I.O.S.

STRUCTURE AND EVOLUTION OF THE ROCKALL AND EAST GREENLAND CONTINENTAL MARGINS

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A. INTRODUCTION: WORK UNDERTAKEN BY IOS UP TO APRIL, 1985

This report summarises geological and geophysical studies of the Rockall and East Greenland continental margins (Fig.1) undertaken by IOS on behalf of the Department of Energy. The report concentrates on the period 1979 to 1985 but draws heavily on earlier IOS studies of the Rockall area which began around 1967. A summary of these studies comprises the first part of this review, and a complete bibliography of IOS publications relevant to the project is included as Appendix A

B. IOS GEOLOGICAL AND GEOPHYSICAL SURVEYS IN THE AREA.

The National Institute of Oceanography (NIO, now IOS) operated their first cruises to the Rockall area (Fig.1) onboard R.R.S.Discovery using a hull-mounted side-scan sonar and precision echo-sounder (Crease 1967, Cartwright 1968). These early surveys began to improve an understanding of the morphology and surface geology of the Rockall area pioneered by the Royal Naval Hydrographic Department in the late nineteenth century. Following these early cruises, a programme of geological and geophysical research flourished during the next decade, involving a wide range of sampling and geophysical sensing techniques operated by IOS. These included single and multichannel seismic reflection profiling, seismic refraction profiling, magnetic and gravity measurements, precision depth recordings, GLORIA long range sidescan sonar, rock dredging, rock coring, sediment coring, and camera stations. This programme was concluded with the most recent multichannel seismic site surveys in support of the deep drilling programme carried out during the International Phase of Ocean Drilling (IPOD, legs 48 & 81, Montadert, Roberts et al, 1979, Roberts, Schnitker et al, 1984). Additional data acquired by universities, seismic companies or other institutes, and obtained through purchase or exchange, have also been used in the geophysical interpretation of the area. A chronological summary of the cruises and principal data sources used in the project forms Appendix B.

In 1969 H.M.S. Hecla carried out a bathymetric, magnetic and gravity survey over Rockall Bank for the Hydrographic Department (Roberts & Jones 1975, Roberts et al. 1985). Roberts (1969) speculated that a Tertiary volcanic centre underlay Rockall Bank, and quoted early reports of dredged basalts (Cole & Crook, 1910) to support this hypothesis. The first major geophysical cruise to the Rockall Plateau and Trough operated by NIO was Discovery Cruise 29 (Laughton 1970a) during which seismic reflection and refraction data were collected along with magnetic and gravity profiles. The following year the Deep Sea Drilling Project drilled two sites in the Hatton-Rockall basin (Laughton, Berggren et al. 1972), (Fig. 1), establishing a Tertiary stratigraphy for the central Rockall Plateau. Seismic reflection profiles forming the site survey for the drill sites were recorded during Discovery 33 (Laughton 1970b) during which a wide angle seismic refraction experiment using disposable sonobuoys was also carried out in the Rockall Trough. In 1971, a charter vessel, the M.V. Surveyor, was used in geological and geophysical investigations across Rockall Plateau and Anton Dhorn seamount (Wilson & Roberts 1971). Seismic reflection profiles and magnetic and bathymetric data were collected in addition to rock dredge and surface sediment grab samples, the latter as part of a study of carbonate sediments on the Scottish shelf and Rockall Bank (Fig. 2, Appendix C, Wilson, 1979).

Rock samples recovered by divers from the vicinity of Rockall Island (Fig.1) during 1972 showed a close affinity with the British Tertiary igneous province, supporting suggestions of igneous centres underlying Rockall Bank (Roberts & Eden 1974, Roberts _et al_. 1974a). Discovery Cruise 47 involved an extensive geophysical survey of much of the Rockall Plateau and southern Rockall Trough and samples were obtained using a drill provided by the Institute of Geological Sciences (IGS, now British Geological Survey). A sample of microperthitic granulite obtained by drilling was dated radiometrically as Precambrian (Roberts _et al_.1973). The seismic reflection data obtained on Cruise 47 enabled the construction of the first sediment thickness maps for the Rockall area (Roberts 1975a). In 1973, a further shallow-water drilling programme on Rockall Bank was completed using the chartered Vickers Oceanics submersible Pisces III operated from Discovery during a joint IOS/IGS cruise (Roberts & Eden 1974). Video and still-photography were used to examine the sediment fill of iceberg plough marks previously detected on sidescan sonar records (Belderson _et al_. 1973). Further seismic reflection and refraction profiles, magnetic and bathymetric data were collected during Discovery Cruise 60 (Roberts _et al_.1974b), with a particular aim of studying the ocean-continent transition zone to the south and west of Rockall Plateau. Using the contrast between ages of the oceanic magnetic anomalies to the west and to the south of Rockall Plateau it was argued that continental separation south of Rockall Plateau was initiated during the early Cretaceous (approximately 105 Ma) while the northwest Rockall margin was not separated from the Greenland margin until the earliest Eocene (anomaly 24, approximately 55Ma).

GLORIA Mark II (Geological LOng Range Inclined Asdic, Somers _et al_. 1978) was tested on its first major cruise trial during Discovery Cruise 84 (Laughton 1977). A sidescan swath was completed in the southwestern Rockall Trough to evaluate the resolution of the sonar system over sedimentary structures on the Feni Ridge. In that area, sediment waves with a relief of between 10 and 30 metres, previously observed on high resolution seismic profiles were recorded over the maximum range of insonification (30km) either side of the ships track (Roberts & Kidd 1979).

During mid 1976, Seismograph Services Limited were commissioned to undertake a 48-channel seismic reflection survey over the southwest Rockall Plateau to provide a site survey for IPOD Leg 48 drilling. This survey also included a seismic refraction profile. These data, coupled with the drilling of IPOD Leg 48 sites 403, 404, 405 and 406 during 1976, Fig. 1, (Montadert, Roberts et al. 1979) allowed a detailed evaluation of the Tertiary seismic stratigraphy of the Rockall Plateau area (Roberts et al. 1979a). Uncertainty still persisted, however, as to the age and character of the underlying basement, and the precise nature of the ocean-continent transition (OCT) west of Rockall Plateau. In this area, the OCT is obscured beneath a thick wedge of gently NW-dipping oceanward-divergent reflector sequences (Fig. 4) which were not sampled during Leg 48 mainly because of technical problems encountered during drilling.

In 1978, a geophysical cruise using the M.V. Criscilla (Miles et al. 1979) was programmed to collect multichannel seismic reflection profiles, along with gravity and magnetic data, over the Iceland-Faeroe Ridge and the northwestern margin of Rockall Plateau. Despite being curtailed due to severe weather problems, several geophysical profiles were obtained south of the Faeroes and over the Wyville-Thomson Ridge. Poor weather conditions coupled with engine failure also hindered the M.V. Starella cruise to the East Greenland continental margin during 1979 (Roberts et al. 1979b). Single and multichannel seismic profiles, magnetic and gravity data as well as GLORIA sonographs were recorded along several margin-parallel and margin-normal lines. The existence of dipping reflector sequences was confirmed, not only over the inferred continent-ocean transition zone, but also beneath wide areas of the adjacent ocean floor and continental shelf (Fig. 4).

The M.V. Starella cruise marked the commencement of a 3-year joint IOS-Durham University research contract, during which all available published and unpublished geophysical data for the East Greenland margin was compiled and interpreted. An existing dataset, including profiles recorded by Durham University on several earlier geophysical cruises, was augmented by data exchange and reprocessing. This enabled a reappraisal of the distribution of dipping reflectors along the southeast Greenland margin and an estimation of crustal thickness variation using gravity models (Uruski & Parson 1985). In 1981, a further multichannel site survey over the western margin of the Rockall Plateau was commissioned in preparation for the IPOD Leg 81 drilling. This was shot using the Western Geophysical "Maxipulse" system in an attempt to obtain deeper seismic penetration of the dipping reflector sequence. The site survey included a single gravity profile across the margin (Roberts & Ginzburg 1984).

Penetration of the reflectors was again attempted during the IPOD Leg 81 with limited success. Subaerial basalt flows and volcaniclastic sediments were sampled from the upper 183m of the acoustic basement, of which only the lowest 70m were correlated with the dipping reflector sequence (Roberts, Schnitker et al. 1984).Following the Leg 81 sampling, 5000km of 12-channel seismic reflection data shot by Durham University over the dipping reflector margins of East Greenland, the East Jan Mayen Ridge, The Western Norwegian margin, and the Faeroes and Rockall margins were reprocessed and used to compare and contrast dipping reflector configurations and distributions. Finally, a deep drill site was occupied during IPOD Leg 94 (Site 610); it was located in the southern Rockall Trough, over the Feni Ridge sediment Drift (Kidd, Ruddiman et al. in press). The drilling results allowed a recalibration of the Tertiary seismic stratigraphy in the Rockall Trough (Masson & Kidd, in press) and a revision of stratigraphic correlation between the Rockall Plateau and Trough originally proposed by Roberts (1975a).

C. SPECIFIC AREAS.

1. Rockall Plateau

The geology of the Rockall Plateau has been summarised and presented in early work by (Roberts 1975a,b & c). From coring and dredging work it is known that Precambrian rocks underlie Rockall Bank and in all probability also underlie Hatton Bank (Roberts *et al*. 1972). Deep drilling during DSDP Leg 12 (Sites 116 and 117) in the Hatton Rockall Basin established a stratigraphy for the Tertiary and Quaternary cover, and provided a calibration of the existing seismostratigraphy. In particular, the regional seismic event "R4", mapped by Roberts (1975a) over the Plateau and Trough was dated as Eocene/Oligocene. Seismic horizons corresponding to Tertiary basalt recovered from the base of Site 117 have been traced across much of the Rockall Plateau and were originally considered "acoustic basement" by workers using early single channel seismic reflection data. Commercial multichannel seismic reflection profiles, however, have revealed a layered structure to some of these volcanics although, generally, it is still not possible to resolve the deeper metamorphic basement.

Between Hatton and Rockall Banks, the Hatton-Rockall Basin lies between 1000 and 1500m water depth, and contains up to 2.5 seconds two-way time (TWT), (approximately 3-4 km) of Tertiary sediments. Seismic refraction profiles and gravity anomaly models indicate that the basin is underlain by a thin continental crust (Scrutton & Roberts, 1971).

2. Rockall Trough

The Rockall Trough separates Rockall Bank from shallow water areas to the west of the British Isles. Water depths within the trough vary between 3000m at its southern end, where it opens into the North Atlantic Basin, and less than 1000m at its northern end, where it is closed by the Wyville-Thomson Ridge (Fig.1). Roberts *et al*. (1983) suggested that the Wyville-Thomson Ridge is made up of Palaeocene lavas and that prior to the Palaeocene, the Faeroe-Shetland Channel to the north and the Rockall Trough to the south formed a "continuous seaway at least 1 km deep". The Faeroe-Shetland Channel area,however, was not part of the area studied during this project and here its origin and structure are only discussed in regional terms.

The Rockall Trough is one of the few areas of the North Atlantic of which the age, evolution and structure are not well understood. Both the age of the basin and the crustal structure beneath it are the subject of controversy. Age estimates vary between Permian and Early Cretaceous and the crustal structure argument hinges on whether the trough is underlain by oceanic or thinned continental crust.

Age of the Rockall Trough:

Earliest estimates of the age of the Rockall Trough suggested that it formed in Jurassic or Early Cretaceous time (see Roberts,1975a). More recently, two schools of thought have emerged, one advocating a Permian age (Russell, 1976; Russell & Smythe, 1978), the other an Early Cretaceous age (Roberts *et al*,1981; Miles & Roberts, 1981; Hanisch, 1983, 1984; Price & Rattey, 1984). Both age estimates are based primarily on regional considerations because little direct evidence is available. Tertiary igneous activity has produced extensive lava and/or sill complexes which mask the deeper structure, and no deep drilling has yet been carried out in the Rockall Trough which has succeeded in reaching the underlying strata. Roberts *et al*. (1981) believed that they had identified oceanic magnetic anomalies of Cretaceous age in the southern Rockall Trough, but their magnetic anomaly models are by no means unique. Scrutton and Bentley (pers. comm. 1985), who have reworked the magnetic and gravity data in the southern Trough, would question the identification of the oceanic anomalies and, indeed, whether oceanic crust is present at all.

Considerable evidence for an Early Cretaceous rift phase on the margin of the Faeroe-Shetland Channel now exists (Ridd, 1981; Price & Rattey, 1984; Hanisch, 1984). This provides the strongest evidence for the Rockall Trough/Faeroe-Shetland Channel being a rift basin of Cretaceous age. The increasing number of recently published papers which support the Cretaceous age show that this is currently the most popular hypothesis. In contrast, the Permian age hypothesis appears to be losing support, although the lack of knowledge regarding the deep structure of the Rockall rift and the very general nature of the Permian hypothesis make it difficult to argue against.

Crustal Structure of the Rockall Trough:

No published evidence is available which unequivocally defines the crustal structure beneath the Rockall Trough. Rather poor quality seismic refraction data shot in the early 1970's suggests that the Moho occurs at a depth of around 12 km beneath the Trough but no velocity structure was obtained for the crust itself (see Roberts, 1975a). It is not possible, therefore, to distinguish between a thin continental or an oceanic crustal structure. As noted above, we now believe that the "oceanic magnetic anomalies" identified by Roberts et al. (1981) do not represent a unique interpretation of the magnetic anomaly patterns observed over the southern Rockall Trough and that a thin continental crust intruded by igneous material is also a possibility (Scrutton and Bentley, pers. comm.). Further north, in the Faeroe-Shetland Channel, Bott & Smith (1984) have interpreted seismic refraction data in terms of an oceanic crustal structure. However, their refraction line, shot across the Channel, and across the strike of the major geological features in the area, presents many problems in interpretation, and their main 6.0-6.6 km/s crustal refractor could, in fact, arise from either oceanic or continental crust.

Stratigraphy of Rockall Trough:

The stratigraphy of the Rockall Trough has been studied by Roberts (1975a), Roberts et al. (1981) and Masson & Kidd (in press). The Tertiary stratigraphy of the trough has been calibrated by the DSDP site 610 drillsite (Masson & Kidd, in press) situated on top of the Feni sediment drift in the south-west Rockall Plateau (Roberts & Kidd, 1979). The pre-Tertiary section has not been dated directly but correlation with DSDP drillsites in the Porcupine Abyssal Plain to the south (Masson et al. 1985) suggests a thin upper Cretaceous section underlain by a thicker syn-rift Early Cretaceous section. We have no evidence for pre-Cretaceous sediments.

3. West Rockall Margin

The continental margin west of the Rockall Plateau has been extensively studied using multichannel seismic reflection techniques and DSDP drillsites, (Montadert, Roberts et al. 1979; Roberts et al.1979a; Roberts, Schnitker et al. 1984).

Morphologically, the margin west and south of Rockall Plateau is composed of three sections, each of which is generally characterised by steep scarp slopes (Fig. 1). The southernmost section occupies an approximately north-south scarp at 20°W, between 54° and 55°30'N. Extending from the northern end of this section, the central margin trends approximately east-west along 55°30'N. The northern and longest section extends northeastwards from this point to north of Hatton Bank. This last section has been the most intensively studied, and our understanding of it has benefitted greatly from the results of IPOD Legs 48 and 81 (Fig. 1).

Seismic reflection profiles across the southernmost section of the margin reveal a basement structure dominated by a scarp downthrowing acoustic basement more than 2.0 seconds to the west. Although the north-south scarp must lie close to the ocean-continent transition (OCT), available seismic reflection data is inadequate for its precise location. South of 55° 30'N and west of 20°W, The magnetic pattern is confused and weak, locally interrupted by the effects of seamounts. The overall anomaly character is oceanic, however, and Roberts et al. (1979a) tentatively identify anomaly 31 (Fig. 3).

Westwards from 20°W, an east-west striking, moderately steep basement scarp at approximately 55°30'N marks the position of the transform sheared margin at the southern margin of the Rockall Plateau which was drilled at Sites 405 & 406 of DSDP Leg 48. If the weak magnetic anomalies to the south of this margin have been correctly identified, the transform margin was operative at least from the Maastrichtian (approx. 68 Ma), and may have initiated earlier, perhaps contemporaneously with the margin to the south at anomaly 33/34 time, 75 Ma.

From seismic reflection profiles shot orthogonal to the margin, the west Rockall OCT is a classic example of a 'dipping reflector' passive margin (Fig.4, Hinz 1981; Roberts & Montadert, 1980; Parson & Roberts 1981) at which the structure of the ocean-continent transition is obscured beneath a thick rock sequence characterised by oceanward divergent, NW-dipping seismic reflectors (Figs. 5a & 5b). These reflectors increase in inclination away from the continent, and also vary in apparent dip throughout the margin. Unpublished IOS profiles yield true dip values of up to 18°, although at their landward limits, the reflectors can be traced into a subhorizontal attitude to become indistinguishable from much of the flat-lying Tertiary basalt cover of the Rockall Plateau. The structure of the marginal area is in detail highly complex, attitudes of reflectors varying rapidly both along strike and down-dip. An example of an area of such complexities is illustrated in Fig. 6. In this section of the continent-ocean transition between 57°N and 60°N, the distribution of dipping reflectors has been mapped using a series of evenly-spaced multichannel seismic reflection profiles. Earliest oceanic magnetic anomalies have been traced principally from marine magnetic surveys (Roberts & Jones 1975) with some magnetic features identified over the western Hatton Bank using aeromagnetic surveys (Unpublished data, Fairey Surveys 1974). Anomalies 24A & 24B, clearly defined south of 57° (Fig. 3), cannot be traced northeastwards of 57°N. The northeastward part of anomaly 23 is interrupted at 58°N, although to the north a broad linear magnetic feature may mark its possible continuation. The irregular distribution of dipping reflectors and magnetic linear features to the east of the true oceanic floor clearly indicates the complexities of the separation of Rockall from East Greenland. Similar correlatable irregularities in the magnetic and gravity signatures at the formerly conjugate section of the east Greenland margin are discussed in Section C4.

Early workers suggested that the dipping reflector sequences may have been composed of thick deltaic and volcaniclastic sediments deposited in a rift valley environment (Roberts _et al_. 1979a). More recent ideas, from Mutter _et al_. (1982) and Hinz (1981), among others, however, and corroborated in part by the limited penetration of the sequences during DSDP Leg 81 (Roberts, Schnitker et al. 1984), indicate that the dipping reflector sequences primarily comprise basalts which are chemically indistinguisable from oceanic tholeiitic basalts. It is not known whether oceanic or continental crust lies beneath the dipping reflector sequence on the Rockall Margin, and it will require a programme of deep drilling and seismic refraction studies to remove all of the uncertainty. An early seismic refraction profile recorded over the dipping reflector sequence between 55° 59'N/ 23° 31'W and 56° 16'N/ 23° 03'W indicated a weak seismic refractor at about 6.0 km depth, approximately the base of the resolved reflector sequence, of about 5.9 km/second (Fig.7). This continental-type value for the 'basement' would agree broadly with models of dipping reflector formation indicated by Parson (1983) and Smythe (1983). In these models, a series of basaltic extrusives comprise the main part of the dipping reflector sequences, although a proportion of volcaniclastic sediment (Roberts et al. 1984 a & b) must clearly contribute to the pile.

4. East Greenland Margin

The southern East Greenland margin between the southernmost point of Greenland (Kap Farvel) and the Denmark Strait is the former conjugate of the western Rockall Plateau margin (Fig. 1). North of the Denmark Strait, the central East Greenland margin has been studied in its regional context, although its conjugate margin, in the southeast More Basin, has not formed part of this project. A compilation of published and unpublished geophysical data from the formerly adjacent east Jan Mayen Ridge margin (Pelton 1985) has provided an additional area for regional comparative studies.

A detailed geophysical compilation and appraisal of the East Greenland margin was undertaken at Durham University under an IOS contract between 1980 and 1983. Geophysical data from a single IOS cruise to the margin was augmented by records collected by Durham University during the years 1973, 1974, 1976 and 1977. Additional data obtained from the Centre Nationale pour l'Exploitation des Oceans, the US Navy, Lamont-Doherty Geological Observatory and the Deutsche Hydrographische Institut were compiled and interpreted by Uruski and Parson (1985). They traced continuous wide zones of dipping reflector sequences eastwards from areas of the margin overlying unequivocally continental crust to those overlying early oceanic crust (between anomalies 24 and 19 in age, 55 - 44

Ma) (Figs. 3 & 4). They were also able to identify well defined sequences of SE-dipping reflectors in relatively young oceanic crust (9.5 Ma), forming part of the western Icelandic 'shelf'. Magnetic anomalies were used throughout the interpretations to define the extent and the age of the ocean crust and provided constraints on the position of the ocean-continent transition used in gravity models across the margin. In general the models support suggestions of an oceanward-divergent wedge of moderate density rock (approximately 2.4 Gg/m^3) approximately 4.0-5.0 km thick, overlying a continental basement of greater density (Fig.8). The early ideas for the East Greenland margin structure, originally proposed by Featherstone et al. (1977), still await testing by deep drilling and seismic reflection and refraction programmes. Without specific control from refraction profiles, however, the results of the gravity modelling attempted by Uruski & Parson (1985) are far from unique. The positions of a number of fracture zones were traced by linking consistent lateral offsets of the traces of linear oceanic magnetic anomalies (Fig. 3). One such zone of offsets in the earliest anomalies 24A & 24B to 22 between 60°40'N, 40°40'W and 60°15'N, 38°40'W (x on Fig. 3) correlates well with the zone of offset anomalies described above for Rockall. Detailed analyses of margin structure have served to improve precision in the development of continental reconstruction programmes (Miles, in prep.).

Several large scale regional features can be recognised from the regional geophysical compilations. Among these are the Icelandic Plateau Escarpment, a rectilinear and vertical, northwesterly downthrow in acoustic basement which extends from offshore NW Iceland northeastwards for more than 300 km in length. Its origin is as yet uncertain. To the southwest of the Blosseville Kyst, the Blosseville Escarpment, formed by a basement downwarp to the southeast, and observed on isopach and gravity data, is interpreted as an offshore continuation of the East Greenland Coastal flexure (Wager & Deer 1938).

D. SUMMARY AND DISCUSSION

Following the study of continental margins of Rockall and East Greenland commissioned by the Department of Energy, we have been able to make a number of conclusions regarding the structure and evolution of OCT's of interest not only to passive margins in the North East Atlantic, but also to those elsewhere in the world. The main conclusions can be summarised as follows:-

(1) The 'dipping reflector' sequences which characterise the western and north western margin of the Rockall Plateau and southeastern Greenland consist, at least in their upper part, of a series of laterally extensive lava flows. Outside their central wedge formation, they may extend landward, subhorizontally, to mask continental basement, and seaward in a variety of attitudes, either steeply inclined or shallowing into an acoustically chaotic zone.

(2) In general and in detail, the separation of the East Greenland and Rockall is one of broad diachroneity and range structure. In a wide sense, the margins encompass classic examples of rifted, transform/shear, and dipping reflector types, of an age range spanning from before anomaly 33/34 (Aptian, Albian, 100 Ma) to anomaly 23/24 (Early Eoc, 53 Ma). Within these broad limits, the margin displays a more detailed diachroneity, evinced by the distribution of earliest magnetic anomalies, relating to irregularities in opening of only a few million years.

(3) The seismic stratigraphy of the Tertiary sediments of the Rockall Plateau, Rockall Trough and western margin have been independently established following DSDP and IPOD drilling legs. Early proposals correlating seismic events throughout the entire area (e.g. 'R4') have undergone reappraisal.

Several aspects of the structure and evolution of the Rockall and east Greenland margins remain uncertain. The problems of deep crustal character and precise position of OCT have been appreciated for some time, but we have focussed our attention on a number of outstanding gaps in our regional and local knowledge of the margin. These gaps include -

(a) A lack of knowledge of the crustal affinity of that area of seafloor lying between the Faeroes Block and the northern Rockall Plateau. The upstanding shoal areas of the Banks (Bill Bailey's, Lousy, George Bligh and Faeroe) are separated by wide areas of deeper seafloor, but of a shallower depth than the adjacent oceanic Icelandic Basin. The origins of the Banks as either seamounts or continental fragments, and the intervening seafloor as attenuated continental, transitional or oceanic crust are unknown.

(b) The Rockall Trough remains an uncertainty in terms of its age, structure and history of formation. There is no direct evidence to firmly establish any pre-Cretaceous history for the Trough, and even this age is derived from the extrapolation of a seismic stratigraphy constrained by DSDP results from Legs 48 and 80 to the south. New ideas derived from interpretations of recent geophysical data in the southern trough include the possibility of an intruded and attenuated continental floor to the trough.

(c) The type of crust underlying the central part of the dipping reflector sequence masking the ocean-continent transition is unknown. Deep drilling has failed to sample the base of the reflectors on two legs (48 and 81) and although preliminary interpretation of refraction data indicated a deep refractor with continental-type velocities beneath the dipping reflector wedge, the results of more sophisticated refraction programme completed by Cambridge and Durham Universities during 1985 (Unpublished data) are anxiously awaited.

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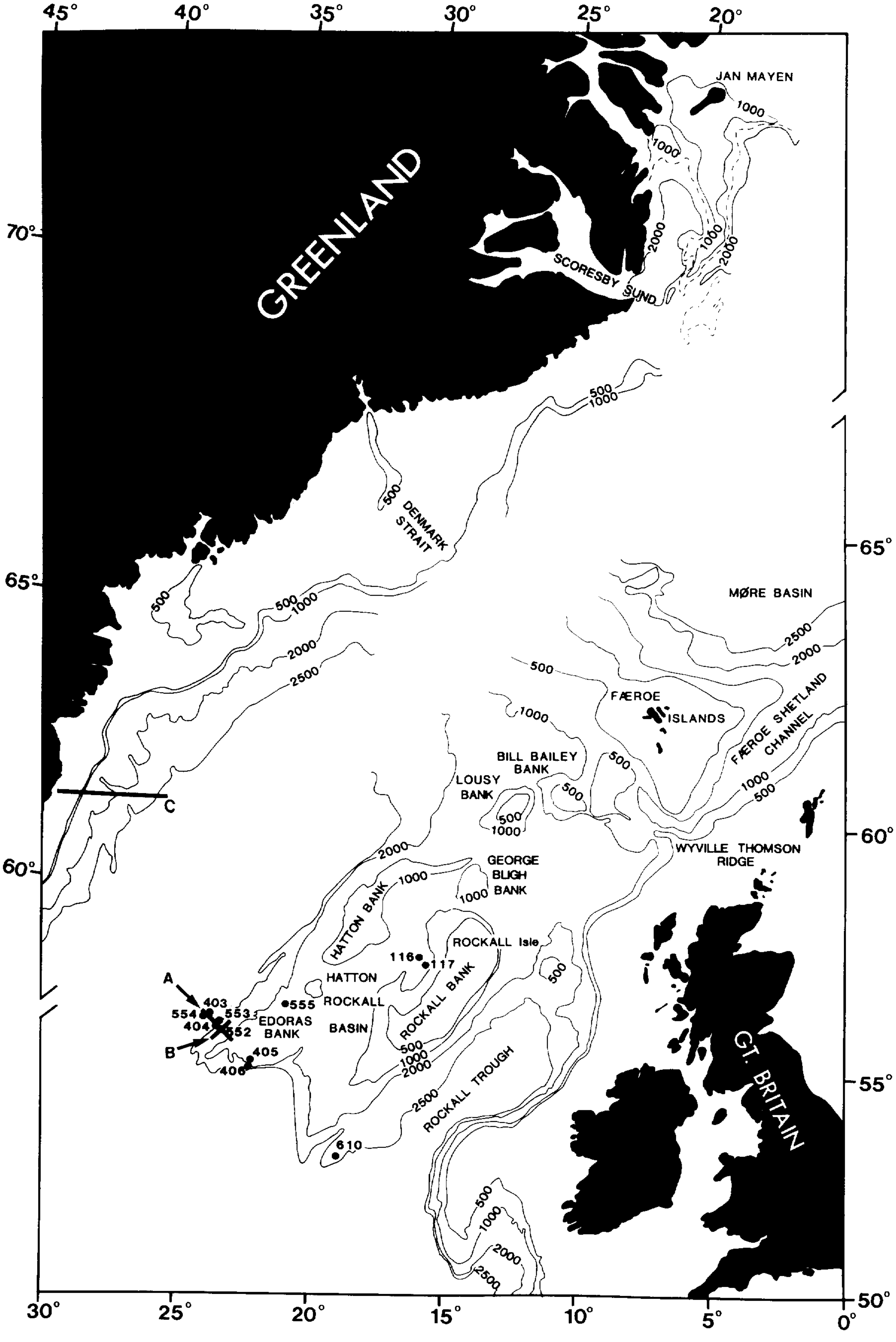
Figure 1: Continental reconstruction of the Rockall and East Greenland margins toanomaly 13, after Nunns (1983 a & b). Bathymetry in metres taken from GEBCO sheet 5.04. (GEBCO 1978). Numbered dots locate DSDP and IPOD drillsites (116, 117: Leg 12; 403, 404, 405, 406: Leg 48; 552, 553, 554, 555: Leg 81; 610: Leg 94, for references see text.) **A** locates seismic reflection line 76 - 8 illustrated in Fig. 5, **B** locates seismic refraction line 76 - 5 illustrated in Fig. 7, **C** locates line of gravity model presented in Fig. 8.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FÆROE SHETLAND CHANNEL
BILL BAILEY BANK
LOUSY BANK
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WYVILLE THOMSON RIDGE
GEORGE BLIGH BANK
HATTON BANK
ROCKALL Isle
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Figure 2: Sample sites on Rockall margin and NE Atlantic collated by I.O.S. Squares - drill/core sites; Circles - dredge sites; Crosses - grab samples. A full listing of these sample sites, their location, and published source (if available) forms Appendix C. R - Rockall Island; F - Faeroe Islands; S - Shetland Islands.

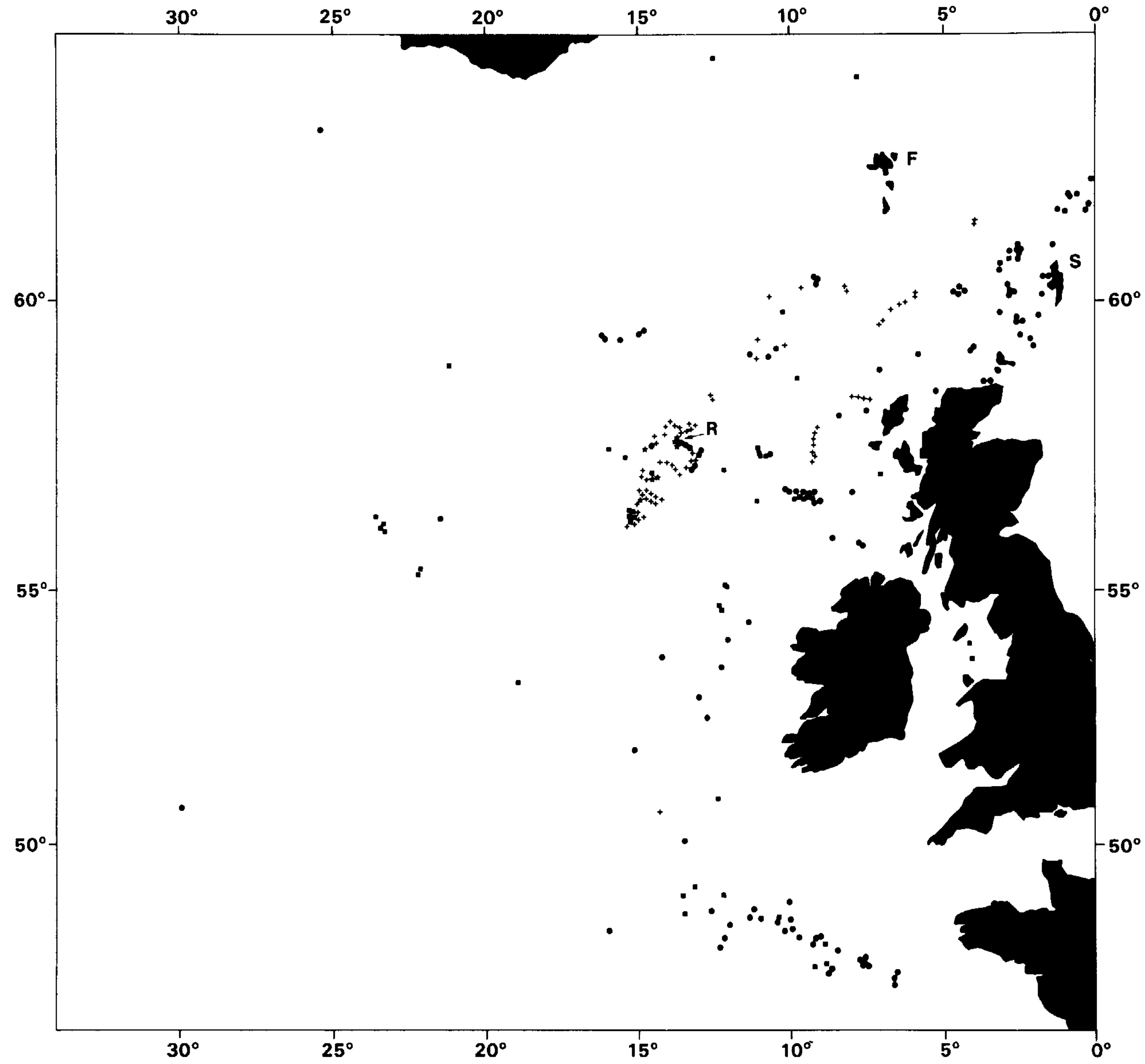
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Figure 3: Continental reconstruction of Rockall and East Greenland to anomaly 13,after Nunns (1983 a & b). Crosses locate approximate position of axis at anomaly 13 time. Magnetic anomalies are taken from Nunns (1983 a), Uruski & Parson (1985) and Roberts *et al*. (1985). Box locates detailed study area of NW Rockall margin illustrated in Fig. 6, and X identifies fracture zone in conjugate section of East Greenland margin. For discussion see text, Sections C3 & C4.

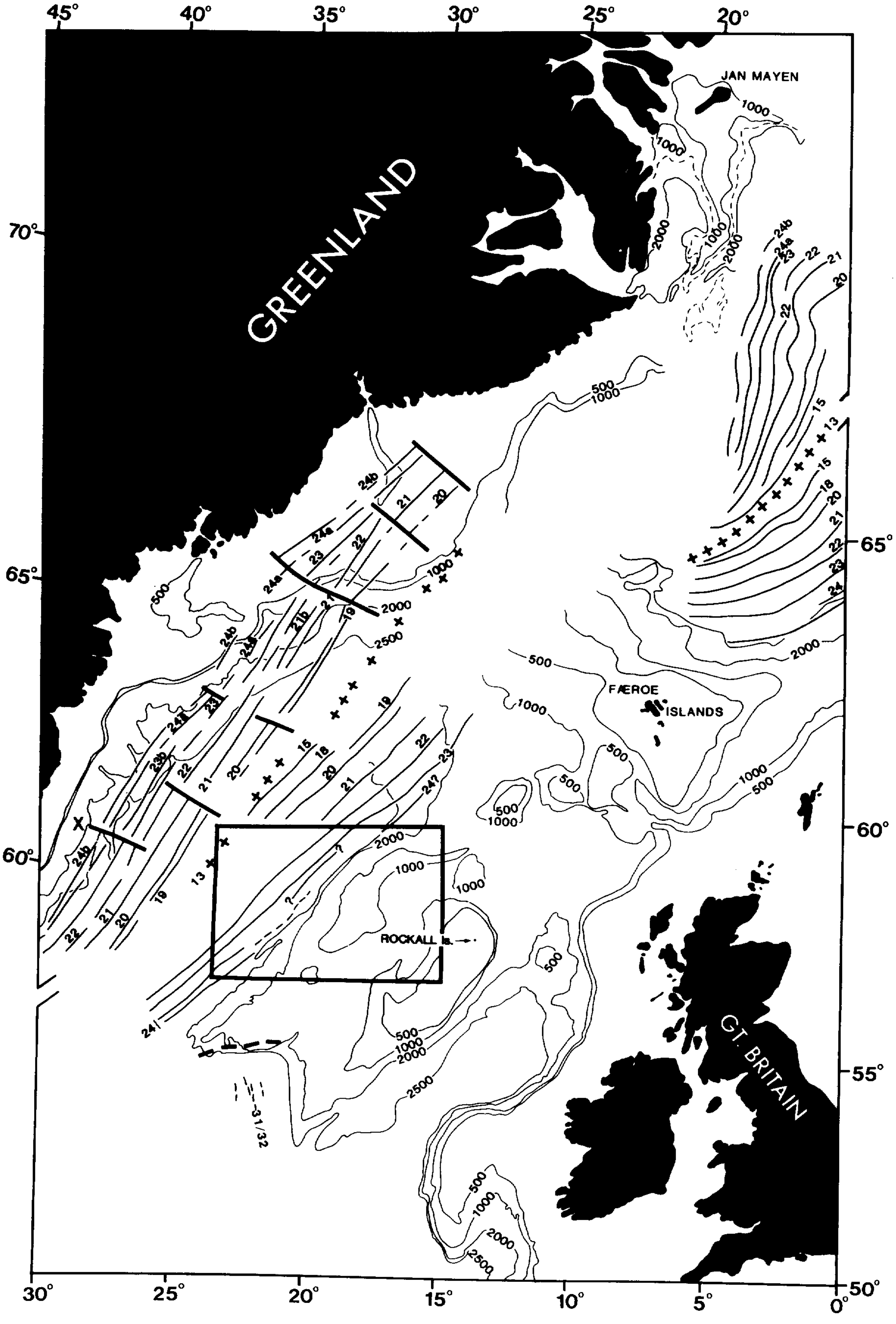
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Figure 4: Continental reconstruction of Rockall and East Greenland to anomaly 13,after Nunns (1983 a & b), illustrating distribution of dipping reflector sequences on the Rockall, East Greenland and More Basin margins. Arrows indicate diagrammatic dip direction at oceanward limit of reflector sequences. Sequence distribution in East Greeland from Uruski & Parson (1985).

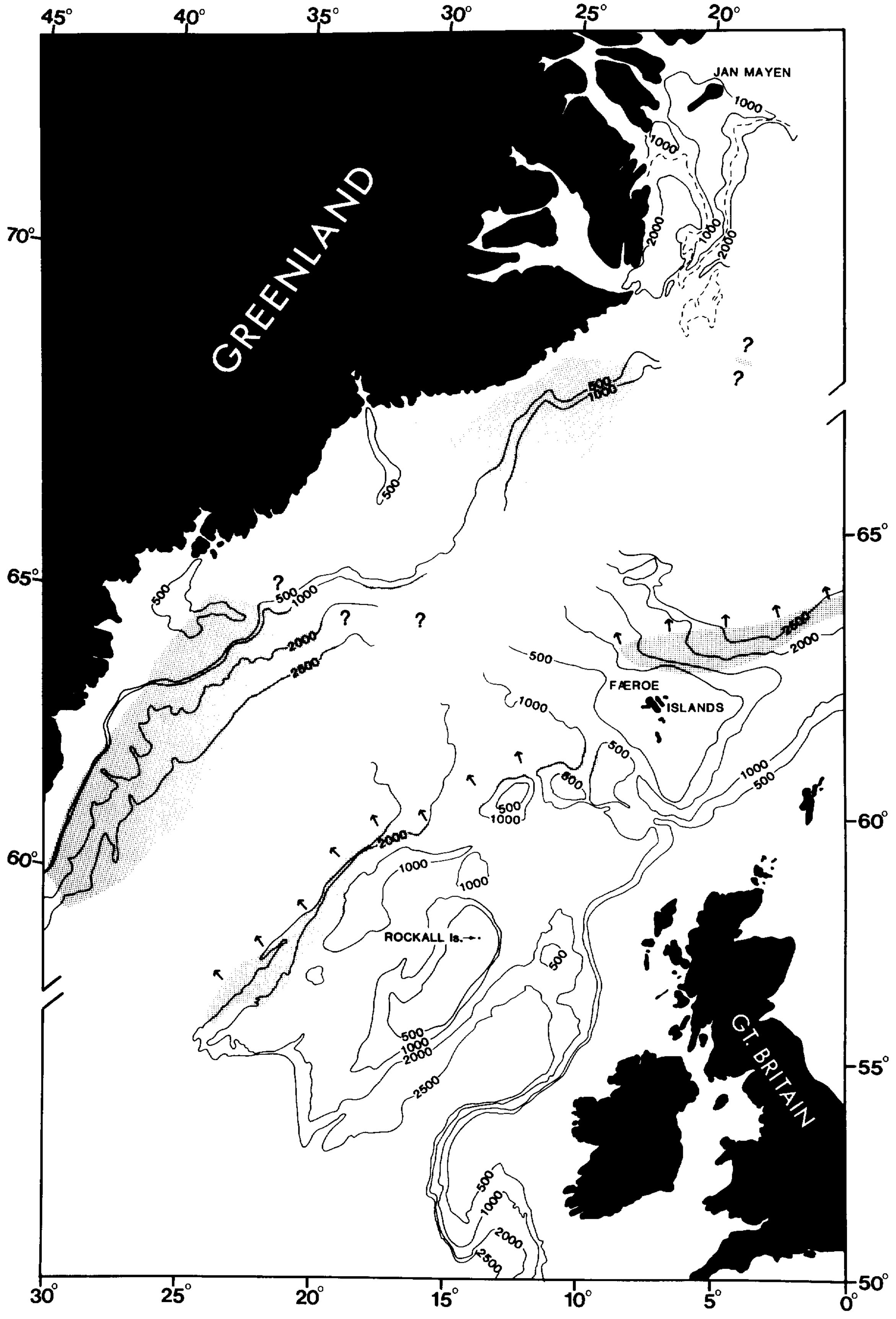
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Figure 5(a): 48-channel seismic reflection profile IPOD 76 - 8, across the WesternRockall margin (located on Fig.1). Central section illustrates dipping sub parallel and weakly divergent reflector sequences, eastern section (landward) suggests some continuation of subhorizontal events, western section (oceanward) is almost completely obsured in diffraction hyperbolae.

Figure 5(b): Depth-migrated line drawing interpretation of Fig. 5(a), illustrating principal dipping reflector horizons underlying Miocene/Eocene unconformity (lower dashed horizon). Note vertical exaggeration of 2=1. True dips of reflectors in central section do not exceed 15°. A full description of the digitisation and depth-migration, which includes weighted vertical and horizontal extrapolation between velocity picks is included in Appendix D.

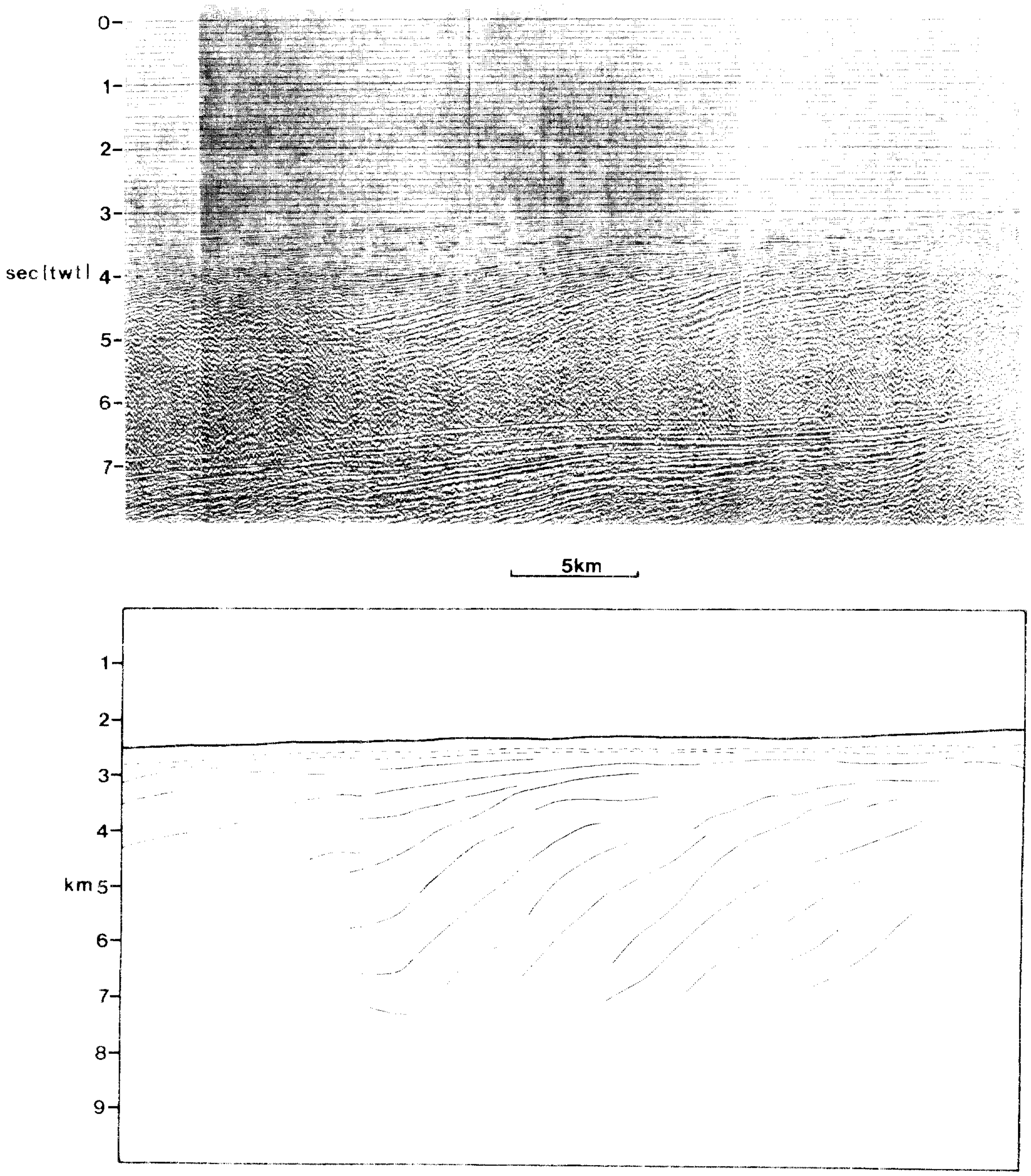

0
1
2
3
sec (twt) 4
5
6
7
5km
1
2
3
4
km 5
6
7
8
9

Figure 6: Detailed geophysical interpretation of part of the NW Rockall continental margin. Figure illustrates disruption of oceanic magnetic anomaly 23, broad deflection of both dipping reflector distribution and trend of major positive magnetic anomalies over Hatton Bank, and the anomalous positive bathymetric feature of Endymion Spur, all approximately centred on Latitude 58°N. Discussion in text suggests the presence of early fracture zone offsets correlatable to similar detailed structure in the East Greenland Margin. 'Oceanic' anomalies from Roberts _et al_. (1985), 'Continental' anomalies from Fairey surveys (Unpublished data).

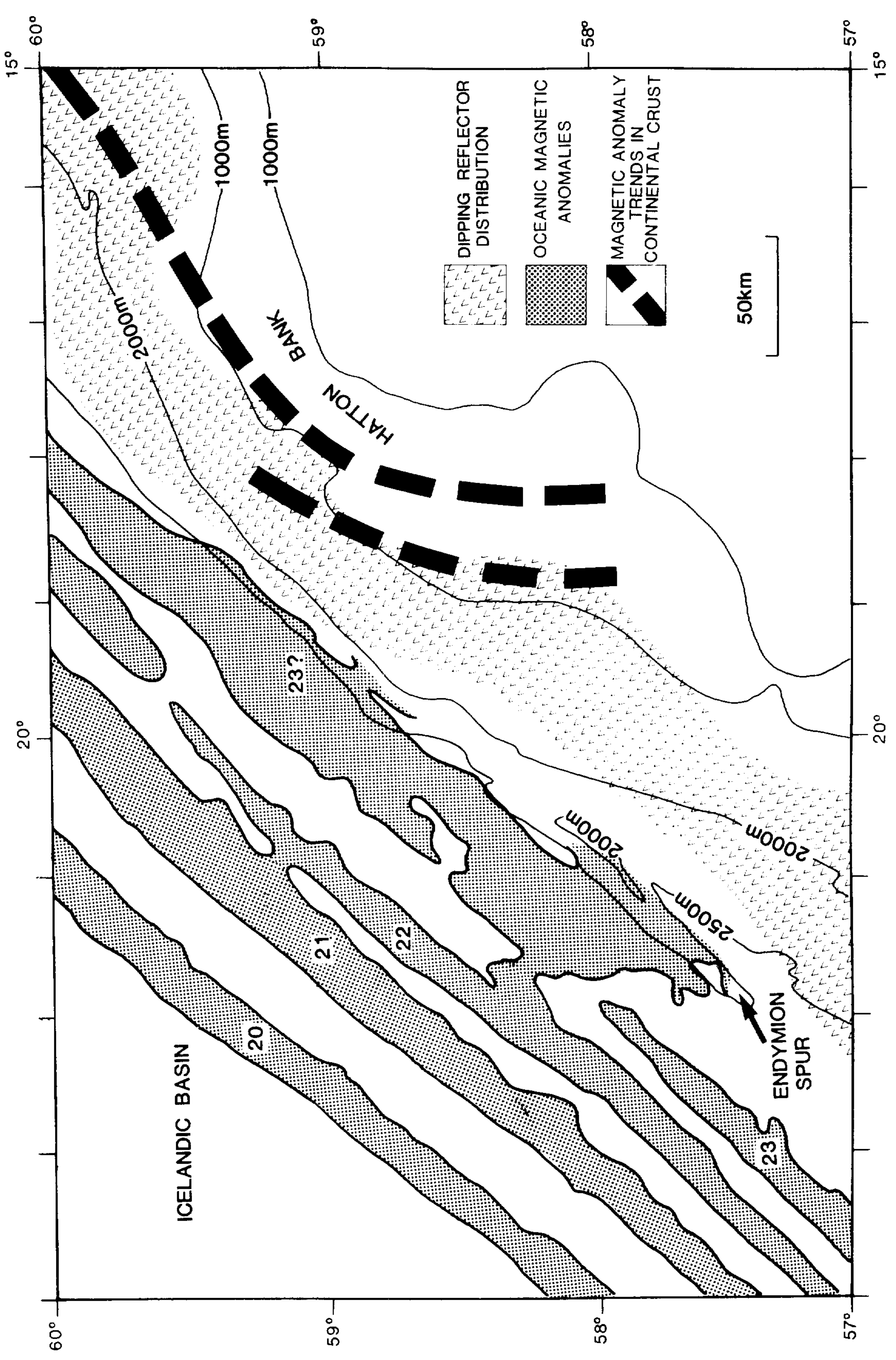

15°
20°
60°
59°
58°
57°
HATTON BANK
1000m
1000m
2000m
2000m
2000m
2500m
ICELANDIC BASIN
ENDYMION SPUR
20
21
22
23
23?
DIPPING REFLECTOR DISTRIBUTION
OCEANIC MAGNETIC ANOMALIES
MAGNETIC ANOMALY TRENDS IN CONTINENTAL CRUST
50km

Figure 7: Ray tracing model of seismic refraction profile IPOD 76 - 5, a strike-parallel line over the dipping reflector sequence, West Rockall Margin (located on Fig. 1). No account has been taken of lateral variations, and horizontal refractors have been determined at 2.29, 3.10, 3.70 and 6.10 km depth from normal incident velans. Vp (calculated) as continuous lines in upper figure correlate well with Vp (observed) as crosses. Vs (observed) as broken lines are unmodelled. 5.9 - 6.2 km/s refractor calculated at 6.1 km depth discussed in text.

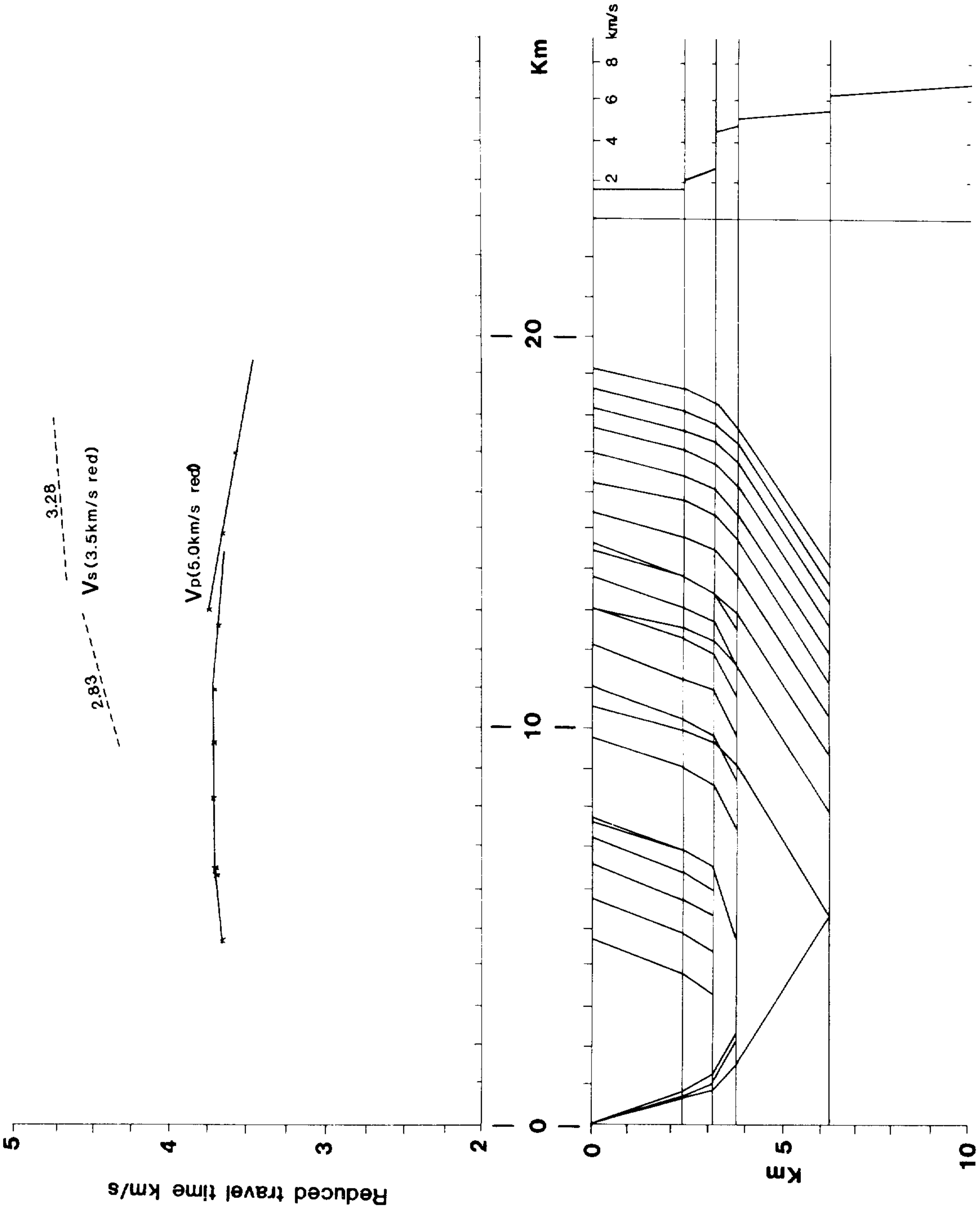
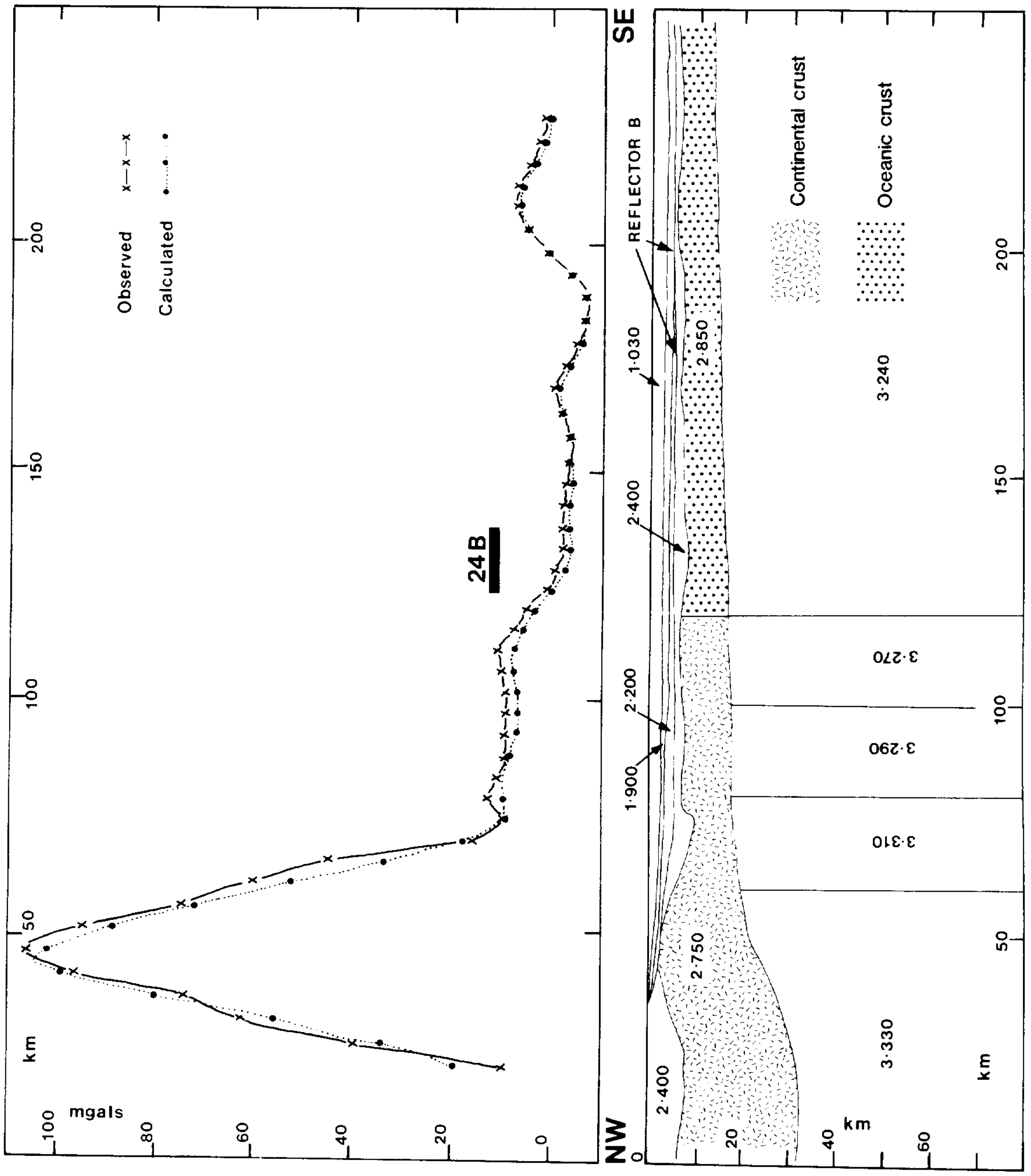

Reduced travel time km/s
5
4
3
2
Vs(3.5km/s red)
3.28
2.83
Vp(5.0km/s red)
0
10
20
Km
0
5
10
Km
2
4
6
8
km/s

Figure 8: Two-dimensional Free air gravity model for multichannel seismic reflection profile C (located in Fig. 1). Lower section of figure illustrates distribution of prisms of different densities in Gg/m^3. Upper section of figure compares observed (shipboard measurements) and calculated profiles. Position of earliest identifiable magnetic anomaly 24B is marked. Reflector B refers to upper surface of dipping reflector sequence as discussed by Uruski & Parson (1985).

LINE C


mgals
100
80
60
40
20
0
km
50
100
150
200
Observed x—x—x
Calculated •·····•
24B
NW
SE
0
REFLECTOR B
1·030
2·850
2·400
2·200
1·900
2·400
2·750
3·330
3·310
3·290
3·270
3·240
Continental crust
Oceanic crust
20
40
60
km

APPENDIX A: Relevant publications derived from the project by year.

1966

CURRAY, J.R., MOORE, D.G., BELDERSON, R.H., & STRIDE, A.H., 1966. Continental Margin of Western Europe: Slope Progradation and Erosion. Science, 154, 265 - 266.

1967

CREASE, J., *et al*., 1967. R.R.S. 'Discovery' Cruise 17, 3rd June - 8th July, 1967. Instrument trials and oceanographic observations. N.I.O. Cruise Report No. 17, 9 pp & figs.

STRIDE, A.H., BELDERSON, R.H., CURRAY, J.R. & MOORE, D.G., 1967. Geophysical evidence on the origin of the Faeroe Bank Channel - 1. Continous reflection profiles. Deep-Sea Research, 14, 1 - 6.

1968

CARTWRIGHT, D.E., *et al*., 1968. R.R.S. 'Discovery' Cruise 22, 18th June - 25th July, 1968. Tidal current array near St. Kilda. N.I.O. Cruise Report No. 22, 6 pp.

TUCKER, M.J., 1968. R.R.S. 'Discovery' Cruise 24, 19th September - 30th September, 1968. Geological investigations. N.I.O. Cruise Report No. 24, 1 pp & figs.

1969

ROBERTS, D.G., 1969. New Tertiary volcanic centre on the Rockall Bank, eastern North Atlantic Ocean. Nature, 223, 819 - 820.

STRIDE, A.H., CURRAY, J.R., MOORE, D.G. & BELDERSON, R.H., 1969. Marine geology of the Atlantic continental margin of Europe. Phil. Trans. R. Soc. London, A, 264, 31 - 75.

1970

KENYON, N.H. & STRIDE, A.H., 1970. The tide-swept continental shelf between the Shetland Isles and France. Sedimentology, 14, 159 - 173.

LAUGHTON, A.S., 1970. R.R.S. 'Discovery' Cruise 29, 2nd August - 6th October, 1969. 'GLORIA' in the Azores and geophysics on and around Rockall Plateau. N.I.O. Cruise Report No. 29, 24 pp & figs.

LAUGHTON, A.S., *et al.*, 1970. R.R.S. 'Discovery' Cruise 33, 14th April - 21st May, 1970. DSDP site surveys and geology and geophysics around King's Trough. N.I.O. Cruise Report No. 33, 23 pp & figs.

ROBERTS, D.G., 1970. Recent geophysical studies on the Rockall Plateau and adjacent areas. Proceedings of the Geological Society, No. 1662, 87 - 93.

ROBERTS, D.G., BISHOP, D.G., LAUGHTON, A.S., ZIOLKOWSKI, A.M. & SCRUTTON, R.A., 1970. New sedimentary basin on Rockall Plateau. Nature 225, 170 - 172.

1971

BELDERSON, R.H., KENYON, N.H. & STRIDE, A.H., 1971. Holocene sediments on the continental shelf west of the British Isles. pp. 157 - 170 in vol. 2, The Geology of the East Atlantic continental margin (ed. F.M. Delaney). London: Her Majesty's Stationery Office. 170 pp. (Institute of Geological Sciences. Report No. 70/14).

ROBERTS, D.G., 1971. New geophysical evidence on the origin of the Rockall Plateau and Trough. Deep-Sea Research, 18, 350 - 360.

SCRUTTON, R.A. & ROBERTS, D.G., 1971. Structure of Rockall Plateau and Trough, Northeast Atlantic. pp. 77 - 87 in Vol. 2, The Geology of the East Atlantic Continental margin (Ed. F.M. Delaney). London: Her Majesty's Stationery Office. 170 pp. (Institute of Geological Sciences, Report No. 70/14).

WILSON, J.B. & ROBERTS, D.G., 1971. M.V. 'Surveyor' Cruise 71/1, 26th February - 11th April, 1971. Tide gauges: Geology and geophysics on the Hebridean Shelf and on the Rockall Plateau. N.I.O. Cruise Report No. 38, 10 pp & figs.

1972

DAVIES, T.A. & LAUGHTON, A.S., 1972. Sedimentary processes in the NOrth Atlantic Ocean. In: Laughton, A.S., Berggren, W. et al., 1972. Initial Reports of the Deep Sea Drilling Project, vol. 12, Washington, DC: U.S. Govt. Printing Office. 905 - 934.

JONES, M.T., 1972. Bathymetric and magnetic traverses in the area of Rockall Bank and King's Trough: R.R.S. 'Discovery' Cruise 33, 14th April - 21st May, 1970. N.I.O. Data Report, Geophysics No. G1, 151 pp.

LAUGHTON, A.S., BERGGREN, W.A. et al., 1972. Initial Reports of the Deep Sea Drilling Project, vol. 12. Washington, DC: U.S. Govt. Printing Office.

OLIFF, N.J., 1972. Bathymetric and magnetic traverses over the Rockall Plateau: R.R.S. 'Discovery' Cruise 47, 9th June - 3rd July, 1972. N.I.O. Data Report, Geophysics, No. G4, 20 pp & figs.

ROBERTS, D.G., 1972. Rockall Islet and the Rockall Plateau: Pamphlet produced for the Search Exhibition at the Science Museum.

ROBERTS, D.G., 1972. Site survey in Hatton-Rockall Basin (Sites 116 and 117). pp. 1201 - 1208 in vol. 12, Initial Reports of the Deep Sea Drilling Project, A.S. Laughton, W.A. Berggren et al., Washington, DC: U.S. Government Printing Office, 1243 pp.

ROBERTS, D.G., 1972. Slumping on the eastern margin of the Rockall Bank, North Atlantic Ocean. Marine Geology, 13, 225 - 237.

ROBERTS, D.G., MATTHEWS, D.H. & EDEN, R.A., 1972. Metamorphic rocks from the southern end of the Rockall Bank. Journal of the Geological Society, 128, 501 - 506.

ROBERTS, D.G., et al., 1972. R.R.S. 'Discovery' Cruise 47, 9 June - 3 July, 1972. Geology and geophysics on and around the Rockall Plateau. N.I.O. Cruise Report No. 52, 37 pp & figs.

1973

BELDERSON, R.H., KENYON, N.H. & WILSON, J.B., 1973. Iceberg plough marks in the Northeast Atlantic. Palaeogeography, Palaeoclimatology and Palaeoecology, 13, 215 - 224.

ELLETT, D.J. & ROBERTS, E.G., 1973. The overflow of Norwegian Sea Deep Water across the Wyville-Thomson Ridge. Deep-Sea Research, 20, 819 - 835.

MILLER, J.A., MATTHEWS, D.H. & ROBERTS, D.G., 1973. Rock of Grenville Age from Rockall Bank. Nature Physical Science, 246, p. 61.

ROBERTS, D.G., ARDUS, D. & DEARNLEY, R., 1973. Precambrian rocks drilled on the Rockall Bank. Nature Physical Science, 244, 21 - 23.

1974

ROBERTS, D.G., 1974. In the depths of the Rockall Plateau. Geographical Magazine, 46, 269 - 275.

ROBERTS, D.G., 1974. Structural development of the British Isles continental margin and the Rockall Plateau. pp. 343 - 359. In: The Geology of continental margins (eds. C.A. Burk and C.L. Drake). New York: Springer-Verlag.

ROBERTS, D.G. & EDEN, R.A., 1974. D.E. 'Vickers Voyager' and PISCES III. 19th June - 4th July, 1973. Submersible investigations of the geology and benthos of the Rockall Bank. I.O.S Cruise Report No. 1, 22 pp & figs.

ROBERTS, D.G., FLEMMING, N.C., HARRISON, R.K., BINNS, P.E. & SNELLING, N.J., 1974. Helen's Reef: A microgabbroic intrusion in the Rockall intrusive centre, Rockall Bank. Marine Geology, 16, M21 - M30.

ROBERTS, D.G., HOGG, N.G., BISHOP, D.G. & FLEWELLEN, C.G., 1974. Sediment distribution around moated seamounts in the Rockall Trough. Deep-Sea Research, 21, 175 - 184.

ROBERTS, D.G. et al., 1974. R R.S. 'Discovery' Cruise 60, 26th February - 22nd March, 1974. Seismic reflection profiling on the Rockall Plateau and in the South Western Approaches. I.O.S. Cruise Report No. 8, 17 pp & figs.

1975

FLEMMING, N.C., BINNS, P.E. & ROBERTS, D.G., 1975. Helen's Reef: Geology and bathymetry. Institute of Geological Sciences Report No. 75/1, 838 - 860.

ROBERTS, D.G., 1975. Marine geology of the Rockall Plateau and Trough. Philosophical Transactions of the Royal Society of London, A, 278, 447 - 509.

ROBERTS, D.G., 1975. Sediment distribution on the Rockall Bank, Rockall Plateau. Marine Geology, 19, 239 - 257.

ROBERTS, D.G., 1975. Tectonic and stratigraphic evolution of the Rockall Plateau and Trough. pp. 77 - 89 in Vol. 1; Petroleum and the continental shelf of Northwest Europe: Proceedings of the Conference, London, 1974. (Ed. A.W. Woodland). London: Applied Science Publishers Ltd. on behalf of the Institute of Petroleum. 501 pp.

ROBERTS, D.G., 1975. The solid geology of the Rockall Plateau. Institute of Geological Sciences Report No. 75/1, 1 - 10.

ROBERTS, D.G. & CASTON, V.N.D., 1975. Petroleum potential of the Deep Atlantic Ocean. In: Proc. 9th World Petroleum Congress, Tokyo, May 1975. Vol. 2, pp. 281 - 298. London: Applied Science Publishers.

ROBERTS, D.G. & EDEN, R.A., 1975. Geological investigations on the Rockall Bank using the submersibles PISCES III. 8th Symposium of the Underwater Association, U.K. Held at the Polytechnic of North London, 20th - 21st September, 1974.

ROBERTS, D.G. & JONES, M.T., 1975. Magnetic anomalies and the early evolution of the N.E. Atlantic. (Abstract - Meeting of the EGS, Reading, September, 8 - 12, 1975).

1976

MILES, P.R., 1976. Bathymetric and magnetic traverses over the southwest margin of the Rockall Plateau. R.R.S. 'Discovery' Cruise 60, 26th February - 22nd March, 1974. I.O.S. Data Report No. 9, 23 pp & figs.

MONTADERT, L., ROBERTS, D.G. *et al.*, 1976. "Glomar Challenger" sails on Leg 48. Geotimes, 21 (12), 19 - 23.

1978

LAUGHTON, A.S. & ROBERTS, D.G.,1978. Morphology of Continental Margins. Philosophical Transactions of the Royal Society of London, A, 290, 75 - 85.

ROBERTS, D.G. & JONES, M..T., 1978. A bathymetric, magnetic and gravity survey of the Rockall Bank, H.M.S. 'Hecla' 1969. Admiralty Marine Science Publication No. 19, 43 pp.

1979

MONTADERT, L., ROBERTS, D.G. *et al.*, 1979. Initial Reports of the Deep Sea Drilling Project, 48: Washington DC: U.S. Government Printing Office.

ROBERTS, D.G.,1979. Evaluation of Western speculative seismic survey off N. Iceland (Western Geophysical). I.O.S. Internal Document No. 69. 5 pp & figs. (unpublished manuscript).

ROBERTS, D.G. & KIDD, R.B., 1979. Abyssal sediment wave fields on Feni Ridge, Rockall Trough: Long-range sonar studies. Marine Geology, 33, 175 - 191.

ROBERTS, D..G. & MASSON, D.G., 1979. Age and structure of the southern Rockall Trough - a new assessment. I.O.S. Internal Document No. 83, 11 pp & figs. (unpublished manuscript).

ROBERTS, D.G. & MONTADERT, L., 1979. Evolution of passive rifted margins - perspective and retrospective DSDP Leg 48. *In*: Montadert, L., Roberts, D.G. *et al.*, Initial Reports of the Deep Sea Drilling Project, 48: Washington DC: U.S. Government Printing Office, 1143 - 1154.

ROBERTS, D.G. & MONTADERT, L., 1979. Margin palaeoenvironments of the Northeast Atlantic. *In*: Montadert, L., Roberts, D.G. *et al.*, Initial Reports of the Deep Sea Drilling Project, 48: Washington DC: U.S. Government Printing Office, 1099 - 1118.

ROBERTS, D.G., HUNTER, P.M. & LAUGHTON, A.S., 1979. Bathymetry of the Northeast Atlantic: continental margin around the British Isles. Deep-Sea Research, 26A, 417 - 428 and Admiralty Chart No. C6567.

ROBERTS, D.G., MONTADERT, L. & SEARLE, R.C., 1979. The western Rockall Plateau: Stratigraphy and structural evolution. *In*: Montadert, L., Roberts, D.G. *et al.*, Initial Reports of the Deep Sea Drilling Project, 48, Washington DC: U.S. Government Printing Office, 1061 - 1088.

WILSON, J.B., 1979. Biogenic carbonate sediments on the Scottish continental shelf and on Rockall Bank. Marine Geology, 33, M85 - M93.

1980

ROBERTS, D.G. & MONTADERT, L., 1980. Contrast in the structures of the passive margins of the Bay of Biscay and Rockall Plateau. Philosophical Transactions of the Royal Society of London, A, 294, 97 - 103.

ROBERTS, D.G., *et al.*, 1980. Geological setting and principal results of drilling on the margins of the Bay of Biscay and Rockall Plateau during Leg 48. Philosophical Transactions of the Royal Society of London, A, 294, 65 - 75.

ROBERTS, D.G. et al., 1980. R.V. 'Starella' Cruise 1/79. Geophysical surveys on the East Greenland margin. I.O.S. Internal Document No. 73, 16 pp. (unpublished manuscript).

1981

LAUGHTON, A.S., ROBERTS, D.G. & HUNTER, P.M., 1981. Chart C6566. Bathymetry of the Northeast Atlantic: Sheet 1 Reykjanes Ridge and Rockall Plateau. Taunton: Ministry of Defence, Hydrographic Department.

MILES, P.R. & ROBERTS, D.G., 1981. The magnetisation of Rosemary Bank Seamount, Rockall Trough, Northeast Atlantic. Earth and Planetary Science Letters, 54, 442 - 448.

PARSON, L.M. & ROBERTS, D.G., 1981. Dipping reflector sequences in the vicinity of the continent/ocean transition on passive Atlantic margins and the interpretation of the Irish formula. I.O.S. Internal Document No. 125, 10 pp & figs.

ROBERTS, D.G., MASSON, D.G. & MILES, P.R., 1981. Age and structure of the southern Rockall Trough: New evidence. Earth and Planetary Science Letters, 52, 115 - 128.

WILSON, J.B., 1981. Biogenic carbonate sediments on the Scottish continental shelf and on Rockall Bank. (Abstract of paper presented at Geological Society of London, Marine Studies Group). Journal of the Geological Society 138, p. 500).

WILSON, J.B. et al., 1981. R.R.S. 'Discovery' Cruise 123, August 5th - September 10th, 1981. Geological investigations on the continental slope to the west of the British Isles and Norway. I.O.S. Cruise Report No. 131, 11 pp 6 figs.

KENYON, N.H., 1981. A GLORIA survey of the northwest European continental slope. Dock and Harbour Authority, 63, 207 - 208.

1982

REES, A.I., BROWN, C.M., HAILWOOD, E.A. & RIDDY, P.J., 1982. Magnetic fabric of bioturbated sediment from the northern Rockall Trough: Comparison with modern currents. Marine Geology, 46, 161 - 173.

STRIDE, A.H., 1982. Geotechnical importance of GLORIA survey of the European continental slope. Paper 2.5 in Oceanology International 1982, Vol 1. Kingston-upon-Thames: Spearhead Exhibitions Ltd. (7 pp).

1983

PARSON, L.M., 1983. Structure and evolution of the western edge of the Rockall Plateau (Abstract). Geological Society Newsletter, 12, (1) 16 - 17.

ROBERTS, D.G., BOTT, M.H.P. & URUSKI, C.I., 1983. Structure and origin of the Wyville-Thomson Ridge. In: Structure and Development of the Greenland-Scotland Ridge: New Methods and Concepts. (Eds. Bott, M.H.P. *et al*.) Plenum Press, New York.

1984

KENYON, N.H., 1984. Morphology of the continental slope north of the Scotland from R.R.S. 'Discovery' Cruise 123. Prepared for the Department of Environment. I.O.S. Internal Document No. 225, 24 pp. (Unpublished manuscript).

ROBERTS, D.G., SCHNITKER, D. *et al*., 1984. Initial Reports of the Deep Sea Drilling Project, 81, Washington DC: U.S. Government Printing Office, 923 pp.

1985

PELTON, C.D., 1985. Geophysical interpretation of the structure and development of the Jan Mayen Ridge. I.O.S. Report No. 205. 39pp.

ROBERTS, D.G., JONES, M.T., & HUNTER, P.M., 1985. Magnetic anomalies in the Northeast Atlantic. I.O.S. Report and 2 charts No. 207. 9pp.

URUSKI, C.I. & PARSON, L.M., 1985. Geophysical compilations on the East Greenland Continental Margin and their use in gravity modelling across the continent-ocean transition. I.O.S. Report No. 214. 53pp.

In Press

DICKSON, R.R. & KIDD, R.B. Deep circulation in the southern Rockall Trough - the oceanographic setting of DSDP Site 610. In: Kidd, R.B., Ruddiman, W.F. *et al.*, Initial Reports of the Deep Sea Drilling Project, Washington DC: U.S. Government Printing Office.

HAILWOOD, E.A. & KIDD, R.B. Magnetic fabric results from Leg 94 drill sites. In: Kidd, R.B., Ruddiman, W.F. *et al.*, Initial Reports of the Deep Sea Drilling Project, 94: Washington DC: U.S. Government Printing Office.

HILL, P.R. & KIDD, R.B. Morphology and sedimentation of the Feni and Gardar sediment drifts. In: Kidd, R.B., Ruddiman, W.F. *et al.*, Initial Reports of the Deep Sea Drilling Project, 94: Washington DC: U.S. Government Printing Office.

JACOBS, C.L. Site surveys for DSDP Sites 608, 609 and 610, eastern North Atlantic Ocean. In: Kidd, R.B., Ruddiman, W.F. *et al.*, Initial Reports of the Deep Sea Drilling Project, 94: Washington, DC: U.S. Government Printing Office.

KIDD, R.B. & PEARSON, I. Unconformities in Northeastern Atlantic drill sites: revisions based on Leg 94 drilling. In: Kidd, R.B., Ruddiman, W.F. *et al.*, Initial Reports of the Deep Sea Drilling Project, 94: Washington DC: U.S. Government Printing Office.

KIDD, R.B. & RUDDIMAN, W.F. History of sediment drift formation in the Northeast Atlantic Ocean. In: Kidd, R.B., Ruddiman, W.F. *et al.*, Initial Reports of the Deep Sea Drilling Project, 94: Washington DC: U.S. Government Printing Office.

KIDD, R.B., RUDDIMAN, W.F. *et al.*, Initial Reports of the Deep Sea Drilling Project, 94: Washington DC: U.S. Government Printing Office.

MASSON, D.G. & KIDD, R.B. Tertiary seismic stratigraphy of the southern Rockall Trough around DSDP Site 610 (Leg 94). In: Kidd, R.B., Ruddiman, W.F. *et al.*, Initial Reports of the Deep Sea Drilling Project, 94: Washington DC: U.S. Government Printing Office.

APPENDIX B: Main geophysical and geological sampling cruises discussed in this report.

Key:-

B	Precision bathymetry
C	Rock coring
Drill	Drilling (DSDP)
DS	Dredge station(s)
G	Gravity
GS	Grab station(s)
LR	Long-range side scan sonar
M	Magnetics
MS	Multichannel seismic reflection profiling
RD	Rock drilling
RF	Seismic refraction profiles
SR	Short-range side scan sonar
SS	Single-channel seismic reflection profiling
SUB	Submersible sampling

APPENDIX B

Main Geophysical and Geological Sampling Cruises Discussed in This Report

Survey	Operator	Year	Area Surveyed (data collected)
Discovery 29	IOS	1969	Rockall Plateau (SS,RF,G,M,B)
Discovery 33	IOS	1970	Hatton-Rockall Basin, Rockall Trough (SS,M,B)
DSDP Leg 12	DSDP	1970	Hatton-Rockall Basin, Rockall Bank (SS,M,B, Drill)
MV Surveyor 1/71	IOS	1971	Rockall Plateau (SS,M,B,GS,DS)
Discovery 47	IOS	1972	Rockall Plateau (SS,SR,M,B,C,RD,GS)
MV Vickers Voyager	IOS/IGS	1973	Rockall Bank (SR,M,B,SUB)
Shackleton	Durham University	1973	Rockall Plateau & Margin, Margins of E. Greenland
Discovery 60	IOS	1974	Rockall Plateau (SS,SR,M,B)
Shackleton	Durham University	1974	E.Greenland Margin(SS,G,M,B)
WI Survey	Western Geophysical	1975	Rockall Trough, Rockall Plateau (MS)
NA Surveys Phases I, II & III	Western Geophysical	1975,6,9	Rockall Trough, Rockall Plateau (MS)
IPOD Survey	Seismograph Services Ltd. for IOS	1976	W. Rockall (MS,RF)
Shackleton 6/76	Durham University	1976	E. Greenland, Rockall & Norwegian Margins (SS,G,M,B)
IPOD Leg 48	DSDP	1976	W. Rockall (SS, Drill)
Shackleton 8/77	IOS/Cambridge University	1977	Reykjanes Ridge, N. Rockall Plateau (B,G,M)
Shackleton 9/77	Durham University	1977	E. Greenland, Jan Mayen Ridge. (MS,B,M,G)

Discovery 84	IOS	1977	Rockall Trough (LR,SR,SS,M,B,G)
CM Survey	S & A Geophysical for IOS	1977	Rockall Trough (MS,G,M,B)
MV Criscilla	IOS	1978	Wyville Thomson Ridge (MS,M,G)
MV Starella 1/79	IOS	1979	East Greenland (LR,SS,B,M)
IOS Survey	Western Geophysical for IOS	1981	W. Rockall (MS,G)
IPOD Leg 81	DSDP	1981	W. Rockall (SS, Drill)
IPOD Leg 94	DSDP	1983	Rockall Trough (SS,Drill)
Challenger 1/84	Edinburgh University	1983	Rockall Trough (SS,G,M,B)

APPENDIX C: Details of sample stations in the Rockall area. All dredge, core, grab and dive stations are located in Figure 2. Sample results are compiled and held on open file at I.O.S.

Station details include: Latitude, Longitude, survey details and data source if available.

SMBA = Scottish Marine Biological Association.

DREDGE STATIONS

POSITION		SURVEY	DATA SOURCE
59 26.100	-14 55.500		Watts et al.,1975
59 20.200	-15 30.400		"
59 24.100	-16 7.300		"
57 24.000	-10 45.000		Jones et al., 1974
58 9.500	-7 29.500	SURVEYOR 71/1	Wilson & Roberts, 1971
57 36.000	-14 30.900	"	" "
57 8.000	-13 14.000	"	" "
57 12.800	-13 7.200	"	" "
57 34.000	-13 28.000		Jones et al.,1972
56 15.400	-15 11.000		Roberts et al., 1972
56 16.000	-15 11.000		" "
59 24.100	-16 7.300		" "
56 16.000	-15 13.000		" "
57 30.420	-13 17.400		? ? ? ? ? ? ? ? ? ?
57 24.600	-13 3.200		" "
57 12.900	-13 7.200		" "
57 8.000	-13 14.500		" "
56 16.110	-15 11.050		" "
61 38.800	0 50.400	JOHN MURRAY 6	Cartwright & Wilson, 1972
61 39.100	0 35.800	"	" "
61 53.800	0 4.000	"	" "
61 29.200	0 14.100	"	" "
61 25.000	0 19.200	"	" "
61 24.900	-1 14.800	"	" "
61 23.800	-1 1.300	"	" "
60 52.400	-1 23.200	"	" "
60 22.300	-1 32.000	"	" "
60 22.000	-1 43.600	"	" "
60 6.200	-1 45.800	"	" "
60 8.100	-4 21.100	"	" "
60 10.000	-4 29.100	"	" "
60 6.300	-4 29.100	"	" "
60 6.300	-4 34.300	"	" "
59 48.000	-3 12.300	"	" "
58 39.700	-3 29.000	"	" "
58 39.800	-3 38.800	"	" "
58 29.500	-5 14.200	"	" "
59 6.000	-5 48.300	"	" "
59 12.700	-4 5.800	"	" "
59 25.200	-2 28.200	"	" "
59 20.700	-2 9.200	"	" "
59 15.000	-2 4.500	"	" "
59 45.200	-1 53.200	"	" "
61 38.800	0 52.500	CHALL. 12/79.	Wilson & Gould et al., 1983
61 39.000	0 52.700	"	" "
60 46.020	-2 40.330	"	" "
60 45.230	-2 51.010	"	" "
60 38.220	-2 55.770	"	" "
59 40.010	-2 34.720	"	" "
59 39.660	-2 29.300	"	" "
59 12.570	-4 6.190	"	" "

59	11.390	-4	8.100	"	"	"
59	13.090	-4	4.620	"	"	"
58	3.880	-8	23.800	"	"	"
56	44.420	-7	56.600	"	"	"
55	55.800	-8	39.280	"	"	"
55	56.100	-8	38.140	"	"	"
55	55.620	-8	37.300	"	"	"
55	54.890	-8	36.530	"	"	"
60	49.200	-2	29.200	CHALL. 9/81.	Wilson et al.,1982	
60	49.300	-2	33.400	"	"	
60	43.900	-2	32.300	"	"	
60	47.400	-2	36.000	"	"	
60	47.200	-2	38.100	"	"	
59	42.000	-2	36.400	"	"	
60	39.800	-2	33.800	"	"	
55	50.200	-7	44.400	"	"	
55	48.940	-7	40.820	CHALLENGER 14/74	Wilson et al., 1975	
58	50.610	-7	4.500	"	"	
60	33.990	-3	8.750	"	"	
60	30.690	-3	9.570	"	"	
47	0.100	-6	37.000		Auffret et al., 1979	
47	7.700	-6	36.300		"	
47	16.900	-8	41.200		"	
47	43.900	-8	26.700			
47	27.900	-7	35.900		"	
47	30.700	-7	41.800		"	
47	32.600	-7	32.000		"	
47	15.900	-6	32.200		"	
48	1.700	-8	59.300		"	
47	58.600	-9	9.500		"	
48	0.000	-9	41.200		"	
48	11.700	-9	55.000		"	
48	24.000	-9	58.500		"	
48	21.400	-10	24.200		"	
48	21.600	-10	24.400		"	
48	9.400	-10	10.000		"	
48	26.000	-10	58.200		"	
48	16.000	-12	0.000		"	
47	59.100	-12	4.900		"	
47	19.000	-8	40.300		"	
47	54.000	-9	14.200		"	
47	26.500	-7	35.000		"	
47	24.500	-7	29.300		"	
47	59.800	-12	8.400		"	
47	59.800	-12	7.700		"	
47	58.900	-12	6.800		"	
47	59.200	-12	7.100		"	
47	47.500	-12	16.200		"	
47	46.000	-12	19.600		"	
48	34.200	-12	35.100		"	
48	34.800	-12	34.300		"	
48	26.600	-11	19.900		"	
48	36.300	-11	10.100		"	
47	46.900	-12	18.400		"	

54 23.000	-11 21.000		Dobson et al.,1976
51 54.000	-15 6.000		"
54 3.000	-12 2.000		"
53 43.000	-14 11.000		"
57 27.000	-12 57.000		"
60 19.100	-9 13.200		Jones et al.,1982
60 20.300	-9 13.500		"
60 14.700	-9 8.600		"
59 6.000	-11 18.000		Dietrich & Jones, 1980
57 4.300	-14 31.900		Miller et al., 1973.
56 16.500	-15 11.800		"
57 34.000	-14 32.000		Unpub.I.O.S.data.
59 4.000	-10 42.000		Vema & Chain data
60 7.000	-2 50.000		" "
60 9.000	-2 49.000		" "
60 8.000	-2 45.000		" "
60 14.000	-2 53.000		" "
56 16.400	-21 24.200		" "
59 30.000	-14 47.000		" "
59 12.000	-10 28.000		" "
59 20.000	-15 32.000		" "
59 22.000	-16 4.000		" "
57 24.000	-10 46.000		" "
57 24.000	-10 40.000		" "
48 9.180	-15 55.850		" "
62 37.700	-25 21.000		" "
48 47.000	-10 1.500		" "
48 46.000	-10 2.000		" "
50 44.000	-29 52.000		" "
57 35.200	-13 32.000		" "
57 35.200	-13 32.000		" "
55 9.000	-12 5.000	Unpublished,SMBA,bathyal & abyssal benthos data.	
56 46.000	-10 2.000	" " "	
56 36.000	-11 11.000	" " "	
56 47.000	-10 8.000	" " "	
56 45.000	-9 50.000	" " "	
56 45.000	-9 33.000	" " "	
56 43.000	-9 22.000	" " "	
56 43.000	-9 17.000	" " "	
56 43.000	-9 15.000	" " "	
56 36.000	-9 13.000	" " "	
56 30.500	-5 35.800	" " "	
55 3.000	-12 3.000	" " "	
55 4.000	-12 3.000	" " "	
56 36.000	-9 0.000	" " "	
56 37.000	-9 2.000	" " "	
53 31.000	-12 13.000	" " "	
52 56.000	-12 58.000	" " "	
52 32.000	-12 42.000	" " "	
50 3.000	-13 28.000	" " "	
57 5.000	-8 38.400	SURVEYOR 71/1	Wilson & Roberts.,1971
59 14.000	-6 46.000	"	"
55 49.000	-9 9.500	"	"
59 14.500	-6 36.500	"	"

56 41.000	-14 35.000	"	"
59 15.000	-3 27.000	"	"
59 14.300	-3 13.600	"	"
59 32.700	-1 34.200	"	"
59 22.890	-1 32.290	"	"
58 29.500	-5 14.200	"	"

GRAB STATIONS

POSITION	SURVEY	DATA SOURCE
56 47.100 -14 57.500	Surveyor71/1	Wilson & Roberts, 1971
56 45.900 -14 43.000	"	" "
56 43.300 -14 34.500	"	" "
56 41.000 -14 35.000	"	" "
56 39.000 -14 25.500	"	" "
50 38.200 -14 16.900	"	" "
56 37.100 -14 13.200	"	" "
56 31.500 -14 25.500	"	" "
56 33.800 -14 34.500	"	" "
56 36.500 -14 47.100	"	" "
56 36.600 -14 55.000	"	" "
57 24.600 -13 11.700	"	" "
57 23.500 -13 9.500	"	" "
57 22.800 -13 6.500	"	" "
57 15.500 -13 11.500	"	" "
57 14.000 -13 8.200	"	" "
57 9.700 -13 24.000	"	" "
57 2.500 -13 38.000	"	" "
57 7.800 -13 46.900	"	" "
57 12.700 -13 54.500	"	" "
57 15.500 -14 2.500	"	" "
57 15.200 -14 15.000	"	" "
57 54.100 -13 8.100	"	" "
57 50.200 -13 9.500	"	" "
57 48.700 -13 17.000	"	" "
57 48.200 -13 24.000	"	" "
57 47.500 -13 34.000	"	" "
57 50.900 -13 40.000	"	" "
57 54.200 -13 47.500	"	" "
57 57.500 -13 54.700	"	" "
57 52.000 -14 5.000	"	" "
57 43.500 -14 7.200	"	" "
57 35.500 -14 23.200	"	" "
57 17.000 -9 16.000	"	" "
57 22.400 -9 11.000	"	" "
57 27.200 -9 14.000	"	" "
57 32.200 -9 15.000	"	" "
57 41.000 -9 14.000	"	" "
57 47.000 -9 11.500	"	" "
57 51.000 -9 6.000	"	" "
58 24.000 -7 58.000	"	" "
58 23.400 -7 47.000	"	" "
58 22.200 -7 36.200	"	" "
58 21.500 -7 23.000	"	" "
57 53.180 -13 16.250	"	" "
57 42.100 -14 26.800	"	" "
56 21.550 -15 8.410	Discovery 47	Roberts et al., 1972
56 23.340 -15 13.140	"	"
56 21.850 -15 13.770	"	"
56 22.090 -15 11.920	"	"
56 19.290 -15 10.500	"	"

56 18.370	-15 12.520	"	"	
56 17.400	-15 13.110	"	"	
56 16.770	-15 12.410	"	"	
56 16.690	-15 13.070	"	"	
56 14.910	-15 12.210	"	"	
56 13.620	-15 15.800	"	"	
56 15.600	-15 14.600	"	"	
56 17.400	-15 14.300	"	"	
56 19.400	-15 15.600	"	"	
56 20.300	-15 13.100	"	"	
56 23.200	-15 14.900	"	"	
56 22.350	-15 11.900	"	"	
56 23.200	-15 11.600	"	"	
56 24.000	-14 58.200	"	"	
56 18.600	-14 48.400	"	"	
56 15.000	-14 58.200	"	"	
56 10.200	-15 8.000	"	"	
56 11.500	-15 17.400	"	"	
56 57.000	-14 42.800	"	"	
57 1.000	-14 52.700	"	"	
57 6.900	-14 49.200	"	"	
57 4.900	-14 37.800	"	"	
56 16.500	-15 11.800	"	"	
56 31.000	-15 2.000	"	"	
56 41.500	-14 51.500	"	"	
56 32.000	-5 19.000		Unpublished SMBA data.	
59 39.000	-7 0.000		"	"
59 36.000	-7 5.000		"	"
60 12.000	-8 14.000		"	"
60 10.000	-8 14.000		"	"
60 10.000	-8 12.000		"	"
59 50.000	-6 43.000		"	"
59 50.000	-6 43.000		"	"
59 55.000	-6 27.000		"	"
59 55.000	-6 26.000		"	"
59 57.000	-6 14.000		"	"
59 57.000	-6 15.000		"	"
60 6.000	-5 55.000		"	"
60 5.000	-5 55.000		"	"
60 5.000	-5 56.000		"	"
61 13.000	-3 59.000		"	"
61 15.000	-3 59.000		"	"
60 17.000	-9 14.000		"	"
60 17.000	-9 16.000		"	"
60 11.000	-9 38.000		"	"
60 12.000	-9 37.000		"	"
60 2.000	-10 41.000		"	"
60 2.000	-10 40.000		"	"
59 15.000	-10 11.000		"	"
59 15.000	-10 10.000		"	"
59 21.000	-11 3.000		"	"
59 2.000	-11 6.000		"	"
58 24.000	-12 36.000		"	"
58 23.000	-12 34.000		"	"

56 39.000	-9 8.000	"	"

CORE STATIONS

POSITION	SURVEY	DATA SOURCE
53 57.400 -04 8.133		Eden et al.,1969.
53 40.500 -04 3.166		" "
57 25.000 -10 56.000		? ? ? 1974.
57 24.000 -10 51.000		" "
57 24.000 -10 47.000		" "
57 4.000 -14 31.000		Roberts et al.,1973.
56 16.000 -15 13.000		" "
56 16.200 -15 13.000		Roberts et al.,1972.
56 16.400 -15 13.000		" "
57 4.300 -14 31.900		? ? ? 1973.
56 16.500 -15 11.800		" "
56 2.560 -23 13.880	DSDP Leg 81	Roberts,Schnitker et al.,1984
56 5.320 -23 20.610	"	" "
56 17.400 -23 31.690	"	" "
56 33.700 -20 46.930	"	" "
53 13.300 -18 53.200	DSDP Leg 94	Kidd,Ruddiman et al.,(in prep.)
47 22.900 -9 11.900	DSDP Leg 48	Montadert,Roberts et al.,1979
47 25.650 -8 48.620	"	" "
47 52.480 -8 50.440	"	" "
56 8.130 -23 17.640	"	" "
56 3.130 -23 14.950	"	" "
55 20.180 -22 3.490	"	" "
55 15.500 -22 5.410	"	" "
63 21.060 -7 47.270	DSDP Leg 38	Talwani,Udintsev et al.,1976
63 38.970 -12 28.260	"	" "
58 54.400 -21 7.000	DSDP Leg 12	Laughton,Berggren et al.,1972
57 29.760 -15 55.460	"	" "
57 20.170 -15 23.970	"	" "
60 39.000 -2 52.000		Ridd, 1983
48 54.930 -12 9.870		Graciansky,Poag et al.,1981
49 5.280 -13 5.880		" "
48 30.960 -13 26.320		" "
48 54.640 -13 30.090		" "
56 23.290 -15 13.200	Discovery 47.	Roberts et al., 1972
56 21.830 -15 13.690	"	"
56 22.130 -15 11.360	"	"
56 19.370 -15 10.320	"	"
56 18.090 -15 12.950	"	"
56 17.500 -15 13.050	"	"
56 16.800 -15 12.490	"	"
56 16.530 -15 12.530	"	"
56 14.760 -15 12.160	"	"
56 13.600 -15 15.800	"	"
56 15.600 -15 14.400	"	"
56 17.400 -15 14.400	"	"
56 19.200 -15 15.500	"	"
56 20.600 -15 13.200	"	"
56 23.280 -15 14.680	"	"
56 22.400 -15 12.370	"	"
56 23.200 -15 11.600	"	"
56 16.500 -15 11.800	"	"

57	4.270	-14	31.950	"	"
55	2.000	-12	3.000		Unpublished,SMBA data.
56	32.000	-5	19.000		" "
55	4.000	-12	6.000		" "
55	3.000	-12	3.000		" "
55	4.000	-12	4.000		" "
55	3.000	-12	5.000		" "
55	4.000	-12	2.000		" "
55	3.000	-12	3.000		" "
54	41.000	-12	17.000		" "
56	35.000	-11	3.000		" "
57	8.000	-12	9.000		" "
57	28.000	-11	0.000		" "
56	37.000	-9	49.000		" "
56	38.000	-9	29.000		" "
56	39.000	-9	40.000		" "
56	39.000	-9	23.000		" "
56	39.000	-9	13.000		" "
58	42.000	-9	43.000		" "
57	3.000	-7	1.000		" "
54	37.000	-12	13.000		" "
48	27.000	-10	20.000		" "
48	27.000	-10	21.000		" "
50	55.000	-12	21.000		" "

DIVE SITES

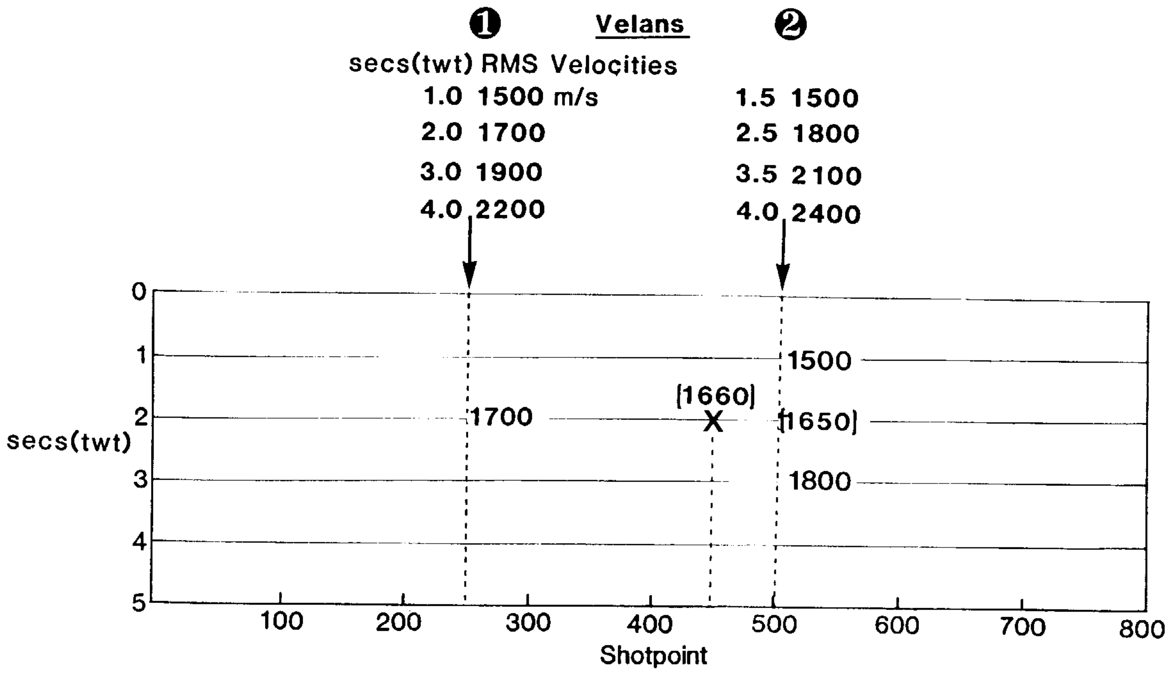
POSITION		SURVEY	DATA SOURCE
57 39.400	-13 38.800	Vickers Voyager	Roberts & Eden, 1974
57 39.550	-13 39.100	"	" "
57 37.800	-13 43.200	"	" "
57 37.300	-13 45.200	"	" "
57 54.900	-13 52.300	"	" "
57 3.750	-14 32.000	"	" "
56 58.500	-14 35.600	"	" "
56 58.100	-14 43.400	"	" "
57 36.600	-14 29.100	"	" "
57 29.300	-14 43.500	"	" "
56 35.300	-14 52.300	"	" "
56 34.000	-14 58.900	"	" "
57 34.100	-13 42.000	"	" "
57 33.850	-13 39.400	"	" "

APPENDIX D

Depth Migration Programme (used in construction of Fig. 5b)

In order to present seismic reflection profiles in a more useful depth-migrated format, a suite of depth migration programmes was written for a BBC micro computer. These programmes calculate and plot the true depths of key reflectors, using depths (TWT) interpreted from reflection profiles, and velocities derived from velans (calculated during seismic processing). Velans data are entered as a series of RMS velocities and TWT picks are located along track by shotpoint values. Interpreted key reflectors, including the dipping reflectors and suitable Tertiary sediment horizons are manually digitised and entered at intervals of 30 shotpoints (1.5 km) or less. True depths are computed using a programme involving vertical and horizontal extrapolation between velan picks. In detail, this programme assumes a linear relationship between adjacent velocity analyses and subjacent velocity picks. Proportional velocity values are calculated to correct sections of interpreted seismic horizons falling between values provided in the velans, in a manner illustrated schematically in Fig. App.D 1.

The programme provides a rapid and flexible means to obtain a first approximation to a true depth section. The limitations of performing the migration in this fashion, however, are obvious and are under refinement. Firstly, the assumed linear relationship in both horizontal and vertical dimensions is unrealistic and requires an integrated extrapolation. Secondly, the laborious manual digitisation requires full replacement by an automatic process.



Point X = 2 secs at Shotpoint 450

Velocity at Velan 1 = 1700 m/s. Velocity at Velan 2 calculated proportionally = 1650 m/s.

Velocity at Point X is caculated proportionally in the horizontal axis as 1660 m/s. True depth is therefore 2 x 1660 / 2000 kms. (1.66 kms.)

Fig App-D1

```
 10 REM ***** Program to calculate true depths
 11 REM ***** from digitised seismic reflection data
 12 REM ***** C.D. PELTON 1985
 20 VDU26,12
 30 DIM Z(40,60)
 40 DIM K(40,3)
 50 PROCtitle
 60 PROCinput
 70 PROCvcalc
 80 DEF PROCtitle
 90 PRINTTAB(12) CHR$(141);CHR$(132);"VELAN"
100 PRINTTAB(12) CHR$(141);CHR$(132);"VELAN"
110 PRINT CHR$(132)"This programme converts"
120 PRINT CHR$(132) "seconds two-way time to true depth."
130 PRINT
140 PRINT CHR$(134)"After ´DEPTH´ prompt,type"
150 PRINT CHR$(134)"C/R to place results in plotting file."
160 PRINT
161 PRINT CHR$(129)"PRESS ´SPACE BAR´ TO CONTINUE."
162 IF GET =-32 THEN 163
163 CLS
164 ENDPROC
170 DEF PROCinput
180 VDU132,157
190 PRINT CHR$(134)"File of velan data?";
200 INPUT SPC(1)A$
210 @%=&20205
220 Y=OPENIN (A$)
230 FOR J%=2 TO 60 STEP 2
240 IF EOF#Y THEN 410
250 INPUT#Y,N%
260 S%=J%
270 IF N%=0 THEN J%=99:GOTO 400
280 INPUT#Y,P
290 I%=1
300 REPEAT
310 I%=I%+1
320 INPUT#Y,T
330 IF T=0 THEN 390
340 INPUT#Y,V
350 Z(1,J%-1)=N%
360 Z(1,J%)=P
370 Z(I%,J%-1)=T
380 Z(I%,J%)=V
390 UNTIL T=0
400 NEXT J%
410 CLOSE# Y
420 VDU28,0,24,39,3
430 ENDPROC
570 DEF PROCvcalc
580 Q%=1
590 REPEAT
```

```
  600 PRINT
  610 PRINT CHR$(131)"DEPTH IN SECS.TWT.";
  620 INPUT SPC(1)T
  630 IF T>0 AND T<10 THEN 690
  640 IF T=0 THEN 1230
  650 IF T>=10 PRINT CHR$(129);CHR$(136) T " seconds!-Is this
correct! Y/N"
  660 INPUT SPC(1)T$
  670 IF T$="Y" THEN 690
  680 IF T$="N" THEN 610
  690 PRINT
  700 PRINT CHR$(130)"SHOTPOINT";
  710 INPUT SPC(1)S
  720 IF S<Z(1,2) OR S>Z(1,S%-2) THEN PRINT CHR$(129)"Shotpoint
value out of area!":GOTO 700
  730 J%=0
  740 REPEAT
  750 J%=J%+2
  760 UNTIL S<=Z(1,J%)
  770 FOR I%=2 TO 40
  780 B=Z(I%+1,J%-1)
  790 D=Z(I%+1,J%)
  800 C=Z(I%,J%)
  810 A=Z(I%,J%-1)
  820 R=Z(1,J%-1)
  830 M=Z(1,J%)
  840 IF T<=A OR T<=B OR B=0 THEN I%=99
  850 NEXT I%
  860 IF T<=A THEN 910
  870 IF T<=B GOTO 930
  880 IF B=0 THEN 890
  890 Z=C
  900 GOTO 940
  910 Z=C
  920 GOTO 940
  930 Z=(((((T-A)/(B-A))*(D-C)))+C)
  940 IF S=M THEN O=Z*T/(2*10^3):GOTO 1190
  950 FOR I%=2 TO 40
  960 F=Z(I%+1,J%-3)
  970 H=Z(I%+1,J%-2)
  980 E=Z(I%,J%-3)
  990 G=Z(I%,J%-2)
 1000 P=Z(1,J%-3)
 1010 N=Z(1,J%-2)
 1020 IF F=0 OR T<=E OR T<=F THEN I%=99
 1030 NEXT I%
 1040 IF F=0 THEN 1090
 1050 IF T<=E GOTO 1070
 1060 IF T<=F GOTO 1110
 1070 W=G
 1080 GOTO 1120
 1090 W=G
```

```
1100 GOTO 1120
1110 W=(((((T-E)/(F-E))*(H-G)))+G)
1120 IF S=N THEN O=W*T/(2*10^3):GOTO 1190
1130 L=(S-Z(1,J%-2))/(Z(1,J%)-Z(1,J%-2))
1140 IF Z<W THEN 1180
1150 IF Z>W THEN 1160
1160 O=((L*(Z-W))+W)*T/(2*10^3)
1170 GOTO 1190
1180 O=(W-(L*(W-Z)))*T/(2*10^3)
1190 PRINT CHR$(134)"True depth="O"kms":Q%=Q%+1
1200 K(Q%,1)=O
1210 K(Q%,2)=S
1220 K(Q%,3)=T
1230 UNTIL T=0
1240 PROCfile
1250 ENDPROC
1260 DEF PROCfile
1270 PRINT CHR$(129)"Name of plotting file?"
1280 INPUT B$
1290 V=OPENOUT (B$)
1300 PRINT
1310 PRINT CHR$(129)"Horizon";
1320 INPUT H%
1330 K(1,2)=H%
1340 PRINT#V,H%
1350 FOR X%=2 TO Q%
1360 PRINT#V,K(X%,1),K(X%,2),K(X%,3)
1370 NEXT X%
1380 CLOSE#V
1390 CLS
1400 VDU31,0,10:VDU130,157:PRINT CHR$(129)"Data loaded to file:"B$
1410 PRINT CHR$(134)"Do you want to continue? Y/N";
1420 INPUT C$
1430 IF C$="Y" THEN CLS:PROCvcalc
1440 IF C$="N" THEN VDU26,12:GOTO 1450
1445 ENDPROC
1450 END
```