(INUM) = XOMIN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     LWRK, IWRK, LIWRK, IFAIL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    NZEST, NKNOTX, LAMBDA, NKNOTZ, MU, CT, SIGMA, IRANK, WRK,
                                                                                                                                                   XVALO(INUM) = XOMAX
                                                                                                                             ZVALO(INUM) = ZOMIN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              = ', SIGMA, IRANK
```

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                                                                                                     00
                                                                                                                                                                                                                                                                                                                                                                                                                     170
                                                                                                                                                                                                                                190
                                                                                                                                                                                                                                                                        180
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          160
                                                                                                                                                                                      200 CONTINUE
                                  Routine required to calculate the derivatives F(n) of the variable Y(n)
                                                                               SUBROUTINE FCN(T, Y, F)
                                                                                                                                                                 CALL GREND
                                                                                                                                                                                                                                                                                                                                                                                                                                                         DO 170 NLEVL = LEVO, LEV1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CALL E02DBF(N, NKNOTX, NKNOTZ, XVALO, 2VALO, FF, LAMBDA, MU, VPOINT, NPOINT, CT, NC, IFAIL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IFAIL = 0
                                                                                                                                                                                                                              FORMAT (8F10.6)
                                                                                                                                                                                                                                                                                                                                                                                                                     CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DO 160 JJJ = 1, NZIM
IO = (JJJ - 1) * NXIM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE (6,*)'IFAIL3 - ', IFAIL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     WRITE (6, *)'INTERPOLATING TRAVEL TIMES '
                                                                                                                                                                                                          CALL FRAME
                                                                                                                                                                                                                                                CALL CONTRA(FF1, 1, NXIM, N3, 1, NZIM, N4, CLEVL, LEVO, LEV1)
                                                                                                                                                                                                                                                                      CONTINUE
                                                                                                                                                                                                                                                                                                                                  DO 180 IZ = 1, NZIM
                                                                                                                                                                                                                                                                                                                                                       CALL ZERO(10000, FF1)
                                                                                                                                                                                                                                                                                                                                                                             NZP = NZ - 1
                                                                                                                                                                                                                                                                                                                                                                                               NXP = NX - 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 LEV1 = 15
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      LEV0 = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL SCALES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CALL BORDER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CALL MAP (XMO, XM1, ZM1, ZMO)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL PSPACE (XPO, XP1, ZPO, ZP1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IF (XMW .GT. ZMW) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                XMW = XM1 - XM0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   ZMW = ZM1 - ZMO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        ZM1 = NZIM * HOIM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            MIOH = 0MZ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                XM1 = NXIM * HOIM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    MIOH = 0MX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE (6, *)'OK1'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ZP0 = .05
ZP1 = .95
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 XP0 = .05
XP1 = .95
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            XP0 = .5 * (1. - XWID)

XP1 = .5 * (1. + XWID)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE (8,190) (FF(IIII + IO), IIII=1, NXIM)
                                                                                                                                                                                                                                                                                                              DO 180 IX = 1, NXIM
                                                                                                                                                                                                                                                                                                                                                                                                                                       CLEVL(NLEVL) = 2.5E-3 * REAL(NLEVL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        XWID = .9 * XMW / ZMW
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ZP1 = .5 * (1. + ZWID)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ZP0 = .5 * (1. - ZWID)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ZWID = .9 * ZWW / XWW
                                                                                                                                                                                                                                                                                      FF1(IX,NZIM - IZ + 1) = REAL(FF(IX + (IZ - 1)*NXIM))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             NPOINT, ADRES, NADRES, IFAIL)
```

for RK extrapolation using the above equations.

DOUBLE PRECISION Y(4), T, F(4)

DOUBLE PRECISION VO, UXO, UZO
COMMON /DATA/ VO, UXO, UZO
G = UXO \* Y(2) + UZO \* Y(4)
F(1) = Y(2)
F(2) = VO \* (UXO - G\*Y(2))
F(3) = Y(4)
F(4) = VO \* (UZO - G\*Y(4))
RETURN
END

# Appendix A.5

# The raytracing subroutine

#### **RAYTRA**

The subroutine RAYTRA is another two-point raytracing program. It uses a simple, laterally invariant velocity model, resulting in very fast raytracing. The subroutine is called from the Kirchhoff migration program in appendix A.8 and returns the travel time between any two points in the velocity model.

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                                                                                                                                                                                                                                                                                                            20
                                                                                                                                                                                                                                                                                                                              10 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   SUBROUTINE TO RAYTRACE FROM POINT (XSTART, ZSTART) TO (XEND, ZEND)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       No lateral velocity variations
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 Written by M J Findlay 1990
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       Variables: ACC defines raytracing accuracy in metres
                                                                                                                                                                                                                                                                   DETERMINE END POINT LAYER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CHECK FOR ZERO - LENGTH RAYPATH
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IN 2-DIMENSIONAL VELOCITY FIELD DEFINED BY :
                                          RAYTRACE FROM IMAGEPOINT TO SOURCE / RECEIVER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DETERMINE IMAGE POINT LAYER
                                                                                                    CONTINUE
                                                                                                                      CONTINUE
                                                                                                                                                                                                                                                                                                            CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     SUBROUTINE RAYTRA (NLAMAX, NDEPTH, DEPTH, VH, VV, XSTART, 2START, L
XEND, ZEND, DZGRID, ACC, MAXLOP, THETAP, THETAO, TAUO,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IF (XSTART .EQ. XEND .AND. ZSTART .EQ. ZEND) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            NRAY = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               PI2 = PI / 2.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   PI = 3.1415926535
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DOUBLE PRECISION TEMA, TEMB, TEMC, TEMCC, TEMD, TEME, TEMDD
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             REAL TIME (31), THET (31)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                REAL DEPTH (NDEPTH), VH (NLAMAX), VV (NLAMAX), XINTS (31), DIST (31)
                                                                                                                                                                                                                           DO 30 NL = 1, NLAMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                  DO 10 NL = 1, NLAMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      LOGICAL RECLAY
IF (ABS(DEPTH(LAYING + 1) - ZSTART) .LT. DZGRID/100.)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DEPTH(layer top), VV(layer), VH (layer)
                                                                                                                                                                                                    IF (DEPTH(NL + 1) .GT. ZEND - DZGRID/100.) THEN
                                                                                                                                             END IF
                                                                                                                                                                                                                                                                                                                                                   END IF
                                                                                                                                                                                                                                                                                                                                                                                                             IF (DEPTH(NL + 1) .GT. ZSTART - DZGRID/100.) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   GO TO 150
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     TAU0 = 0.0
                                                                                                                                                                                                                                                                                                                                                                   GO TO 20
                                                                                                                                                               GO TO 40
                                                                                                                                                                                    LAYSOR = NL
                                                                                                                                                                                                                                                                                                                                                                                          LAYIMG = NL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        NLAMAX = total no. of layers there are (NLAMAX+1) depths
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      DZGRID = Vertical grid size used by migration algorithm
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                THETA0 = takeoff angle (-pi/2 --> 3pi/2) 0.0=horizontal to right
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               VH, VV specify horizontal and vertical velocity components in
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 MAXLOP = Maximum no. of searches for raypath
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             TAU0 = travel time
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               THETAL = Raypath angle at (XEND, ZEND)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     LAYIMG = layer of starting point
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     THETAL, NRAY)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            each layer (elliptical approxn to transverse isotropy)
                                                                                                                                                                                                                                                                                                                                                     ററ
                      C
                                                                                                        60
                                                                                                                                                                                                                                                  DOWN
                      υP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        END
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                END IF
```

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C TRACING FRO C LAYSOR (1sor)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 50 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                        SPECIAL CASE FOR VERTICAL RAYPATHS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    TRACING FROM (XSTART, ZSTART) in layer LAYING TO (XEND, ZEND) in
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  ELSE IF (XEND . EQ. XSTART) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IF (ABS (DEPTH (LAYSOR + 1) - ZEND) .LT. DZGRID/100.) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IF (XEND .LT. XSTART) THETAO = THETAO + PI END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IF (XEND - XSTART .LT. - DZGRID/100.) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IF (THETAP .LT. 2.*PI) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   ELSE IF (XEND - XSTART .GT. DZGRID/100.) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   IF (ZEND .LT. ZSTART) THETA0 = PI + PI2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IF (ZEND .LT. ZSTART) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF (ZEND .LT. ZSTART) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                  THETAB = P12 + .01
THETAT = -P12 - .01
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              THETAT = PI + PI2 + .01
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       THETAB = PI2 - .01
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            THETAO = ATAN (THETAO)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                THETAO = (ZEND - ZSTART) / (XEND - XSTART)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                THETAO = PI2
                                                                                                                                                                                                                                                                                                                                       IF (LAYSOR .EQ. LAYIMG) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  THETAO - THETAP
                                                                                                                                                                                                                                                          ELSE IF (THETAO .EQ. PI2) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         ZEND = ZEND + DZGRID / 100.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          ZSTART = ZSTART + DZGRID / 100
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                ZSTART = ZSTART - DZGRID / 100.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   LAYSOR - LAYSOR + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    LAYING - LAYING + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            ZEND = ZEND + DZGRID / 100
                                                                                                                                                   TAU0 = D0 / VV(LAYIMG)
DO 60 NL = LAYIMG + 1, LAYSOR - 1
TAU0 = TAU0 + D0 / VV(LAYSOR)
                        DO = ZEND - DEPTH (LAYSOR)
                                                   CONTINUE
                                                                                                                                                                                                       D0 = DEPTH(LAYIMG + 1) - ZSTART
                                                                                                                                                                                                                                                                                     TAU0 = D0 / VV(LAYSOR)
                                                                                                                                                                                                                                                                                                              D0 = ABS(ZEND - ZSTART)
                                                                                                    T0 = D0 / VV(NL)
                                                                                                                             DO = DEPTH(NL + 1) - DEPTH(NL)
                                                                         TAU0 = TAU0 + TO
```

D0 = ZSTART - DEPTH(LAYIMG)

```
NOW START RAYTRACING
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     ZINTB = 1E9
ZINTT = -1E9
DTHETA = 0.05
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     TAU0 = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DO 140 I = 1, MAXLOP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            GO TO 150
                                                                                                                                                                                                                                                                                                                                                                                                                                        CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                          NLAY = LAYIMG
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF (THETAO .GT. 3.*PI2 .OR. THETAO .LT. - PI2) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       RECLAY = .FALSE.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CALL ZERO(31, TIME)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             NRAY = I
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 THETA = THETAO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   END IF
                                                                                                                                                      FLSE
                                                                                                                                                                                                            END IF
                                                                                                                                                                                                                                                                                                                        IF (NLAY .EQ. LAYSOR) RECLAY = .TRUE.
IF (THETA .LT. 0.0 .OR. THETA .GT. PI) THEN
                                                                                                                                                                                                                                                                                                                                                               END IF
                                                                                                                                                                                                                                                                                                                                                                                                                IF (ABS(THETA) .LT. 1.E-3 .OR. ABS(THETA - PI) .LT. 1.E-3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                           THETA = THETAO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ZPO = ZSTART
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                XPO = XSTART
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DO 80 JJJ = 1, 31
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL ZERO(31, DIST)
                                                                                              DIST(NLAY) = SQRT(DX**2 + DZ**2)
                                                                                                                  END IF
                                                                                                                                                                                      IF (ABS(THETA) .EQ. PI2 .OR. THETA .EQ. 3*PI2) THEN
TEMP3 = TEMP1 * COS(THETA) ** 2
TEMP4 = TEMP2 * SIN(THETA) ** 2
                                       TEMP2 = VH(NLAY) ** 2
                                                         TEMP1 = VV(NLAY) ** 2
                                                                            THET (NLAY) = THETA
                                                                                                                                                                                                                                              DZ = DEPTH(NLAY + 1) - ZPO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              XINTS(JJJ) = -1000.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 70 NL = LAYIMG - 1, LAYSOR + 1, -1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IF (THETA0 .LT. - P12) THETA0 = THETA0 + DTHETA GO TO 140
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     DO = DEPTH(LAYSOR + 1) - ZEND
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 TAU0 = D0 / VV(LAYIMG)
                                                                                                                                  DX = DZ / TAN(THETA)
                                                                                                                                                                         DX = 0.0
                                                                                                                                                                                                                              ZPO = DEPTH(NLAY + 1)
                                                                                                                                                                                                                                                                                                       DZ = DEPTH(NLAY) - ZPO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   TAU0 = TAU0 + D0 / VV (LAYSOR)
                                                                                                                                                                                                                                                                                     ZPO = DEPTH(NLAY)
                                                                                                                                                                                                                                                                                                                                                                                 THETA = THETA + 2.E-3
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IF (THETAO .GT. 3.*PI2) THETAO = THETAO - DTHETA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DO = DEPTH(NL + 1) - DEPTH(NL)
TO = DO / VV(NL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           TAU0 = TAU0 + TO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       იიი
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                                                                                                                                                                                                                                                   CHECK TO SEE IF CLOSE TO SOURCE POSITION
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                FIND INTERSECTION POINT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CHECK FOR RAY PASSING BEYOND ENDPOINT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               FIRST CHECK FOR RAY WITHIN CAPTURE RADIUS
                                                                                                                                                 RAY FOUND
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     RAY FOUND
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IF (VTHETA .LT. 0.0) WRITE (6,*)'108', TEMP1, TEMP2, TEMP3,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IF ((THETA .GT. PI2 .AND. XPO .LT. XEND) .OR. (THETA .LE.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      GO TO 150
END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ERR = SQRT ((XPO - XEND) **2 + (ZPO - ZEND) **2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IF (THETA .LT. 0.0 .OR. THETA .GT. PI) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   XPO = XPO + DX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         TIME (NLAY) - DIST (NLAY) / VTHETA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  VTHETA - SQRT (VTHETA)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           VTHETA = (TEMP1*TEMP2/(TEMP3 + TEMP4))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IF (ERR .LE. ACC) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       XINTS (NLAY + 1) = XPO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      XINTS (NLAY) = XPO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DO 100 NI = 1, NLAMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CONTINUE
                                                                                                                                                                                                  Ħ
                                                                                                                                                                                                                                                                                                                                                                                                                                                   ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     PI2 .AND. XPO .GT. XEND)) THEN IF (THETA .GT. PI2) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           TAU0 = 0.0
                                                                                                                                                                                                                                                                                                    END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IF (DX .EQ. 0.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            TEMP 4
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    TAU0 = TAU0 + TIME(NL)
                                                                                                                                                                                                  (ABS (ZINT - ZEND) .LT. ACC) THEN
TEMP3 = TEMP1 * COS(THETA) ** 2
TEMP4 = TEMP2 * SIN(THETA) ** 2
                                                                                                                                                                                                                                                                                                                                               DZDASH = DZ * DXDASH / DX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DZDASH = ZEND - (ZPO - DZ)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DXDASH = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        ZINT = ZPO
                                              TEMP2 = VH(NLAY) ** 2
                                                                                                                                                                                                                                                                                                                                                                         DXDASH = XEND - XOLD
                                                                                                                                                                                                                                                                                                                                                                                                  ZOLD = ZPO - DZ
                                                                        TEMP1 = VV(NLAY) ** 2
                                                                                                  THET (NLAY) = THETA
                                                                                                                                                                                                                                                                                                                          ZINT = ZOLD + DZDASH
                                                                                                                                                                                                                                                                                                                                                                                                                          XOLD = XPO - DX
                                                                                                                       DIST(NLAY) = SQRT(DXDASH**2 + DZDASH**2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             WRITE (6, *)'RAY OUT L.H. SIDE '
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6, *)'RAY OUT R.H. SIDE '
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              C C RAY FOUND SO RETURN TO MAIN PROGRAM C
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           0 0 0
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           110
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 NEXT RAY (RAY NOT FOUND)

IF (ZINT ...
                                                                                                                                                                                                                                                                                                                                                                                                                                                                              RAY OUT TOP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CHECK FOR RAY OUT TOP OR BOTTOM & CALCULATE NEW INTERCEPTION POINTS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    NEED TO STORE THETAO FOR INTEGRAL KERNEL
                                                              RAY OUT BOTTOM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      ELSE IF (NLAY .EQ. 1 .AND. (THETA .LT. 0.0 .OR. THETA .GT. PI)
                                                                                                                         ELSE IF (NLAY .EQ. NLAMAX .AND. (THETA .GT. 0.0 .AND. THETA .
                                                                                                                                                                                                                                                                    ELSE IF (ZINT .LT. ZINTB .AND. ZINT .GT. ZEND)
                                                                                                                                                                                                                                                                                                                                                      ZINT = ZPO - ABS(DXNEW*TAN(THETA))
END IF
                                                                                                                                                                                                                                                                                                                                                                                                 ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                     DXNEW = XEND - XPO
IF (ABS (THETA) .EQ. PI2) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       GO TO 140
END IF
                 DXNEW = XEND - XPO
IF (ABS(THETA) .EQ. PI2) THEN
                                                                                                                                               GO TO 140
                                                                                                                                                                 THETA0 = .5 * (THETAT + THETAB)
                                                                                                                                                                                      END IF
                                                                                                                                                                                                                                                                                                                                 IF (ZINT .GT. ZINTT .AND. ZINT .LT. ZEND) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 VTHETA = (TEMP1*TEMP2/(TEMP3 + TEMP4))
IF (VTHETA .LT. 0.0) WRITE (6,*)'152', TEMP1, TEMP2,
                                                                                                                                                                                                                                                                                                                                                                                                                 2INT = -1.E9
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                END IF '
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          GO TO 150
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DO 110 NI = 1, NIAMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      TAU0 = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      TIME (NLAY) - DIST (NLAY) / VTHETA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        VTHETA = SQRT (VTHETA)
                                                                                                                                                                                                                                                                                           ZINTT = ZINT
                                                                                                                                                                                                                                                                                                               THETAT = THETAO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              THETAO = .5 * (THETAT + THETAB)
                                                                                                                                                                                                        ZINTB = ZINT
                                                                                                                                                                                                                            THETAB = THETAO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 ELSE IF (ZINT .LT. ZINTB .AND. ZINT .GT. ZEND)
ZINT = 1.E9
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  ) THEN
                                                                                                      LT. PI)) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 (ZINT .GT. ZINTT .AND. ZINT .LT. ZEND)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            TAU0 = TAU0 + TIME(NL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     ZINTB = ZINT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         THETAB = THETAO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ZINTT = ZINT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          THETAT = THETA0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               TEMP3, TEMP4
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               THEN
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      RAY NOT CRITICAL SO JUMP OUT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      RAY NOT FOUND AND STILL IN GRID SO APPLY SNELL'S LAW AND CHECK FOR SUPERCRITICAL RAYS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CRIT = ATAN(SQRT(1./TEM))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            V00 = VV(NLAY)
IF (ABS(THETA) .EQ. PI2 .OR. THETA .EQ. 3*FI2) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CRIT = PI2 - CRIT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF (THETA .LT. 0.0 .OR.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            V0 = VH(NLAY)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IF (ABS(THETA) .LT. CRIT .OR. ABS(THETA - PI) .LT. CRIT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IF (TEM .LT. 0.0) WRITE (6,*)'235', V00, V1,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IF (VO .GE. V1) GO TO 120
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 TEM = V00 ** 2 * (V1**2 - V0**2) / V0 ** 4
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         V1 = VH(NLAY + 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  V1 = VH(NLAY - 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 IF (THETA .LT. 0.0 .OR. THETA .GT. PI) NLAY = NLAY - 2 GO TO 130
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             NLAY = NLAY + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ELSE IF (ZINT .LT. ZINTB .AND. ZINT .GT. ZEND)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IF (ZINT .GT. ZINTT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                 IF (THETA .GT. PI) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        GO TO 140
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               THETAO = .5 * (THETAT + THETAB)
THETA0 = THETA0 + DTHETA
ELSE IF (THETA .GT. - PI2) THEN
                                                                                                                                                                                                                                                                  ELSE IF (THETA .GT. PI2) THEN
                                             ELSE IF (THETA .GT. 0.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     ZINTB - ZINT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            ZINTT - ZINT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            THETAB - THETAO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                ZINT = ZPO + ABS (DXNEW*TAN (THETA) )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   THETAT - THETAO
                                                                                                                                                                                                                                                                                     THETAO = .5 * (THETAT + THETAB)
                                                                                                                                                                                                                                                                                                                END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                              IF (ZPO .LT. ZEND) THEN
                                                                                         END IF
                                                                                                                                                         IF (ZPO .GT. ZEND) THEN
                                                                                                                                                                              END IF
                                                                                                                                                                                                                                             IF (ZPO .LT. ZEND) THEN
                                                                 THETA0 = .5 * (THETAB + THETAT)
                                                                                                                                                                                                                                                                                                                                                                                                    ZINTT = ZPO
                                                                                                              ZINTB = ZPO
                                                                                                                                    THETAB = THETAO
                                                                                                                                                                                                     ZINTT = ZPO
                                                                                                                                                                                                                        THETAT = THETA0
                                                                                                                                                                                                                                                                                                                                     ZINTB = ZPO
                                                                                                                                                                                                                                                                                                                                                          THETAB = THETA0
                                                                                                                                                                                                                                                                                                                                                                                                                           THETAT = THETA0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         THETA .GT. PI) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        .AND. ZINT .LT. ZEND) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                8
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THETAO = THETAO - DTHETA

END IF

GO TO 140

RAY IS SUPERCRITICAL SO JUMP OUT AND TRY NEXT RAY
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TEME = TEMB \* SQRT(TEMC + TEMDD\*TEMD)
THETA2 = ATAN(SQRT(TEMA)/TEME)
C THETA2 IS NOW ANGLE TO VERTICAL
IF (THETA .GT. PI) THEN C APPLY SNELL'S LAW C set thetal to final ray angle at XEND, ZEND C GO BACK TO MAIN PROG C START RAYTRACING TO RECEIVERS C NEXT RAY TO THIS SOURCE 130 150 CONTINUE 140 CONTINUE 2 1 RETURN END THETAL = THETA END IF ELSE TEMD = VH(NLAYO) \*\* 2 - VH(NLAYO) \*\* 2

TEMDD = VV(NLAYO) / VH(NLAYO)

TEMDD = TEMDD \*\* 2

ALFAC = TEMC + TEMDD \* TEMD

IF (ALFAC .LT. 0.0) WRITE (6,\*)'281', VH(NLAYO), VH(NLAY),

V(NLAYO), VV(NLAY), THETA, TEMA, TEMB, TEMC, TEMCC, ELSE IF (THETA .GT. PI/2) THEN
THETA2 = PI2 + THETA2
ELSE IF (THETA .GT. 0.0) THEN IF (THETA .LT. 0.0 .OR. THETA .GT. PI) NLAY = NLAY - 2
TEMA = VH(NLAY) \*\* 4 \* VV(NLAY0) \*\* 2
TEMB = VV(NLAY) \* VH(NLAY0)
TEMCC = DBLE(PI2 - THETA)
TEMCC = TAN(TEMCC) THETA2 = THETA2 - PI2 END IF ELSE NLAY = NLAY + 1 GO TO 90 CONTINUE TEMC = DBLE(VH(NLAYO)) / TEMCC THETA = THETA2 TEMC = TEMC \*\* 2 NLAYO = NLAY THETA2 = PI2 - THETA2 THETA2 = 3 \* PI2 - THETA2 TEMD, TEMDD, TEME

## Appendix A.6

# The finite-difference migration program

**EXTRAPREV** 

The program EXTRAPREV carries out finite-difference migration in the (x,z,t) domain. A file of imaging times generated for each grid point by raytracing is attached to unit 11 at run time. The wavefield may be plotted at particular time steps as it regresses from the receivers, and the final migrated section is plotted.

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                                                                                                                                                                                                                                                                                                                                                               ററ
                                                                                                                                                                                                                                                                                                                                                                                       THIS ZEROS ARRAY U(X, Z, T=0, 1, 2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          SEE RENAUT&PETERSEN, GEOPHYSICS 1989
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      POLO, POL2 DEFINE POLYNOMIAL COEFFICIENTS FOR ABSORBING BOUNDARIES
                                                                                                                                                                                                                                                                                                                                                                                                                                                        10 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      REQUIRES USE OF SUBROUTINE LIBRARY TSAR4_L, *GHOST80 AND PRIOR DETERMINATION OF EXCITATION TIMES BY RAYTRACING PROG
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CONDITION FINITE DIFFERENCE MIGRATION.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     WRITTEN BY M J FINDLAY 1989
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         (TRAVEL TIMES ATTACHED TO UNIIT 11 AT RUN TIME)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CAN HANDLE LATERAL VELOCITY VARIATIONS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  ALGORITHM PROVIDED BY MCMECHAN (GEOPHYSICS V50 P627-636)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              PROGRAM TO CARRY OUT ACOUSTIC REVERSE TIME EXCITATION IMAGING
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      (ABSORBING BOUNDARY CONDITIONS FROM RENAUT&PETERSEN GEOPHYSICS 1989)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CHARACTER*17 OPFILE, IPFILE, IFNAM1, IFNAM2, IFNAM3
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             PARAMETER (PI=3.1415926535898, POLO=21.*PI/64., POL2=-15.*PI/64.)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       PARAMETER (NHOR=140, NVER=140, NTIM=3, NSAM=1024, NCHN=95)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CALL ZERO(NSAMSP, REFRES(1,1))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     DATA NCOL /1, 7, 4, 6, 5, 3, 8, 2, 1/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           INTEGER NMOV (20), IXS (NCHN), IZS (NCHN), NCOL (9)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CHARACTER*1 ALPDUM (NVER*4)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                REAL REFRES (NVER, NHOR), IMT (NHOR, NVER), ARR(128), RMT (NHOR) DOUBLE PRECISION X(256), X1(256), Z1(256), C(256), XEVAL,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   REAL UR4 (NVER, NHOR), RPLOT (NSAM), Z (NVER), XCORS (NCHN),
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            PROGRAM EXTRAP
                                                                                   READ (5,*) IX0, IZ0
                                                                                                                                                                                                        WRITE (6,*)'ENTER TIME SAMPLE INTERVAL (millisecs):'
                                                                                                                                                                                                                                     READ (5,*) IXMAX, IZMAX
                                                                                                                                                                                                                                                                    WRITE (6,*)'ENTER MAXIMUM GRID VALUES IN X & Z (<128) :'
                                                                                                                                                                                                                                                                                                 READ (5,*) H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 10 I = 1, NVER * 4
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CALL ZERO(NSAMT, U(1,1,1))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        NSAMT = NHOR * NVER * NTIM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    NSAMSP = NHOR * NVER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           WRITE (6,*) PI
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                COMPLEX CX(2048), CX1(256)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DOUBLE PRECISION ZPRIME (256)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    REAL V (NHOR, NVER), TRACES (NSAM, NCHN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 REAL U(NHOR, NVER, NTIM), TERM1, TERM2, TERM3, A
DELAYT = DELAYT * 1.E-3
                            READ (5,*) DELAYT
                                                      WRITE (6,*)'ENTER DELAY TIME OF SOURCE IN MILLISECS :'
                                                                                                                  WRITE (6,*)'LOCATION OF REAL SOURCE :'
                                                                                                                                                 DT = DT * 1.E-3
                                                                                                                                                                         READ (5,*) DT
                                                                                                                                                                                                                                                                                                                                WRITE (6, *)'ENTER GRID POINT SPACING (METRES):'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              IMPLICIT REAL(A - H,O - Z)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  ALPDUM(I) = 'e'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   TT (NSAM), AMPMAX, XMAX, ZMAX, AMPSCL, RREC, TMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 ZCORS (NCHN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      XPRIME (256)
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100
                                                                                                          90
                                                                                                                                                                                                                     80
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            70
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           50
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      30 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              20 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 30 J = 1, NSOR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    DO 20 II = 1, NSOR
WRITE (6,*) 'Enter coords (X,2) of "source" *', II, ' : '
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              NSAMFT = NSOR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     DO 50 J = 1, LENTAP / 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (6,*)'Enter shot number to be restored in file:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL POWER2 (NSAMFT, LX0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            READ (5,*) NPOWER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (6,*)'INTERPOLATE SPATIALLY BY POWER OF 2 (ENTER POWER) :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  READ (5,*) NOYST2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE (6,*)'REMOVE T**2 RAMP 0=NO 1=YES(AND APPLY T**.5)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CLOSE (12)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         READ (5, *) NSHOT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    READ (5, *) NSOR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE (6,*)'Enter number of "source" positions :'
                                                                                                                                                                                                                                                                                                                                                         DO 130 JJ = 1, NSAM
                                                                                                                                                                                                                                                                                                                                                                                                             CALL POWER2 (NSAMIT, LX1)
                                                                                                                                                                                                                                                                                                                                                                                                                                     NSAMIT = NSAMFT * 2.0 ** NPOWER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   IF (NPOWER .EQ. 0) GO TO 180
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             RNP = REAL(2**NPOWER)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IF (NOYST2 .EQ. 1) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        OPEN (12, FILE = IFNAM2, STATUS='UNKNOWN', FORM='UNFORMATTED', ACCESS=
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                LEN = 4104
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        READ (5, 190) IFNAM2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    WRITE (6,*)'ENTER NAME OF FILE CONTAINING SEISMOGRAMS'
                                                                                                                                                                                                                                                                                                                                                                                   LRAMP = LXO - NSAMFT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               LENTAP = NINT (REAL (NSOR) /5.0) * 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IDSHOT = (NSHOT - 1) * (NSOR + 1) + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DO 40 I = 1, NSAM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          NIDC - IDSHOT + J
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   READ (5,*) XCORS(II), ZCORS(II)
                                                                                                                                                                                                                     CONTINUE
                                                                                                                                                                                                                                                                    DO 80 II = 1, NSAMFT
                                                                                                                                                                                                                                                                                                   RAMPO = TRACES (JJ, NSAMFT)
                                                                                                                                                                                                                                                                                                                               CALL ZERO (512, CX)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 70 I = 1, NSAM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           FACTOR = .5 - \cos(2.*pi*real(J)/real(lentap)) / 2.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             READ (12, REC=NIDC) (TRACES(I, J), I=1, NSAM)
  CONTINUE
                                                    DO 100 II = LX0 / 2 + 2, LX1
                                                                              CALL FORK(LXO, CX, -1.0)
                                                                                                          CONTINUE
                                                                                                                                                                                        DO 90 II = NSAMFT + 1, LX0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           'DIRECT', RECL=LEN)
                          CX(II) = 0.0
                                                                                                                                                                                                                                            CX(II) = CMPLX(TRACES(JJ, II), 0.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        DO 60 J = 1, NSOR
                                                                                                                                    CX(II) = CMPLX(RAMP0*FAC)
                                                                                                                                                              FAC = REAL(LXO - II) / REAL(LRAMP)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           TRACES(I, NSOR - J + 1) = TRACES(I, NSOR - J + 1) * FACTOR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  TRACES(I, J) = TRACES(I, J) * FACTOR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    FACTOR = 1. / (REAL(I)) **
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                TRACES(I, J) = TRACES(I, J) * FACTOR
```

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110
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            140
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     120 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     150
                                                                                                                                                                                                                                                                                                                   200 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    190 FORMAT (A17)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               180 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    170 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      160 CONTINUE
                                                                                                                                                                                                                                                              210 FORMAT (5(I3, 2x, I3, 1x, I3, 4x))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   NOW DO INTERPOLATION OF COORDINATE VALUES
                                                                                                                                                                                                                                                                                                                                                                                                                       DO 200 II = 1, NSOR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    MSOR = 2 ** NPOWER * NSOR - (2*NPOWER - 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             WRITE (6,*)'DXINTL = ', DXINTL WRITE (6,*)'NFINAL = ', NFINAL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        N1 = NSOR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DXINTL = DXINTF / (RNP)
NFINAL = NSOR * 2 ** NPOWER - (2*NPOWER - 1)
                                               CALL POWER2 (NSAMFT, LX0)
                                                                                                                                                                                                                                                                                     WRITE (6,210) (II, IXS(II), IZS(II), II=1, NSOR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 170 II = 1, NFINAL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DO 160 \text{ II} = 1, NFINAL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      N0 = N1 - 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             N2 = (N1 - 1) * N1 / 2
                           NSAMIT = NSAMFT * 2.0 ** NPOWER
                                                                               NSAMFT = NSTART
                                                                                                                                 RNP = REAL(2**NPOWER)
                                                                                                                                                        READ (5,*) NPOWER
                                                                                                                                                                               WRITE (6,*)'INTERPOLATE TEMPORALLY (ENTER POWER OF 2):'
                                                                                                                                                                                                            READ (5,*) NSTART
                                                                                                                                                                                                                                     WRITE (6,*)'Enter first time sample to start from :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                    IXSMAX = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE (6,*)'NSOR = ', NSOR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   DXINTF = 1.0
CALL POWER2 (NSAMIT, LX1)
                                                                                                    IF (NPOWER .EQ. 0) GO TO 280
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 XCORS(II) = XPRIME(II)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL FORK(LX1, CX, 1.0)
                                                                                                                                                                                                                                                                                                                                                                                            IXS(II) = NINT(XCORS(II)/H)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ZCORS(II) = ZPRIME(II)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CALL E01AAF(X, X1, C, N1, N2, N0, XEVAL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 140 III = 1, NSOR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DO 120 II = 1, NSAMIT - 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DO 110 II = LX1, LX1 / 2 + 2, -1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CALL E01AAF(X, Z1, C, N1, N2, N0, XEVAL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     DO 150 III = 1, NSOR
                                                                                                                                                                                                                                                                                                                                            IF (IXS(II) .GT. IXSMAX) IXSMAX = IXS(II)
                                                                                                                                                                                                                                                                                                                                                                       IZS(II) = NINT(ZCORS(II)/H)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ZPRIME(II) = C(N2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            XPRIME(II) = C(N2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                XEVAL = X(1) + DBLE(DXINTL*(II - 1))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CX(II) = CONJG(CX(LX1 + 2 - II))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            X(III) = DBLE(III)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  X(III) = DBLE(III)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  21(III) = 2CORS(III)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           X1(III) = XCORS(III)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     TRACES(JJ, II) = REAL(CX(II)) * SQRT(RNP)
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260
270
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        220
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  250
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      240
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             230
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            300 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      280 CONTINUE
                                                                                                                                                                                                             320
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   290 FORMAT (8(F10.4))
                                                                                                                                                           330 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DO 310 J = 1, NSOR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            LENTIM = NINT (REAL (NSTART) /10.0) * 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                NSAMP0 = 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        NSTART = NSTART * 2 ** NPOWER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    NSAMO = NSAM * 2 ** NPOWER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 270 JJ = 1, NSOR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           LRAMP - LXO - NSAMET
                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 330 NL = 1, NLAYER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                      VMAX = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IDEPTH = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                READ (5, *) NLAYER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DT = DT / RNP
                                                              READ (5, *) IYNANS
                                                                                          WRITE (6,*)'INCLUDE POINT DIFFRACTOR 1=Y 0=N:'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (6,*)'ENTER NO. OF LAYERS :'
                                                                                                            IZP = IZ0
                                            IF (IYNANS .EQ. 1) THEN
                                                                                                                                       IXP = IXO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DO 300 I = 1, LENTIM / 2

FAC = .5 - COS(2.*PI*REAL(I)/REAL(LENTIM)) / 2.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CALL FORK (LXO, CX, -1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        DO 230 II = NSAMFT + 1, LX0

FAC = REAL(LX0 - II) / REAL(LRAMP)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CALL ZERO (2048, CX)
                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,*)'ENTER VELOCITY OF MEDIUM', NL, ' (metres / sec)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CALL FORK (LX1, CX, 1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 240 II = LX0 / 2 + 2, LX1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DO 220 II = 1, NSAMET
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         RAMPO - TRACES (NSAMFT, JJ)
                                                                                                                                                                                                             CONTINUE
                                                                                                                                                                                                                                                    DO 320 IZ = 1, NTHICK
DO 320 IX = 1, IXMAX
                                                                                                                                                                                                                                                                                                                              READ (5,*) THICK
                                                                                                                                                                                                                                                                                                                                                WRITE (6, *)'ENTER THICKNESS OF LAYER', NI,
                                                                                                                                                                                                                                                                                                                                                                         IF (VL .GT. VMAX) VMAX = VL
                                                                                                                                                                                                                                                                                                                                                                                               READ (5,*) VI
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   DO 260 II = 1, NSAMIT - 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              DO 250 II = LX1, LX1 / 2 + 2, -1
                    WRITE (6, *) 'ENTER IX, IZ, VEL(IX, IZ)'
                                                                                                                                                                                     IDEPTH = IDEPTH + NTHICK
                                                                                                                                                                                                                                                                                                      NTHICK = NINT(THICK/H)
READ (5,*) IXP, IZP, VPOINT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CX(II) = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CX(II) = CONJG(CX(LX1 + 2 - II))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CX(II) = CMPLX(RAMPO*FAC)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CX(II) = CMPLX(TRACES(II, JJ), 0.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             TRACES(II, JJ) = REAL(CX(II)) * SQRT(RNP)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           TRACES (NSTART - I + 1, J) = TRACES (NSTART - I + 1, J) * FAC
                                                                                                                                                                                                                               V(IX, IZ + IDEPTH) = VL
                                                                                                                                                                                                                                                                                                                                                     ' (metres)'
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C C START OF SOURCE AT T = 0 C
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 000
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                   370 CONTINUE
                                                                  410 CONTINUE
                                                                                                                                                                                                   400 FORMAT (8F10.6)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             360 IT = NSTART
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            340 CONTINUE
                                                                                                                                                                                                                                 390 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           350 FORMAT (A10)
                  START LOOP OVER ALL TIME SAMPLES
                                                                                                                                                             SETUP PLOTTING ARRAY Z(NZ)
                                                                                                                                                                                                                                                                                                                                                                                                                    SET UP IMAGE TIME CONDITION
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         H=GRID POINT SPACING
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DEFINE COLOURS FOR GHOST80 OUTPUT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,*)'2nd or 4th Order finite difference approximation :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           READ (5,*) CUTO
                                                                                                                                                                                                                                                                                                                                                                        00
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      DO 370 \text{ II} = 1, NSOR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CALL PAPER(1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE (6, *) 'ENTER OUTPUT FILE NAME :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                READ (5,*) NMOVIE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (6,*)'ENTER NUMBER OF DIFFERENT MOVIE FRAMES REQUIRED'
                                                                                                              DO 410 II = 1, IZMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              READ (5,190) IFNAM3
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          READ (5,*) IPTYPE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     WRITE (6,*)'ENTER WAVEFIELD PLOT TYPE (1=WIGGLE 2=PIXEL(COLOUR)) :
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   READ (5, *) NORD
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    WRITE (6,*)'ENTER CUTOFF RATIO FOR S/N :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 340 NM = 1, NMOVIE
                                                                                                                                                                                                                                                                                                                                                                        390 JJ = 1, NVER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                U(IXS(II), IZS(II), ITO - 1) = TRACES(NSTART, II)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                READ (5,*) NMOV(NM)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (6,*)'ENTER SAMPLE TIME #', NM
                                                                                                                                                                                                                                                     CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    A = (V(IXS(II), IZS(II))*DT/H)
                                                                                      Z(II) = REAL(II) * H
                                                                                                                                                                                                                                                                                                                        DO 380 \text{ II} = 1, NHOR
                                                                                                                                                                                                                                                                                                                                                READ (11,400) (RMT(II), II=1, NHOR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IF (DT .GE. H/(SQRT(2.)*V(IXS(II), IZS(II)))) THEN
                                                                                                                                                                                                                                                                                                IMT(II, JJ) = NINT(RMT(II)/DT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     WRITE (6, *)'ALGORITHM UNSTABLE '
                                                                                                                                                                                                                                                                           IMT(II,JJ) = IMT(II,JJ) + NINT(DELAYT/DT) + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WRITE (6,*)'DT,H,V=',DT,H,V(IXS(II),IZS(II))
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V(IXP, IZP) = VPOINT

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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           C 'NOW APPLY ABSORBING BOUNDARY CONDITIONS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         n
                                                                                                                              440
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            OPTION TO MAKE SURFACE BOUNDARY ABSORBING
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               INCLUDE FREE SURFACE BY MAKING U(IX, Z=0) = 0.0 ????
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   Н
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DO 560 IT = NSTART - 1, NMOV(NMOVIE),
WRITE (6,*)'TIME SAMPLE : ', IT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      TIMEIT = (IT - 1) * DT
                                                                                                                              CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 440 IX = 3, IXMAX - 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 430 IZ = 2, IZMAX - 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 TERM2 = U(IX, IZ + 1, IT0) + U(IX, IZ, IT0 - 2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     DO 430 IX = 2, IXMAX - 1
                                                                                                                                                                                       U(IX,IZ,IT0) = UINIT - U(IX,IZ + 1,IT0 - 2)
                                                                                                                                                                                                                                                                                                                                                                                    IX + 1, IZ, IT0 - 2) + U(IX - 1, IZ, IT0 - 2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               TERM1 = U(IX, IZ, IT0 - 1) + U(IX, IZ + 1, IT0 -
                                                                                                                                                                                                                                                            UINIT = (TERM1 + TERM2 + TERM3) / (A + POLO
                                                                                                                                                                                                                                                                                                                           TERM3 = -TERM3 * A ** 2 * POL2
                                                                                                                                                                                                                                                                                                                                                                                                                                             TERM3 = U(IX + 1, IZ + 1, IT0) + U(IX - 1, IZ + 1, 
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  TERM2 = TERM2 * (A - POL0 + 2.*POL2*A**2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            TERM1 = TERM1 * 2.0 * POL0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               A = V(IX, IZ) * DT / H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    12 = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IF (IT .EQ. IMT(IX, IZ)) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              IF (NORD .EQ. 2 .OR. IX .EQ. 2 .OR. IZ .LE. 1 .OR.
IX .EQ. IXMAX - 1 .OR. IZ .EQ. IZMAX - 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            A = (V(IX, IZ) * DT/H)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            REFRES(IZ, IX) = U(IX, IZ, IT0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WRITE (8, *) IX, IZ, IMT(IX, IZ)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              U(IX,IZ,IT0) = ALPHA - U(IX,IZ,IT0 -
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TERM1 = (2. -10. *A**2 / 3.) *U(IX,IZ,IT0-1)
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U(IX,IZ,IT0) = TERM1 - TERM2 + TERM3
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                                                                                                                                                                                                                   TERM1 = (U(IX, IZ - 1, IT0) + U(IX - 1, IZ, IT0)) / H
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                                                                                                                                 TERM2 = (U(IX, IZ, IT0 - 1)) * SQRT(2.) / (VDASH*DT)
                                                                                                                                                                                                                                                                                                                   VDASH = V(IX, IZ)
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                                                             U(IX,IZ,IT0) = (TERM1 + TERM2) / (2./H + SQRT(2.)/(VDASH*DT))
                                                                                                                                                                                                                                                                                                                                                                                              IZ = IZMAX
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IF(ABS(U(IX, IZ, ITO))*TIMEIT .LT.A0*TREF/CUTO)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               U(IX,IZ,IT0) = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               2) + U(
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                                                                                                                                                                                                                                                                                                                                                                          IX = 1
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UPPER RIGHT HAND CORNER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     LOWER LEFT HAND CORNER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  U(IX,IZ,IT0) = (TERM1 + TERM2) / (2./H + SQRT(2.)/(VDASH*DT))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          TERM1 = (U(IX,IZ - 1,IT0) + U(IX + 1,IZ,IT0)) / H

TERM2 = (U(IX,IZ,IT0 - 1)) * SQRT(2.) / (VDASH*DT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             TERM2 = (U(IX,IZ,IT0 - 1)) * SQRT(2.) / (VDASH*DT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               TERM1 = (U(IX, IZ + 1, IT0) + U(IX - 1, IZ, IT0)) / H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       VDASH = V(IX, IZ)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           U(IX,IZ,IT0) = (TERM1 + TERM2) / (2./H + SQRT(2.)/(VDASH*DT))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             TERM1 = (U(IX, IZ - 1, IT0) + U(IX - 1, IZ, IT0)) / H
TERM2 = (U(IX, IZ, IT0 - 1)) * SQRT(2.) / (VDASH*DT)
U(IX,IZ,IT0) = (TERM1 + TERM2) / (2./H + SQRT(2.)/(VDASH*DT))
                                           TERM2 = (U(IX,IZ,IT0 - 1)) * SQRT(2.) / (VDASH*DT)
                                                                             TERM1 = (U(IX, IZ - 1, IT0) + U(IX + 1, IZ, IT0)) / H
                                                                                                                                                                                                                                                                            U(IX,IZ,IT0) = (TERM1 + TERM2) / (2./H + SQRT(2.)/(VDASH*DT))
                                                                                                                                                                                                                                                                                                              TERM2 = (U(IX,IZ,IT0 - 1)) * SQRT(2.) / (VDASH*DT)
                                                                                                                                                                                                                                                                                                                                                         TERM1 = (U(IX, IZ - 1, IT0) + U(IX + 1, IZ, IT0)) / H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           VDASH = V(IX, IZ)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        U(IX, IZ, ITO) = (TERM1 + TERM2) / (2./H + SQRT(2.)/(VDASH*DT))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              U(IX,IZ,IT0) = (TERM1 + TERM2) / (2./H + SQRT(2.)/(VDASH*DT))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                TERM1 = (U(IX,IZ + 1,IT0) + U(IX - 1,IZ,IT0)) / H
TERM2 = (U(IX,IZ,IT0 - 1)) * SQRT(2.) / (VDASH*DT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    VDASH = V(IX, IZ)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           U(IX, IZ, IT0) = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            U(IX,IZ,IT0) = (TERM1 + TERM2) / (2./H + SQRT(2.)/(VDASH*DT))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               TERM1 = (U(IX,IZ + 1,IT0) + U(IX - 1,IZ,IT0)) / H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         U(IX,IZ,IT0) = (TERM1 + TERM2) / (2./H + SQRT(2.)/(VDASH*DT))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          TERM2 = (U(IX,IZ,IT0 - 1)) * SQRT(2.) / (VDASH*DT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               TERM1 = (U(IX, IZ - 1, IT0) + U(IX - 1, IZ, IT0)) / H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       VDASH = V(IX, IZ)
                                                                                                                        VDASH = V(IX, IZ)
                                                                                                                                                                 IZ = IZMAX
                                                                                                                                                                                                                                                                                                                                                                                                     VDASH = V(IX, IZ)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   IZ = IZMAX - 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IX = IXMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IX = IXMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    TERM2 = (U(IX, IZ, ITO - 1)) * SQRT(2.) / (VDASH*DT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              VDASH = V(IX, IZ)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IX = IXMAX - 1
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 IX - IXMAX
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IZ = IZMAX - 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IX = IXMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                          IZ = IZMAX
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  a
                                                                                                                                                                                         C DATA OUT TO UNIT 14
                                                                                                                                                                                                                                                                           C INCLUDE ABOVE COMMENTED STATEMENT TO SUPPRESS PLOT OUTPUT
                                                                                                                                                                                                                                                                                                                                                                                                                                                    \alpha \alpha \alpha
                                                                                                                                                                                                                                                               510
                                                                                                                    520
                                                                                                                                                                                                                                                                                                                                                                                   500
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         480
                                                                                                                                                                                                                                                                                                                                                                                                                                                                           WRITE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         MAKE THIS LINE THE LAST STEP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    UPPER LEFT CORNER
                                                                     NOW GET GRAPHICAL OUTPUT OF U(IX, IZ, ITEND
                                                                                                                                                                                                                                                                                                         IF (IT .EQ. NMOV(NPLOT)) THEN GO TO 500
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    U(IX,I2,IT0) = (TERM1 + TERM2) / (2./H + SQRT(2.)/(VDASH*DT))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CONTINUE

IF (IT .LT. NMOV(NMOVIE) + 1) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 TERM1 = (U(IX, IZ + 1, ITO) + U(IX + 1, IZ, ITO)) / H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   U(IX, IZ, IT0) = (TERM1 + TERM2) / (2./H + SQRT(2.)/(VDASH*DT))

U(IX, IZ, IT0) = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  TERM1 = (U(IX,IZ + 1,IT0) + U(IX + 1,IZ,IT0)) / H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       VDASH = V(IX,IZ)
TERM1 = (U(IX,IZ + 1,IT0) + U(IX + 1,IZ,IT0)) / H
TERM2 = (U(IX,IZ,IT0 - 1)) * SQRT(2.) / (VDASH-DT)
                                                                                                                                                                                                                                                                                                                                                      END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      DO 490 J = 1, NVER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE (19,*) IXP, IZP, IT, U(IXP, IZP, ITO)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DO 480 \text{ II} = 1, NSOR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    U(IX, IZ, IT0) = (TERM1 + TERM2) / (2./H + SQRT(2.)/(VDASH*DT))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         VDASH = V(IX, IZ)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              TERM2 = (U(IX,IZ,IT0 - 1)) * SQRT(2.) / (VDASH*DT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             VDASH = V(IX, IZ)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          TERM2 = (U(IX,IZ,IT0 - 1)) * SQRT(2.) / (VDASH*DT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IZ = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IX = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IZ = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IX = 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                         OUT U(IX, IZ, ITEND) TO FILE ATTACHED TO UNIT 13
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         U(IXS(II),IZS(II),IT0) = TRACES(IT,II)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 490 I = 1, NHOR
                                                                                                                                                                                                                                                             CONTINUE
                                                                                                                                                                                                                                                                                                                                                                               CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IF (IZS(II) .EQ. IZMAX) GO TO 480
DO 530 I = 1, IXMAX
                      AMPMAX = 0.0
                                                                                                                    CONTINUE
                                                                                                                                                                 DO 520 J = 1, NVER
                                                                                                                                                                                                                                                                                                                                                                                                                            DO 500 J = 1, NVER
                                                                                                                                        WRITE (14,290) (U(I,J,ITO - 1), I=1,NHOR)
                                                                                                                                                                                                                                                                                                                                                                                                     WRITE (13, 290) (U(I, J, ITO - 1), I=1, NHOR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  U(I,J,IT0 - 2) = U(I,J,IT0 - 1)

U(I,J,IT0 - 1) = U(I,J,IT0)
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530
                                                                                                                                                                                 550
                                                                                                                                                                                                                             540
                                                                                          560 CONTINUE
                                          DO 580 IX = 1, IXMAX
                                                                     AMPMAX = 0.0
                         DO 570 IZ = 1, IZMAX
                                                                                                                 END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CALL PSPACE(0.91, 0.99, 0.65, 0.90)
CALL MAP(0.0, 1.0, 0.0, 1.0)
IF (ABS(REFRES(IZ, IX)) .GT. AMPMAX) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CALL PCSCEN(0.5,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CALL CTRMAG(15)
                                                                                                                                     NPLOT = NPLOT + 1
                                                                                                                                                          CALL FRAME
                                                                                                                                                                             CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                         DO 550 \text{ IX} = 1, IXMAX
                                                                                                                                                                                                                                                                                                                                                                                                                            AMPMAX = SQRT(AMPMAX)
                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITE (6,*)'IPTYPE = ', IPTYPE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CALL SCALES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CALL BORDER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CALL MAP (0.0, XMAX, ZMAX, 0.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL PSPACE (PX1, PX2, PZ1, PZ2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF (RATIO .LT. 1) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  RATIO = XMAX / ZMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   ZMAX = (REAL(IZMAX) + 1.) * H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            XMAX = (REAL(IXMAX) + 1.) * H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL PLOTNI (0.7, 0.3, NSCALE)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       NSCALE = NINT(2000/AMPMAX)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL PCSCEN(0.5, 0.4, 'SCALE')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CALL PLOTNI (0.7, 0.6, IT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CALL PCSCEN(0.5, 0.7, 'Index')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CALL BORDER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL DEFPEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IF (AMPMAX .EQ. 0.0) AMPMAX = 1.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               PZ1 = 0.05
PZ2 = 0.90
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 PX1 = 0.05
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   PZ1 = 0.475 - P0 / 2.

PZ2 = PZ1 + P0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             PX2 = PX1 + P0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  PX1 = 0.475 - P0 / 2.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 530 J = 1, IZMAX
                                                                                                                                                                                                                                                                                                                                                                                    DO 540 IZ = 1, IZMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     NCHARS = XMAX / .85
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          PX2 = 0.90
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 P0 = .85 / RATIO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           NCHARS = ZMAX / .85
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     PO = RATIO * .85
                                                                                                                                                                                                      CALL PTJOIN (RPLOT, Z, 1, IZMAX, 1)
                                                                                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          UR4(J,I) = REAL(U(I,J,IT0 - 1))
                                                                                                                                                                                                                                                                                                                                                       IF (UR4(IZ, IX) .LT. 0.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF (ABS(UR4(J,I)) .GT. AMPMAX) AMPMAX = ABS(UR4(J,
                                                                                                                                                                                                                                                 RPLOT(IZ) = REAL(IX) + TERMSQ * 2. / AMPMAX
                                                                                                                                                                                                                                                                        END IF
                                                                                                                                                                                                                                                                                                                      ELSE
                                                                                                                                                                                                                                                                                                                                        TERMSQ = -SQRT(-1.*UR4(IZ,IX))
                                                                                                                                                                                                                                                                                           TERMSQ = SQRT(UR4(IZ, IX))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        0.8, 'Time')
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    590 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 570 CONTINUE
                                                                                                                          600
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     OPEN (10, FILE=IFNAM3, STATUS='UNKNOWN', FORM='UNFORMATTED', ACCESS=
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          NIDC = IDSHOT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              NXOUT = IXMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 590 J = 1, IXMAX
NIDC = IDSHOT + J - IX0 + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                WRITE (10, REC=NIDC) (ALPDUM(I), I=1, LEN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IDSHOT = (NSHOT - 1) * (NXOUT + 1) + 1
                                                                                                                                                                                                                                                                         DO 620 \text{ IX} = 1, IXMAX
                                                                                                                                                                                                                                                                                               CALL SCALES
                                                                                                                                                                                                                                                                                                                   CALL BORDER
                                                                                                                                                                                                                                                                                                                                     CALL MAP (0.0, XMAX, ZMAX, 0.0)
                                                                                                                                                                                                                                                                                                                                                                               CALL PSPACE(PX1, PX2, PZ1, PZ2)
                                                                                                                                                                                                                                                                                                                                                                                                     END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            X1PL = XMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                XOPL = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    RATIO = XMAX / ZMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     ZMAX = (REAL(IZMAX) + 1.) * H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CLOSE (10)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             LEN = (IZMAX + 2) * 4
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (RATIO .LT. 1) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      XSIZ = XMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           XMAX = (REAL(IXMAX) + 1.) * H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ZMAX = REAL(IZMAX) * H + 1.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     XSIZ = X1PL-X0PL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       X1PL = REAL(IXSMAX) * H
                                                                                                                                                                                                                                                                                                                                                         CALL MAP (XOPL, X1PL, ZMAX, 0.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           XOPL = REAL(IXO) * H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        P0 = RATIO * .85

PX1 = 0.475 - P0 / 2.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE (10, REC=NIDC) (REFRES(I, J), I=1, IZMAX)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       PZ2 = PZ1 + P0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          P21 = 0.475 - P0 / 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  PZ1 = 0.05
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    PX2 = PX1 + P0
                                                                            DO 610 IZ = 1, IZMAX
                                                                                                                                                                                                                                                   DO 600 \text{ IZ} = 1, IZMAX
                                                                                                                                                                                                                                                                                                                                                                                                                       NCHARS = XSIZ / .85
                                                                                                                                                                                                                                                                                                                                                                                                                                               PX2 = 0.90
                                                                                                                                                                                                                                                                                                                                                                                                                                                                 PX1 = 0.05
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               P0 = .85 / RATIO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    NCHARS = ZMAX / .85
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            PZ2 = 0.90
                                                                                                  CALL PTJOIN (RPLOT, Z, 1, IZMAX, 1)
                                                                                                                          CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 'DIRECT', RECL=LEN)
END IF
                                                        IF (RPLOT(IZ) .GT. (REAL(IX)*H + 1.E-2)) THEN
                                                                                                                                                                  RPLOT(IZ) = REAL(IX) * H + REFRES(IZ, IX) * 3. / AMPMAX
                CALL POSITN(REAL(IX)*H, Z(IZ))
CALL JOIN(RPLOT(IZ), Z(IZ))
                                                                                                                                                                                        ELSE
                                                                                                                                              ENDIF
                                                                                                                                                                                                                               IF (IX .LT. IX0 .OR. IX .GT. IXSMAX) THEN
                                                                                                                                                                                                            GO TO 1800
```

AMPMAX = ABS(REFRES(I2, IX))

```
C Now filter in vertical direction to remove artifacts \ensuremath{\mathtt{C}}
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              C JUMP TO AVOID FILTERING STAGE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              650
                                                                                                                                                                                                                                                                              680
                                                                                                                                                                                                                                                                                                                                                                                                                                                              670 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        640 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           620 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               630 CONTINUE
                                                                                              700
                                                                                                                                                                                                                                                                                                                                                                                               CALL BORDER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CALL PLOTCS (0.05, 0.5, 'DELAY TIME (millisecs) :')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CALL MAP (0.0, 1.0, 0.0, 1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  GO TO 710
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CALL PSPACE (PX1, PX2, PZ2, PZ3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DO 630 JJJ = 1, NSOR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CALL PLOTNC (RX0, RZ0, 250)
                                                                                              CONTINUE
                                                                                                                                                                                                                                                                                                                                               DO 700 \text{ IX} = 1, IXMAX
                                                                                                                                                                                                                                                                                                                                                                       CALL SCALES
                                                                                                                                                                                                                                                                                                                                                                                                                CALL MAP (0.0, XMAX, ZMAX, 0.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL PSPACE (PX1, PX2, PZ1, PZ2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 670 JJ = 1, IXMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           FLOOFF = 0.05
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   FLOWCT = 125
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        FHIOFF = FNYQ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            FNYQ = .5 / H

FHICUT = FNYQ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          N2 = 128
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               N1 = 128
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CALL GREND
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CALL PLOTNE (0.8, 0.5, DEL, 3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     DEL - DELAYT * 1.E3
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            PZ3 = PZ2 * 1.1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                RZO = REAL(IZO) * H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      RX0 = REAL(IX0) * H
                                                 DO 710 JJJ = 1, NSOR
                                                                     CALL PLOTNC (RXO, RZO, 250)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         RXZ = REAL(IZS(JJJ)) * H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             RXI = REAL (IXS (JJJ)) * H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CONTINUE
                                                                                                                                                                                                                                                                            CONTINUE
                                                                                                                                                                                                                                                                                                                      DO 680 IZ = 1, IZMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CONTINUE
RXZ = REAL(IZS(JJJ))
                                                                                                                CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DO 660 II = 1, IZMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CALL BPSCOS (ARR, N1, CX, FLOWCT, FHICUT, FLOOFF, FHIOFF, FNYQ)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        DO 650 II = 1, IZMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CALL ZERO(N1, ARR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CALL PLOTNC (RXI, RXZ, 245)
                                                                                                                                                                                                                                 DO 690 IZ = 1, IZMAX
                                                                                                                                                                                                                                                      CALL PIJOIN (RPLOT, Z, 1, IZMAX, 1)
                         RXI = REAL(IXS(JJJ))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         REFRES(II, JJ) = ARR(II)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  ARR(II) = REFRES(II, JJ)
                                                                                                                                          END IF
                                                                                                                                                                                                                                                                                                  RPLOT(IZ) = REAL(IX) + REFRES(IZ, IX) * 2. / AMPMAX
                                                                                                                                                                                                         IF (RPLOT(IZ) .GT. (REAL(IX) + 1.E-2)) THEN
                                                                                                                                                                               CALL POSITN(REAL(IX), Z(IZ))
                                                                                                                                                             CALL JOIN (RPLOT (IZ), Z(IZ))
```

## Appendix A.7

## The forward modelling program

### **EXTRAP**

The program EXTRAP is a forward modelling finite-difference program which generates synthetic seismograms for a given velocity model and source and receiver geometry. A tapered zero-phase wavelet is used as the source function and the wavefield may be plotted as it expands in time. The final seismograms recorded at the receiver positions are also plotted.

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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               THIS ZEROS ARRAY U(X, Z, T=0, 1, 2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   (10/3PI, -8/3PI)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       (21PI/64,-15PI/64)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     (1, -.5)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               (3G-2G**3,-2G) G=SIN(PI/8)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        VALUES OF PO & P2 (RENAUT&PETERSEN GEOPHYSICS 1989)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  WRITTEN BY M.J. FINDLAY 1989
                                                                                                                 HIGH CUT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       SOURCE FUNCTION IS ZERO-PHASE BUTTERWORTH WAVELET
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                ABSORBING BOUNDARY CONDITIONS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ALGORITHM TAKEN FROM MCMECHAN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   SYNTHETIC SEISMOGRAM GENERATION SUPPORTED
               WRITE (6,*)'RNL = ', RNL
                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,*)'ENTER MAXIMUM GRID VALUES IN X & Z (<128) :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CHARACTER*10 OPFILE, IPFILE, IFNAM1, IFNAM2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          PARAMETER (PI=3.14159265358, POL0=1.0, POL2=~.5)
                                           RNL = RNL / (2.*ALOG10(2.))
                                                                 WRITE (6,*)'RNL = ', RNL
                                                                                       RNL = ALOG10((2.*(10.**(BUT4/10.))) - 1.0)
                                                                                                                                   WRITE (6,*)'Enter low-cut, slope, high-cut, slope 'READ (5,*) BUT1, BUT2, BUT3, BUT4
                                                                                                                                                                                                         READ (5,*) IXO, IZO
                                                                                                                                                                                                                                                                                                                                          DT = DT * 1.E-3
                                                                                                                                                                                                                                                                                                                                                                    READ (5,*) DT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   NSAMT = NSAMS * 6
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         NSAMS = 128 * 128
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  COMPLEX CBUTT(1024)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              REAL UR4(128,128), RPLOT(1024), Z(128), BUTT(1024), BUTT2(1024),
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DOUBLE PRECISION U(128,128,3), TERM1, TERM2, TERM3, A,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IMPLICIT DOUBLE PRECISION (A - H,O -
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          PROGRAM EXTRAP
DO 10 J = 1, NT / 2 + 1
                                                                                                                                                                                 WRITE (6, *)'SOURCE IS ZERO PHASE BUTTERWORTH FNCTN '
                                                                                                                                                                                                                              WRITE (6,*)'ENTER SOURCE POSN (X, Z) GRIDPOINT NUMBERS'
                                                                                                                                                                                                                                                    DF = FNYQ / NF
                                                                                                                                                                                                                                                                            NF = NT / 2
                                                                                                                                                                                                                                                                                                    NT = 1024
                                                                                                                                                                                                                                                                                                                        FNYQ = .5 / DT
                                                                                                                                                                                                                                                                                                                                                                                          WRITE (6, *)'ENTER TIME SAMPLE INTERVAL (millisecs):'
                                                                                                                                                                                                                                                                                                                                                                                                                  READ (5, *) IXMAX,
                                                                                                                                                                                                                                                                                                                                                                                                                                                               READ (5, *) H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,*)'ENTER GRID POINT SPACING (METRES):'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CALL ZERO(NSAMT, U(1,1,1))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          INTEGER NMOV(20), IXR(40), IZR(40)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      REAL BUT1, BUT2, BUT3, BUT4, VINL(5), WIDTH(5)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      REAL SEIS(1024,40), TT(1024), AMPMAX, XMAX, ZMAX, AMPSCL, RREC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            RNL, TMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        SORSIG(1024), V(128,128)
                                                                                                                                                                                                                                                                                                                                                                                                                   IZMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CHEBYCHEV
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     PADE
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               (GEOPHYSICS V50 P627-636)
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TO ACOUSTIC WAVE EQUATION

PROGRAM TO CARRY OUT WAVEFIELD EXTRAPOLATION BY FINITE DIFFERENCE APPROXN

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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    30 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            20 CONTINUE
90 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                  70 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               60 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     50 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             40 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                         Shift origin to NTAP0+1
                                                                                                                                                                                                                                Normalise output wavelet
                                                                                                                                                                                                                                                           80 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         TRANSFORM TO TIME DOMAIN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              LOW CUT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        APPLY TAPER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 70 I = NTAP0 + 2, NT - NTAP0 - 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    DO 50 I = 1, NT
                                                                                                                                                                                                                                                                                                                                      DO 80 I = 1, NTAP0 + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    WRITE (6,*)'NTAP1,NTAP0,LTAP', NTAP1, NTAP0, LTAP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          NTAP1 = NINT(1.E0/(BUT3*DT)) * 0.75
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       DO 40 I = NT, NT / 2 + 2, -1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     DO 30 J = 1, NT / 2 + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE (6,*)'RNL = ', RNL
                                                                                                                                                                                                     CALL NORMAN (NT, BUTT2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DO 60 I = NTAP1, NTAP0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   LTAP = NTAPO - NTAP1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 20 J = 2, NT / 2 + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       BUTT2(1) = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         RNL = RNL / (2.*ALOG10(2.))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    WRITE (6,*)'RNL = ', RNL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          RNL = ALOG10((2.*(10.**(BUT2/10.))) - 1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,*)'NOW LOW CUT..
                                                                                                                                                    DO 90 I = 1, NT
                                                                                                                                                                               BMAX = 0.0
                                                                                                                                                                                                                                                                                                                                                            CALL ZERO(NT, BUTT2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     NTAPO = NINT(1.EO/(BUT3*DT)) * 1.5
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL FORK(NT, CBUTT, 1.)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                ISAM =
                                                                                                                             IF (ABS(BUTT2(I)) .GT. BMAX) THEN
                                                                                                                                                                                                                                                                                  BUTT2(I) = REAL(CBUTT(I + NT - NTAP0 - 1))
                                                                                                                                                                                                                                                                                                           BUTT2(I + NTAP0 + 1) = REAL(CBUTT(I))
                                                                                                                                                                                                                                                                                                                                                                                                                                           CBUTT(I) = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CBUTT(NT - I) = CBUTT(NT - I) * FACTOR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CBUTT(I + 1) = CBUTT(I + 1) * FACTOR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         FACTOR = REAL(NTAPO - I) / REAL(LTAP)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CBUTT(I) = CMPLX(BUTT(I),0.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        ISAM = ISAM + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              BUTT(I) = BUTT(ISAM)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          BUTT(J) = BUTT(J) * BUTT2(J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    BUTT2(J) = SQRT(TEM)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             TEM = 1. / (1. + ((BUT1/RFR)**(2.*RNL)))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    RFR = DF * REAL(J - 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           BUTT (J) - SQRT (TEM)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      TEM = 1. / (1. + ((RFR/BUT3)**(2.*RNL)))
                      SORSIG(I) = DBLE(BUTT2(I))
                                                 END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               RFR = DF * REAL(J - 1)
                                                                                                BMAX = ABS(BUTT2(I))
                                                                          INDSHF = I
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100 FORMAT (A10)
NSAMPO = 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            110
120
                                                                                                                                                                                                                                                                                                                                                                                                                                                    160
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                150
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                140
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             130
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                READ (5, *) IPSORY
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IF (IPSORY .EQ. 1) THEN "
                                                                                                                                                                                                                                                                                                                             READ (5, *) NLAYER
                                                                                                                                                                                                                                        DO 190 NL = 1, NLAYER
                                                                                                                                                                                                                                                                       VMAX = 0.0
                                                                                                                                                                                                                                                                                                                                                            WRITE (6, *)'ENTER NO. OF LAYERS :'
                                                                                                                                                                                                                                                                                                    IDEPTH = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      DO 130 \text{ JJ} = 1, 128
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              OPEN (UNIT=12, FILE=IFNAM2, FORM='FORMATTED', STATUS='OLD')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        OPEN (UNIT=11, FILE=IFNAM1, FORM='FORMATTED', STATUS='OLD')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               WRITE (6,*)'ENTER NAME OF FILE 2:'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WRITE (6, *)'ENTER NAME OF FILE 1:'
                                                                                                                                              WRITE (6,*)'ENTER VELOCITY(S) OF MEDIUM', NL, ' (m / sec)'
                                                                                                                                                                                                         WRITE (6,*)'ENTER NO. OF variations in layer :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IF (ICSANS .EQ. 1) THEN DO 160 \text{ JJ} = 1, 128
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,*)'APPLY COSINE WEIGHTING TO SOURCE WAVEFIELD 1=Y:'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DO 150 \text{ JJ} = 128 - \text{IZSHFT}, 128
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DO 140 JJ = 1, 128 - IZSHFT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CLOSE (12)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            FORMAT (8(D10.4))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 110 JJ = 1, 128
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            READ (5, *) IZSHFT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (6, *)'ENTER SHIFT IN DEPTH TO APPLY +VE ==> UP'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   READ (5, 100) IFNAM2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            READ (5, *) NSAMPO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     WRITE (6,*)'ENTER TIME SAMPLE NUMBER FOR FIRST FILE'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  READ (5,100) IFNAM1
                       WRITE (6,*)'ENTER THICKNESS OF LAYER', NL, ' (metres)'
                                                                                                                    READ (5,*) (VINL(I), I=1, NVARIA)
                                                                                                                                                                             READ (5,*) NVARIA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       READ (5, *) ICSANS
                                                        READ (5,*) (WIDTH(I), I=1, NVARIA)
                                                                                     WRITE (6,*)'ENTER WIDTHS OF FIELD(S) IN METRES :'
READ (5,*) THICK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    READ (11, 120) (U(II, JJ, 1), II=1, 128)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     DO 150 II = 1, 128
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      DO 140 II = 1, 128
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       READ (12,120) (U(II, JJ, 2), II=1,128)
                                                                                                                                                                                                                                                                                                                                                                                                                                                    CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         U(II, JJ, 2) = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          U(II,JJ,2) = U(II,JJ + IZSHFT,2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       U(II,JJ,1) = U(II,JJ + IZSHFT,1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        U(II, JJ, 1) = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 160 II = 1, 128
                                                                                                                                                                                                                                                                                                                                                                                                                                                                              U(II, JJ, 1) = U(II, JJ, 1) * FAC

U(II, JJ, 2) = U(II, JJ, 2) * FAC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          FAC = ABS(REAL(JJ - IZO)) / RLEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      IF (RLEN .EQ. 0.0) RLEN = 1.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  RLEN = SQRT(REAL((II - IX0)**2 + (JJ - IZ0)**2))
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WRITE (6, \*)'INPUT SOURCE WAVEFIELD FROM FILES 1=Y 0=N'

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                                                                                                                                                                                                                                                                                                                                                                                                 C UNIFORM VELOCITY TO START WITH
C START OF SOURCE AT T = 0
                                                                                                                                                        C NOW DEFINE INITIAL WAVEFIELD INCLUDING SOURCE TERM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           180
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           170
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       190 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                      220 FORMAT (A10)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          210 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     200 CONTINUE
                                                                                                        230 \text{ IT} = 1
                                                                                                                                                                                                                                                                                                                        H=GRID POINT SPACING
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               READ (5,*) IRAMP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE (6, *)'APPLY T-RAMP 1=Y 0=N:'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WRITE (6,*)'2nd or 4th Order finite difference approximation :'READ (5,*) NORD
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DO 210 NR = 1, NREC
WRITE (6,*)'ENTER GRID LOCATION (IX,IZ) OF RECEIVER #', NR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     WRITE (6,*)'ENTER NUMBER OF RECEIVERS TO BE SEISMOGRAMMED :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                READ (5,*) CUTO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE (6,*)'ENTER CUTOFF RATIO FOR S/N :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    READ (5,*) IYNANS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE (6,*)'INCLUDE POINT DIFFRACTOR 1=Y 0=N:'
                                                      U(IX0, IZ0, IT0 - 1) = (SORSIG(1))
                                                                                                                                                                                                                                        CALL ZERO(KB40, SEIS(1,1))
                                                                                                                                                                                                                                                                    KB40 = 1024 * 40
                                                                                                                                                                                                                                                                                                                                                                                                                                                                      READ (5,220) OPFILE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              READ (5,*) NREC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     DO 200 NM = 1, NMOVIE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE (6,*)'ENTER NUMBER OF DIFFERENT MOVIE FRAMES REQUIRED'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF (IYNANS .EQ. 1) THEN
                                                                               WRITE (7, *) IT, SORSIG(IT)
                                                                                                                                                                                                               IF (IPSORY .EQ. 1) GO TO 250
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE (6,*)'Enter name of file for seismogram output :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                READ (5,*) NMOVIE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         V(IX, IZ) = VPOINT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  READ (5,*) IX, IZ, VPOINT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           WRITE (6,*)'ENTER IX, IZ, VEL(IX, IZ)'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DO 180 I = 1, NVARIA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        NTHICK - NINT (THICK/H)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              READ (5,*) IXR(NR), IZR(NR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     READ (5, *) NMOV(NM)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6, *)'ENTER SAMPLE TIME #', NM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IXF = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            NMOV(NM) = NMOV(NM) + NTAPO + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IDEPTH = IDEPTH + NTHICK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IXE - IXL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DO 170 IZ = 1, NTHICK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      IF (VL .GT. VMAX) VMAX = VL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               VL - VINL(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IXL - WIDTH(I) / H + IXF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DO 170 IX = IXF, IXL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                V(IX,IZ + IDEPTH) = VL
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240 END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     250 NPLOT = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 START LOOP OVER ALL TIME SAMPLES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               INCLUDE FREE SURFACE BY MAKING U(IX, Z=0) = 0.0 ????
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             2 -
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       Ħ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         A = (V(IX0, IZ0) * DT/H)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DO 410 IT = NSAMPO, NMOV(NMOVIE)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 (DT .GE. H/(SQRT(2.)*V(IX0, IZ0))) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE (6, *)'DT, H, V = '., DT, H, V(IXO, IZO)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DO 270 IZ = 2, IZMAX - 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 TIMEIT = (IT - 1) * DT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE (6,*)'TIME SAMPLE : ', IT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           WRITE (6, *)'ALGORITHM UNSTABLE'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       8
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 270 \text{ IX} = 2, \text{IXMAX} - 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     ELSE
                                                                                                                                                                                                                                                       U(IX,IZ,IT0) = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IF (NORD .EQ. 2 .OR. IX .EQ. 2 .OR. IZ .LE. 1 .OR.
IX .EQ. IXMAX - 1 .OR. IZ .EQ. IZMAX - 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               A = (V(IX, IZ) * DT/H)
                                                                                                                                                                                                                               DO 260 NR = 1, NREC
                                                                                                                                                                                                                                                                                                     END IF
                                                                                                                                                                                                                                                                             IF (ABS(U(IX, IZ, ITO)) *TIMEIT .LT. AO*TREF/CUTO
                                                                                   IF (IX .EQ. IXO .AND. IZ .EQ. IZO
                                                                                                               END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   TERM2 = U(IX + 1, IZ, IT0 - 1) + U(IX, IZ + 1, IT0 -
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         U(IX, IZ, IT0) = TERM1 - TERM2 + TERM3
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             TERM2 = U(IX, IZ, IT0 - 2)
END
                                                                                                                                                                                                           IF (IX .EQ. IXR(NR) .AND. IZ
                                                                                                                                                                                                                                                                                                                         U(IX,IZ,IT0) = ALPHA - U(IX,IZ,IT0 - 2)
                                                                                                                                                                                                                                                                                                                                                                                               ALPHA = TERM1 + A ** 2 * (16*TERM2 - TERM3) / 12.
                                                                                                                                                                                                                                                                                                                                                                                                                     END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                               IF (IZ .GT. 2) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       1) + U(IX - 2, IZ, ITO - 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           TERM1 = (2. - 5.*A**2) * U(IX, IZ, IT0 - 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 TERM3 = TERM3 * A ** 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IF (IZ .GT. 1) TERM3 = TERM3 + U(IX,IZ - 1,IT0 -
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 1) + U(IX,IZ + 1,ITO - 1)
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   TERM1 = 2 * (1 - 2*A**2) * U(IX, IZ, ITO - 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             TERM3 = U(IX + 2, IZ, IT0 - 1) + U(IX, IZ + 2, IT0 -
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IF (IZ .GT. 1) TERM2 = TERM2 + U(IX,IZ - 1,IT0 -
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               1) + U(IX - 1, IZ, ITO - 1)
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                     SEIS(IT, 1) = REAL(SORSIG(IT))
                                         U(IX,IZ,IT0) = SORSIG(IT)
                                                                                                                                     NR) = REAL(U(IX, IZ, IT0))
                                                                                                                                                           IF (IT .GT. (NTAPO + 1)) SEIS(IT - NTAPO - 1,
                                                                                                                                                                                                                                                                                                                                                                                                                                         TERM3 = TERM3 + U(IX, IZ - 2, IT0 - 1)
                                                                                                                                                                                                                                                                                                                                                 ALPHA = TERM1 + A**2 * (4.*TERM2 + TERM3) /6.
                                                                 NTAPO + 3) THEN
                                                                                                                                                                                     THEN
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EQ.
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                                                                                                                                                                                                              IX + 1, IZ, IT0 - 2) + U(IX - 1, IZ, IT0 - 2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                               TERM1 = TERM1 * 2.0 * POL0
TERM2 = U(IX, IZ - 1, IT0) + U(IX, IZ, IT0 - 2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         TERM3 = U(IX, IZ + 1, IT0 - 2) + U(IX, IZ - 1, IT0 -
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          TERM1 = TERM1 * 2.0 * POL0
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U(IX,IZ,IT0) = UINIT - U(IX,IZ - 1,IT0 - 2)
                                                                  UINIT = (TERM1 + TERM2 + TERM3) / (A + POL0)
                                                                                                                                            TERM3 = -TERM3 * A ** 2 * POL2
                                                                                                                                                                                                                                                                                                     TERM3 = U(IX + 1, IZ - 1, ITO) + U(IX - 1, IZ - 1,
                                                                                                                                                                                                                                                                                                                                                                                     TERM2 = TERM2 * (A - POL0 + 2.*POL2*A**2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 TERM1 = U(IX, IZ, ITO - 1) + U(IX, IZ - 1, ITO -
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        A = V(IX, I2) * DT / H
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          NOW RHS
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                                                U(IX,IZ,IT0) = (TERM1 + TERM2) / (2./H + SQRT(2.)/(VDASH*DT))
                                                                                                                 TERM2 = (U(IX,IZ,IT0 - 1)) * SQRT(2.) / (VDASH*DT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          TERM1 = (U(IX, IZ + 1, IT0) + U(IX - 1, IZ, IT0)) / H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   U(IX, IZ, ITO) = (TERM1 + TERM2) / (2./H + SQRT(2.)/(VDASH*DT))
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     TERM1 = (U(IX, IZ - 1, IT0) + U(IX - 1, IZ, IT0)) / H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             U(IX,IZ,IT0) = (TERM1 + TERM2) / (2./H + SQRT(2.)/(VDASH*DT))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   TERM1 = (U(IX, IZ - 1, IT0) + U(IX - 1, IZ, IT0)) / H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    VDASH = V(IX, IZ)
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 TERM2 = (U(IX,IZ;IT0 - 1)) * SQRT(2.) / (VDASH*DT)
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       VDASH = V(IX, IZ)
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IF (ABS(U(IX,IZ,ITO))*TIMEIT .LT. AO*TREF/CUTO) U(IX,IZ,ITO) =
                                                                                                                                                                                      TERM1 = (U(IX, IZ + 1, IT0) + U(IX - 1, IZ, IT0)) / H
                                                                                                                                                                                                                                                            VDASH = V(IX, IZ)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    U(IX, IZ, IT0) = (TERM1 + TERM2) / (2./H + SQRT(2.)/(VDASH*DT))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    TERM2 = (U(IX, IZ, IT0 - 1)) * SQRT(2.) / (VDASH*DT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                VDASH = V(IX, IZ)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 IZ = 1
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 TERM1 = U(IX, IZ, IT0 - 1) + U(IX - 1, IZ, IT0 - 1)
TERM1 = TERM1 * 2.0 * POL0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            U(IX, IZ, IT0) = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   UINIT = (TERM1 + TERM2 + TERM3) / (POL0 + A)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    IX - 1, IZ + 1, ITO) + U(IX - 1, IZ - 1, ITO)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          TERM3 = U(IX, IZ + 1, IT0 - 2) + U(IX, IZ - 
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      TERM2 = U(IX - 1, IZ, IT0) + U(IX, IZ, IT0 - 2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  A = V(IX, IZ) * DT / H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   U(IX,IZ,IT0) = UINIT - U(IX - 1,IZ,IT0 - 2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           TERM2 = TERM2 * (A - POL0 + 2.*POL2*A**2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IF (ABS(U(IX, IZ, ITO)) *TIMEIT .LT. A0*TREF/CUTO)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               TERM3 = -TERM3 * A ** 2 * POL2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              IX = IXMAX
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                                                                    MAKE
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                                                                  THIS LINE THE LAST STEP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         TERM1 = (U(IX,IZ + 1,IT0) + U(IX - 1,IZ,IT0)) / H
TERM2 = (U(IX,IZ,IT0 - 1)) * SQRT(2.) / (VDASH*DT)
                                                                                                                                                                                                                                                                                                                                                                                                                            TERM1 = (U(IX, IZ + 1, IT0) + U(IX + 1, IZ, IT0)) / H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 TERM1 = (U(IX, IZ - 1, ITO) + U(IX + 1, IZ, ITO)) / H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                U(IX,IZ,IT0) = (TERM1 + TERM2) / (2./H + SQRT(2.)/(VDASH*DT))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    TERM1 = (U(IX,IZ - 1,IT0) + U(IX + 1,IZ,IT0)) / H
TERM2 = (U(IX,IZ,IT0 - 1)) * SQRT(2.) / (VDASH*DT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              VDASH = V(IX, IZ)
 8
                                                                                                                                IX =
                                                                                                                                                                                                                                                                   TERM1 = (U(IX,IZ + 1,IT0) + U(IX + 1,IZ,IT0)) / H

TERM2 = (U(IX,IZ,IT0 - 1)) * SQRT(2.) / (VDASH*DT)
                                                                                                                                                                                                                                                                                                                                                                                   U(IX,IZ,IT0) = (TERM1 + TERM2) / (2./H + SQRT(2.)/(VDASH*DT))
                                                                                                                                                                                                                                                                                                                                                                                                        TERM2 = (U(IX,IZ,IT0 - 1)) * SQRT(2.) / (VDASH*DT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                     VDASH = V(IX, IZ)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            TERM2 = (U(IX,IZ,ITO - 1)) * SQRT(2.) / (VDASH*DT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        VDASH = V(IX, IZ)
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         VDASH = V(IX, IZ)
                       WRITE (7,*) IT, SORSIG(IT)
                                                                                                                                                                                                                                                  U(IX, IZ, IT0) = (TERM1 + TERM2) / (2./H + SQRT(2.)/(VDASH*DT))
                                                                                                                                                                                                                                                                                                                  VDASH = V(IX, IZ)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        U(IX, IZ, ITO) = (TERM1 + TERM2) / (2./H + SQRT(2.)/(VDASH*DT))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IZ = IZMAX
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                                                                                                             U(IX, IZ, IT0) = (TERM1 + TERM2) / (2./H + SQRT(2.)/(VDASH*DT))
                                                                                                                                                                               VDASH = V(IX, IZ)
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         NOW GET GRAPHICAL OUTPUT OF U(IX, IZ, ITEND)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WRITE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    END IF
IF (IT .EQ. NMOV(NPLOT)) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IF (IT .GE. NMOV(NMOVIE) - 1) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 OUT U(IX, IZ, ITEND-1) & U(IX, IZ, ITEND) TO FILE ATTACHED TO
                                                                                                                                                                                                                                                                                                                                                                                                                                                        CALL PSPACE(0.05, 0.90, 0.05, 0.90)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CALL PLOTNI(0.7, 0.6, INDEX)
CALL PCSCEN(0.5, 0.4, 'SCALE')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CALL PSPACE(0.91, 0.99, 0.65, 0.90)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    DO 350 J = 1, 128
                                                                                                                                                                                                                                                                                                        DO 400 IX = 1, IXMAX
                                                                                                                                                                                                                                                                                                                               CONTINUE
                                                                                                                                                                                                                                                                                                                                                                    DO 370 II = 1, IZMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL MAP (0.0, XMAX, ZMAX, 0.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL PLOTNE (0.7, 0.3, RSCALE, 2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CALL PCSCEN(0.5, 0.8, 'Time')
CALL PCSCEN(0.5, 0.7, 'Index')
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CALL CTRMAG(15)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CALL BORDER !
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL MAP (0.0, 1.0, 0.0, 1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DO 360 I = 1, IXMAX
                                                                                                                                                                                                                                                                                                                                                                                            CALL SCALES
                                                                                                                                                                                                                                                                                                                                                                                                               CALL BORDER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            RSCALE = (1.0/AMPMAX)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CALL PAPER(1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   AMPMAX = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            INDEX = IT - NTAPO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (AMPMAX .EQ. 0.0) AMPMAX = 1.0
                                                                                                                                                                                                                                                                                                                                                Z(II) = REAL(II)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   DO 360 J = 1, IZMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               WRITE (13, 120) (U(I, J, ITO - 1), I=1, 128)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  U(I,J,IT0 - 2) = U(I,J,IT0 - 1)

U(I,J,IT0 - 1) = U(I,J,IT0)
                                                                                    DO 390 IZ = 1, IZMAX
                                                                                                        CALL PTJOIN (RPLOT, Z, 1, IZMAX, 1)
                                                                                                                                CONTINUE
                                                                                                                                                                                                                                                                                DO 380 IZ = 1, IZMAX
                                                         IF (RPLOT(IZ) .GT. (REAL(IX) + 1.E-2))
                                                                                                                                                                                                                                                        IF (UR4(IZ, IX) .LT. 0.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IF (ABS(UR4(J,I)) .GT. AMPMAX) AMPMAX = ABS(UR4(J,I))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  UR4(J,I) = REAL(U(I,J,IT0 - 1))
                                                                                                                                                   RPLOT(IZ) = REAL(IX) + AMPPL * 2. / SQRT(AMPMAX)
                                                                                                                                                                           END IF
                                                                                                                                                                                                                                       AMPPL = -1.0 * SQRT(-UR4(IZ, IX))
                CALL POSITN(REAL(IX), Z(IZ))
                                                                                                                                                                                              AMPPL = SQRT(UR4(IZ, IX))
CALL JOIN (RPLOT (IZ), Z(IZ))
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                                                                                                                                                                                                                                                                                                                                                                     440
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    410 CONTINUE
                                                                                                                                                                                                         460
                                                                                                                                                                                                                                                                                                                                           450 CONTINUE
                     480 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         430 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    420 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 NOW PLOT OUT SEISMOGRAMS IN SEIS (1024, 40)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE OUT SEIS(1024,40) TO FILE OPFILE
                                                                                                                                                                                                                                                                                            IF (AMPSCL .EQ. 0.0) AMPSCL = 1.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL MAP (0, RREC, TMAX, 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE (2, REC=IDSHOT) (SEIS(I, 1), I=1, 1024)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  OPEN (2, FILE-OPFILE, STATUS-'UNKNOWN', FORM-'UNFORMATTED', ACCESS-
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    WRITE (6,*)'Enter shot number to be saved in file:'
CALL GREND
                                                                                                                                                                                                                                                                          DO 480 NR = 1, NREC
                                                                                                                                                                                                                                                                                                                      AMPSCL = AMPSCL * 1.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DO 450 NR = 1, NREC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DO 430 II = 1, IT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CALL SCALES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CALL BORDER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          TMAX = REAL(IT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                RREC = REAL(NREC) + 1.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CALL PSPACE (0.1, 0.9, 0.1, 0.9)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CLOSE (2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     DO 420 J = 1, NREC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IDSHOT = (NSHOT - 1) * (NREC + 1) + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  READ (5,*) NSHOT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             LEN = 4104
                                                                                                                                                                                                       CONTINUE
                                                                                                                                                                                                                                               DO 460 NT = 1, IT
                                                                                                                                                                                                                                                                                                                                                                   CONTINUE
                                           CONTINUE
                                                                                                                                                                           CALL PIJOIN(RPLOT, TT, 1, IT, 1)
                                                                                                                                                                                                                                                                                                                                                                                                                              DO 440 NT = 1, IT
IF (IRAMP .EQ. 1) SEIS(NT,NR) = SEIS(NT,NR) * TT(NT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               NIDC = IDSHOT + J
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          END IF
                                                                                                                                                          DO 470 NT = 1, IT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           TT(II) = REAL(II)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE (2, REC=NIDC) (SEIS(I, J), I=1, 1024)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 'DIRECT', RECL-LEN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CALL FRAME
                                                                                                                                                                                                                           RPLOT(NT) = REAL(NR) + SEIS(NT, NR) / AMPSCI
                                                                     END IF
                                                                                                                                IF (RPLOT(NT) .LT. (REAL(NR) - 1.E-2)) THEN
                                                                                                                                                                                                                                                                                                                                                                                                         IF (ABS(SEIS(NT,NR)) .GT. AMPSCL) AMPSCL = ABS(SEIS(NT,NR)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                NPLOT = NPLOT + 1
                                                                                                          CALL POSITN(REAL(NR), TT(NT))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CONTINUE
                                                                                        CALL JOIN (RPLOT (NT), TT (NT))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     END IF
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## Appendix A.8

## The migration program

#### **KIRCHMIG**

The program KIRCHMIG carries out Kirchhoff-type migrations by raytracing from each image point to each source and receiver using the subroutine RAYTRA (appendix A.5). The image time calculated for each source receiver pairing is then used to extract the contribution to the image from the appropriate sample in the seismic data. The migrated image is then output to a file for later viewing. The program include several processing options such as the choice of migration operator and the range of reflector dips allowed.

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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        dip range
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              raytracing algorithm
                                                            20 CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          Needs subroutine RAYTRA for raytracing
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Options of different diffraction stacks: Diffraction stack,
                  SET UP RAYTRACING PARAMETERS
                                                                                                                                                                                                                                                                       SET UP VELOCITY MODEL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        VV(ilay) = vertical velocity in layer ilay
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            VH(ilay) = horizontal velocity in layer ilay
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                DEPTH(ilay) = depth to top of layer ilay
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          Allows general sourceareceiver positions
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             VERSION 4.0 WITH FASTER RAYTRACING CODE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CSG(itime, irec, isor) = recorded data
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  (XREC(irec), ZREC(irec)) = coordinates of receiver irec
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    (XSOR(isor), ZSOR(isor)) = coordinates of source isor
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IMAGE(idepth,ioffset) = IMAGED reflectivity at (idepth,ioffset)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Selective raypath muting for shallow-dipping rays, and geological
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             Program to do Kirchhoff migration using RAYTRA anisotropic
                                                                                                                                                                                                                                                                                                                                                           CONTINUE
                                                                                                                                             B
                                                                                                                                                                                    NDEPTH = NLAMAX + 1
                                                                                                                                                                DEPTH(1) = 0.0
                                                                                                                                                                                                        READ (5,*) NLAMAX
                                                                                                                                                                                                                            WRITE (6, *)'ENTER NO. OF LAYERS
                                                                                                                                                                                                                                                                                                                 CALL ZERO(NIMAGE, IMAGE)
                                                                                                                                                                                                                                                                                                                                     NIMAGE = NIMAGZ * NIMAGX
                                                                                                                                                                                                                                                                                                                                                                                                 DO 10 I = 1, 256
                                                                                                                                                                                                                                                                                                                                                                                                                       PI2 = PI / 2.
                                                                                                                                                                                                                                                                                                                                                                                                                                             PI = 3.1415926535
                                                                                                                                                                                                                                                                                                                                                                                                                                                              CHARACTER*1 A(256)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            REAL DEPTH(31), VH(31), VV(31), XSOR(100), ZSOR(100)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    PARAMETER (NSM=512, NSOR1=27, NREC1=24, NIMAGZ=200, NIMAGX=128)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             PROGRAM KIRCH
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CHARACTER*17 FNAME
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       COMPLEX CX(NSM), CO,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             REAL ANG1 (NREC1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         REAL IMAGE (NIMAGZ, NIMAGX)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            REAL XREC(NREC1), ZREC(NREC1), CSG(NSM, NREC1, NSOR1)
                                                                                                                                            20 J = 1, NLAMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    subroutine library TSAR4_L (Time series analysis -- Robinson,
                                                                              DEPTH(J + 1) = THICK + DEPTH(J)
                                                                                                                WRITE (6,*)'Enter VH, VV, Thickness (S.I.) for layer', J
                                                                                                                                                                                                                                                                                                                                                                               A(I) = '\theta'
                                                                                                    READ (5,*) VH(J), VV(J), THICK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                TAUS (NSOR1), TAUR (NREC1), ANGS (NSOR1), ANGG (NREC1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 ANGO (NSOR1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         Ω
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Kirchhoff,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    Claerbout et al.)
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                                                                                                                    50 FORMAT (A17)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      30
                                                                                                                                                                                                                                              READ IN DATA FILE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      APRMUT is also used as stacking angle cut-off
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               SET UP SOURCE AND RECEIVER COORDINATES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    15=CDP gath'
                                                                                  WRITE (6,*)'UP (1) or DOWN (0) -going wavefield :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE (6,*)'Apply Newman amplitude-phase correction (1=Y) ?'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                             WRITE (6,*)'ENTER DIPS OF SOURCE AND RECEIVER ARRAYS IN DEGREES :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                             WRITE (6, *)'ENTER stacking cutoff :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          READ (5, *) IMIGTY
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 WRITE (6,*)'ENTER Migration type 1=Kir stack, 2=Kir int, 3=GK, 4=GRT,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 THEIMU = THEIMU * PI / 180.
APRMUT = .5 * APRMUT * PI / 180.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6,*)'Enter aperture, taper, raymute, apemute in degrees :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DO 30 J = 1, NSOR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 NX = INT((XMAX - XMIN)/DXGRID) + 1
                                                                                                                                                                              WRITE (6,*)'Enter name of datafile to migrate : '
                                                                                                                                                                                                                                                                                                                                   DIPS = DIPS * PI / 180.
                                                                                                                                                                                                                                                                                                                                                                                                                                  READ (5, *) STKOFF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IF (IMIGTY .EQ. 5) NX = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              APRTAP = APRTAP * PI / 180.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           APRANG = .5 * APRANG * PI / 180.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   READ (5,*) APRANG, APRTAP, THETMU, APRMUT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   READ (5, *) NEWMAN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     DSS = SQRT((ZSOR(2) - ZSOR(1))**2 + (XREC(2) - XREC(1))**2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 40 J = 1, NREC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6,*)'Enter no. of receiver positions :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        READ (5,*) NSOR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                WRITE (6,*)'Enter no. of source positions :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          NZ = INT (DEPTH (NDEPTH) /DZGRID) - 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            READ (5,*) XIMO, XIM1, ZIMO, ZIM1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            WRITE (6,*)'Enter Imaging grid area (X0,X1,Z0,Z1) :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE (6,*)'ENTER MINIMUM AND MAXIMUM X-VALUES :'
                                                          READ (5,*) IUP
                                                                                                                                                    READ (5,50) FNAME
                                                                                                                                                                                                                                                                                                                                                                   READ (5,*) DIPS, DIPR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IF (NSOR .EQ. 1) DSS = 1.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF (NREC .EQ. 1) DSG = 1.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DSG = SQRT((ZREC(2) - ZREC(1))**2 + (XREC(2) - XREC(1))**2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            READ (5, *) NREC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              READ (5,*) XMIN, XMAX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      READ (5,*) DXGRID, DZGRID
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,*)'ENTER GRID POINT SPACINGS
                          IF (FNAME .EQ. 'DUMMY') THEN
                                                                                                                                                                                                                                                                                                        DIPR = DIPR * PI / 180
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   READ (5, *) MAXLOP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE (6,*)'Enter no. of angles to try for each raypath :
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           READ (5, *) ACC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE (6,*)'ENTER RAYTRACING ACCURACY IN METRES :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        READ (5,*) XSOR(J), ZSOR(J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            READ (5,*) XREC(J), ZREC(J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         WRITE (6,*)'ENTER COORDINATES OF RECEIVER',
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           WRITE (6,*)'ENTER COORDINATES OF SOURCE', J, ':'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   (DX, DZ) :'
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70
NOW APPLY 1/2-DIFFERENTIAL OPERATOR IF NEEDED
                                                                                                                                                                                                                                        90
                                                                                                                                                                      NOW EQUATE RMS ENERGIES OF CSG
                                                                                                                                                                                                                                                                                                                                                                     CORRECT DATA FROM 3-D TO 2D
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       1: (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          READ (5,*) XDIF, ZDIF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          WRITE (6,*)'Enter spreading correction (power of T) to apply:'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      DO 70 K = 1, NSOR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DO 160 J = 1, NSOR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   OPEN (10, FILE=FNAME, STATUS='OLD', ACCESS='DIRECT', FORM=
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        READ (5, *) TPOWER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 READ (5,*) IDSHOT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        WRITE (6,*)'Entef I.D. of first common shot gather to migrate
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             LEN = 4 * (NSAMR + 2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     DT = DT * 1.E-3
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          READ (5, *) DT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             WRITE (6,*)'Enter sampling interval in millisecs :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (6,*)'Enter no. of samples per trace & NO. NEEDED
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             WRITE (6,*)'Enter coordinates of diffracting point :'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 READ (5,*) NSAMR, NSAMO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DT = .5E-3
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          NSAMR = 256
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               JREC = (NREC + 1) * (J - 2 + IDSHOT) + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      DO 60 J = 1, NREC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CALL ZERO(K24, CSG(1,1,K))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   K24 = NSM * NREC
                                                                                                                             DO 110 K = 1, NREC
                                                                                                                                                                                                                                      CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                         DO 90 K = 1, NREC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                              RMS = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE (6,*)'READING SHOT ...', J
                                                                                                                                                                                                               RMS = SQRT(RMS/REAL(NSAMO*NREC))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                'UNFORMATTED', RECL=LEN)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             NIMAG = INT(TIMAG/DT) + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          TIMAG = TO + T1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            T1 = D1 / VV(1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               D1 = SQRT((XREC(J) - XDIF)**2 + (ZREC(J) - ZDIF)**2)
                                                                                                        DO 100 I = 1, NSAMO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CSG(NIMAG, J, K) = AMP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   AMP = 1.0 / SQRT(TIMAG)
                                                             CONTINUE
                                                                                                                                                                                                                                                            CONTINUE
                                                                                                                                                                                                                                                                                                                          DO 80 I = 1, NSAMO
                                                                                                                                                                                                                                                                                                                                                                                                              READ (10, REC=KREC) (CSG(I, K, J), I=1, NSAMO)
                                                                                                                                                                                                                                                                                                                                                                                                                                   KREC = JREC + K
                                                                                                                                                                                                                                                                           RMS = RMS + CSG(I, K, J) ** 2
                                                                                CSG(I,K,J) = CSG(I,K,J) / RMS
                                                                                                                                                                                                                                                                                                  CSG(I,K,J) = CSG(I,K,J) * (REAL(I)) ** TPOWER
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INVERSE IMPULSE RESPONSE

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.DATA NOW IN ARRAY CSG(time, receiver, source)
C
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     C INVERSE FFT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             130
                                                                                                                                                                                                                                                                                                                                                                                                                                                     140
150
                                                                                                                                                                                                                                                                                                                                                                                                                  160
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              FORWARD FFT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            Subtract PI/4 from PHASE AND MULTIPLY CX BY OMEGA**.5 RAMP
                                                                                                                                                                           LOOP OVER EACH IMAGE POINT DEPTH
                                        TOOP
                                                                                                                                                                                                                                                                          NTOT = NX * NZ
                                                                                                                                      DO 220 JJ = 1, NZ
                                                                                                                                                                                                                                                       LRATOT = 0
                                                                                                                                                                                                                                                                                              NTRIES = MAXLOP
                                                                                                                                                                                                                                                                                                                                                                           END IF
                                                                                                                                                                                                                                   LOST = 0
                                                                                                                                                                                                                  IFOUND = 0
                                     OVER EACH IMAGE POINT HORIZONTALLY
                                                                        WRITE (6,*)'Migrating depth', ZSTART,'....
                                                                                         ZSTART = JJ * DZGRID OR. ZSTART .GT. ZIM1) GO TO 220
                                                                                                                                                                                                                                                                                                                                                                                          CLOSE (10)
                                                                                                                                                                                                                                                                                                                                                                                                                  CONTINUE
DO 210 II = 1, NX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (NEWMAN .EQ. 1) THEN FNYQ = .5 / DT
                                                                                                                                                                                                                                                                                                                                                                                                                                   END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DO 150 K = 1, NREC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DF = FNYQ / REAL (NSAMO/2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                       CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DO 120 I = 1, NSAMO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 140 I = 1, NSAMO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     DO 130 I = 2, NSAMO / 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CX(NSAM0/2 + 1) = CX(NSAM0/2 + 1) * C0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    C0 = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   C0 = SQRT(REAL(NSAM0/2)) * (1.,-1.)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CX(1) = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CALL FORK (NSAMO, CX, -1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CALL FORK (NSAMO, CX, +1.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              FI = DF * (I - 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CSG(I,K,J) = CX(I)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IF (FI .GT. 3*FNYQ/4.) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      CX(I) = CSG(I,K,J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CX(NSAMO + 2 - I) = CONJG(CX(I))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               C1 = SQRT(REAL(I - 1)) * (1.,-1.)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CX(I) = CX(I) * C1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     C1 = SQRT(REAL(NSAMO)*3./8.) * (1.,-1.)
C1 = C1 * 4. * (FNYQ - FI) / FNYQ
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XSTART = (II - 1) * DXGRID + XMIN
NMUTE = 0
IF (IMAGTY .EQ. 5) XSTART = XIM0
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000 C O 00000 0 0 0 იი a ററ 170 CHECK FOR DOWNGOING WAVEFIELD CHECK FOR UPGOING WAVEFIELD PUT TIMES INTO ARRAY TAUS(nsor), ANGLES into ANGO, ANGS COMMON DEPTH POINT GATHER . NOW RAY trace to receivers RAY NOT FOUND NOW RAY TRACE TO SOURCE FROM IMAGE POINT LOOP OVER EACH SOURCE POINT CHECK FOR UPGOING WAVEFIELD 2 1 CALL ZERO(NSOR, ANGS) CALL ZERO (NSOR, TAUS) STACK = 0.0 IF (XSTART .LT. XIMO .OR. XSTART .GT. XIM1) GO TO 210 CALL ZERO (NREC, ANG1) DO 170 KK = 1, NSOR CALL ZERO (NREC, TAUR) CALL ZERO (NREC, ANGG) CONTINUE DO 180 LL = 1, NREC THETAP = 9.9WRITE (7,\*)'Source position not found' END IF ZEND = ZSOR(KK)

IF (IUP .EQ. 1) THEN XEND = XSOR(KK) IF (IUP .EQ. 1) THEN ZEND = ZREC(LL)XEND = XREC(LL) IFOUND = IFOUND + 1 ANGS (KK) = THETAS ANGO(KK) = THETAO TAUS(KK) = TAU0 END IF IF (NRAY .EQ. NTRIES) THEN CALL RAYTRA (NLAMAX, NDEPTH, DEPTH, VH, VV, XSTART, TAU0 = 0.0ELSE THETAP = 9.9 WRITE (7,\*)'XSTART,ZSTART = ', XSTART, ZSTART WRITE (7,\*)'XEND,ZEND = ', XEND, ZEND IF (ZSTART + 0.0 .GT. ZEND) GO TO 170 GO TO 170 LOST = LOST + NREC IF (ZSTART - 0.0 IF (ZSTART - 0.0 .LT. ZEND) GO TO 180 ZSTART, XEND, ZEND, DZGRID, THETAO, TAUO, THETAS, NRAY) ZEND, DZGRID, ACC, NTRIES, THETAP, .LT. ZEND) GO TO 170

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                                                                                                                                                                                                                                                                  a
                                                                                                                                                                                                                                                                                     0.0
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                                                                                                                                                                                                                                                                                                                                                                                                                                C CHECK FOR UPGOING WAVEFIELD
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          LOOP FOR EACH SOURCE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CHECK FOR DOWNGOING WAVEFIELD
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              RAY NOT FOUND
                                                                                                                                                                                                                                                                                                                                                             CHECK FOR DOWNGOING WAVEFIELD
                                                                                                                                                                                                                                                                                       LOOP FOR EACH RECEIVER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 200 KK ≈ 1, NSOR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              WRITE (6,*)'Receiver position not found '
WRITE (7,*)'XSTART,ZSTART = ', XSTART, ZSTART
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CALL RAYTRA (NLAMAX, NDEPTH, DEPTH, VH, VV, XSTART,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  ZEND = ZSOR(KK)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IF (THETAO - PI2 .GT. THETMU) GO TO 200 ELSE IF (THETAO .GT. 0.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              THETAO = ANGO (KK)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ANGG(LL) = THETAG
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ANG1 (LL) - THETA1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               TAUR(LL) = TAU1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (NRAY .EQ. NTRIES) THEN
                                                                                                                                                                                                                                                                                                                                                                                                          ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ELSE IF (THETAO .GT. PI2) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       THETAS = ANGS (KK)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              IFOUND = IFOUND + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      END IF
                                                                                                                                                                                                                                          DO 190 LL = 1, NREC
                                                                                                                                                                                                                                                                                                                                      END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IF (IUP .EQ. 1) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             XEND = XSOR(KK)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IF (THETAO .GT. PI) THEN

IF (3.*PI2 - THETAO .GT. THETMU) GO TO 200
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              IF (TAU0 .EQ. 0.0) GO TO 200
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    TAU0 = TAUS(KK)
                                                                                                                                                                                                                                                                                                                                                                                 IF (ZSTART .GT. ZEND) GO TO 200
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      WRITE (7,*)'XEND, ZEND = ', XEND, ZEND
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IF (ZSTART + 0.0 .GT. ZEND) GO TO 180
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IF (PI2 + THETAO .GT. THETMU) GO TO 200
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   IF (PI2 - THETAO .GT. THETMU) GO TO 200
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             GO TO 180
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     LOST - LOST + 1
                                                                                                                                                                    THETAG = ANGG(LL
                                                                                                                                                                                      THETA1 = ANG1(LL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                     IF (ZSTART .LT. ZEND) GO TO 200
ELSE IF (THETA1 .GT. 0.0) THEN
                                               ELSE IF (THETA1 .GT. PI2) THEN
                                                                                                                                           THETAL - THETAG
                                                                                                                                                                                                                 TAU1 = TAUR(LL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ZSTART, XEND, 2END, D2GRID, ACC, NTRIES, THETAP, THETA1, TAU1, THETAG, NRAY)
                                                                                            IF (THETA1 .GT. PI) THEN
IF (3.*PI2 - THETA1 .GT. THETMU)
                        IF (THETA1 - PI2 .GT. THETMU) GO TO 190
                                                                       GO TO 190
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CHECK FOR UPGOING WAVEFIELD
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CHECK FOR DOWNGOING WAVEFIELD
                                                                           KIRCHHOFF DIFFRACTION STACK
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                Check to see if ray within imaging aperture
                                                                                                                                                                     Source and receiver found so image appropriate travel time
                  ь
                                                                                          NT = INT(TTOT/DT) + 1
IF (IMIGTY .EQ. 1) THEN
                                                                                                                                                                                                            XIANG = ABS(XIANG + PI2)
END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (IUP .EQ. 1) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ZEND = ZREC(LL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IF (TAU1 -. EQ. 0.0) GO TO 190
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               END IF
                                                                                                                                                                                                                                                                                                                                                                                                          ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 ELSE IF (XIANG .GT. 0.0) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IF (XIANG .GT. PI) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             XIANG = (THETA0 + THETA1) / 2.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        XEND = XREC(LL)
                                   ELSE IF (IMIGTY .EQ. 2 .OR. IMIGTY .EQ.
                                                                                                                                  TTOT = TAU0 + TAU1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ELSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (PI2 + THETA1 .GT. THETMU) GO TO 190
                                                       FAC = 1.0
                                                                                                                                                                                                                                                                                                                                                                                                                          XIANG = ABS (XIANG - PI2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IF (ABS(XIANG - PI2) .GT. APRANG)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IF (ABS(XIANG - 3.*PI2) .GT. APRANG)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          IF (ZSTART .GT. ZEND)
                                                                                                                                                                                                                                                                                                                                                                                     IF (ABS(XIANG + PI2) .GT. APRANG)
                                                                                                                                                                                                                                                                                                                                                                                                                                              END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   XIANG = ABS(XIANG - 3.*PI2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 IF (ZSTART .LT. ZEND) GO TO 190
                                                                                                                                                                                                                                                  END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               GO TO 190
                                                                                                                                                                                                                                                                 NMUTE = NMUTE + 1
                                                                                                                                                                                                                                                                                                                                           WRITE (6, *) 'XIANG OUT OF RANGE'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (ABS(XIANG - PI2) .LT. APRMUT)
NMUTE = NMUTE + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       WRITE(6,*) 'XIANG OUT OF RANGE'
GO TO 190
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      NMUTE = NMUTE + 1
                                                                                                                                                                                                                                                                                       IF (ABS(XIANG + PI2) .LT. APRMUT)
                                                                                                                                                                                                                                                                                                                               GO TO 190
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IF (ABS(XIANG - 3.*PI2) .LT. APRMUT)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   WRITE(6,*) 'XIANG OUT OF RANGE'
                  THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            TO 190
```

IF (P12 - THETAL .GT. THETMU) GO TO 190

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                                                                                                                                                                                                                                                  200
                                                                                                                                                                                                                                                                                                                                           190
                                                                                                                                                                                                                                                                                             NEXT SOURCE POSITION
                                                                                                                                                                                                       NEXT GRID POSITION
                                                                                                                                                                                                                                                                                                                                                                                      NEXT RECEIVER TRACE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         GK Integral or GRT Integral
                                                                                                                                                                                                                                                                                                                                                                                                                                 REVERSES SIGN OF CONTRIBUTION FROM DGW
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  TAPER KIRCHHOFF OPERATOR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    KIRCHHOFF INTEGRAL - THETAL IS FINAL (RECEIVER) RAY ANGLE
                                                                                          ELSE
                                                                                                                                                         STACK = REAL (NMUTE)
                                                                                                                                                                                                                                                  CONTINUE
                   IF (NMUTE .EQ. 0) IMAGE(JJ,II) = 0
                                           END IF
                                                                                                                                  IF (STACK .GT. STKOFF) THEN
                                                                                                            IMAGE(JJ, II) = IMAGE(JJ, II) / STACK
                                                               IMAGE(JJ,II) = 0.0
                                                                                                                                                                                                                                                                                                                                           CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      THETAG = THETAG - DIPR - PI / 2.

FAC = SQRT(TAUO/TAU1) * ABS(COS(THETAG))

ELSE IF (IMIGTY .EQ. 3 .OR. IMIGTY .EQ. 4)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IMAGE(JJ, II) = IMAGE(JJ, II) + DELTAP * REAL(IUP*2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  DELTAP = CSG(NT, LL, KK) * FAC * RAMP
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             IF (ABS(XIANG) .LT. (APRANG - APRTAP))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     STACK = STACK + 1.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      RAMP = 1.0 -
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  RAMP = 1.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             THETAS = THETAS - DIPS - PI / 2.
THETAG = THETAG - DIPR - PI / 2.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  FAC = (DSS*ABS(COS(THETAS))*SQRT(TAU1/TAU0) +
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        END IF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IF (TAU1 .EQ. 0.0 .OR. TAU0 .EQ. 0.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         IF (TAU1 .EQ. 0.0) GO TO 190
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 / (APRTAP)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     IF (IMIGTY .EQ. 4) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           DSG*ABS (COS (THETAG) ) *SQRT (TAU0/TAU1) )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF (IMIGTY .EQ. 5) THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        GO TO 190
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          SCAT = THETA0 - THETA1
CSCAT2 = COS(SCAT/2.0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            THETAS = 0.0
THETAG = 0.0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      FAC = FAC * CSCAT2 ** 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         THEN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      (ABS (XIANG) - (APRANG - APRTAP))
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C MUTES point if NO contributions from narrow aperture
C 210 CONTINUE
C C NEXT GRID DEPTH
C 220 CONTINUE
WRITE (6,*) Enter name of output file for image :'
READ (5,50) FNAME
LEN = (NZ + 2) * 4
WRITE (6,*) ENTER I.D. of image to save :'
READ (5,*) ISHOT - 1) * (NX + 1) + 1
OPEN (11,FILE=FNAME,STATUS='UNKNOWN',ACCESS='DIRECT',FORM-
1 UNFORMATTED',RECL=LEN)
WRITE (6,*)'WRITING HEADER TO RECORD ..', IDCODE
WRITE (11,REC-IDCODE) (A(I),I=1,NZ)
DO 230 K = 1, NX
XIM = K * DXGRID + XMIN
KREC = IDCODE + K
WRITE (11,REC=KREC) (IMAGE(I,K),I=1,NZ)
230 CONTINUE
WRITE (6,*)'LEN, NX, NZ = ', LEN, NX, NZ
WRITE (6,*)'LOST RAYS < ', LOST
WRITE (6,*)'FOUND RAYS = ', IFOUND
PERCL = 100. * REAL(LOST) / REAL(LOST + IFOUND)
WRITE (6,*)'PERCENT LOST < ', PERCL
CLOSE (11)
```

