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1. INTRODUCTION

The TASC Magsat investigation covers an area in the eastern Indian Ocean containing several major bathymetric and tectonic features (Fig. 1). The overall objectives of this investigation are:

- Production of magnetic anomaly maps from Magsat data covering the study region (0° - 50° S, 75° E - 115° E)
- Comparison of Magsat and satellite altimeter data in this area, and quantification of their relationships
- Determination of the optimum resolution of Magsat anomaly maps of the study region
- Interpretation of the Magsat data using satellite altimeter and other geophysical data in order to determine the origin and sources of the observed magnetic anomalies.

The first part of this investigation is a study of individual profiles of Magsat data to characterize the quality and resolution capability of the data and to locate major anomalies. Preliminary results of this work are presented in Refs. 1, 2, and 3 and in this report. Important results obtained thus far include a preliminary estimate of the resolution capability (≃250 km), identification of significant anomaly features, and results bearing on the problem of data spike removal.

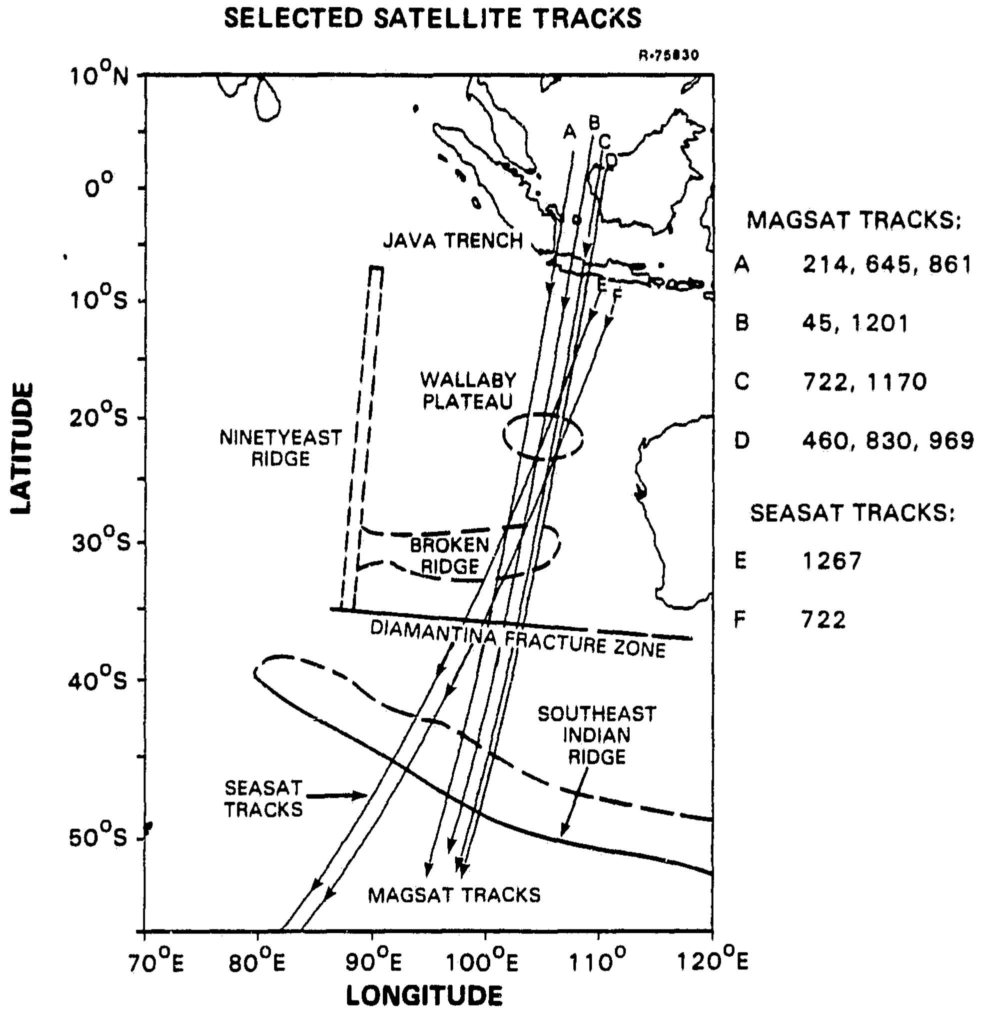

SELECTED SATELLITE TRACKS

Figure 1 Study Area, With Selected Magsat and SEASAT Tracks

2. PROGRESS

The main efforts during this quarter of the TASC Magsat investigation have been to verify the results obtained in the first quarter and to continue the study of individual Magsat anomaly profiles, using data from a newly received Investigator tape. Previous results (Ref. 1) were based on a study of isolated tracks using a preliminary Investigator tape. The recent work used groups of tracks (Fig. 1) which are very close in geographic location (though not necessarily close in altitude). This work has demonstrated the repeatability of certain anomaly features and has also resulted in improved estimates of the anomaly spectrum.

Investigation of the data quality led to analyses of the average value (over 80 vector data points, or $\simeq$ 36 km intervals) and of the standard deviation of this average, as a means of identifying noisy portions of the data. It was discovered that plots of the average value minus the individual (measured) point value are most useful for identification of noisy areas and data spikes.

The results of spectrum analysis were improved over those reported previously. The earlier results (Refs. 1 and 2) showed a noise floor level of 1 to 2 γ (nT), and spectra with a slope of approximately -2. Results using edited (spikes removed) data from the newer Investigator tape show that the noise floor is less than 1 nT and the slope of the spectrum in the region of wavelengths between 1200 km and 250 km is approximately -3. Consequently, the estimated resolution limit has improved from $\simeq$360 km to $\simeq$250 km.

The results presented in the next section will also be presented at the IAGA assembly in Edinburgh (Ref. 3.).

3. RESULTS

One of the objectives of this investigation is to develop quantitative relationships between the gravity field and Magsat magnetic anomalies in the eastern Indian Ocean. This analysis must be done in three dimensions, using data gridded at a reference (constant) altitude. However, for a preliminary and qualitative look at this question, a few individual profiles of satellite data have been considered.

Figure 1 shows the locations of several Magsat and SEASAT ground tracks. The SEASAT radar altimeter observed the sea surface height relative to a reference ellipsoid, which is approximately equivalent to the geoid (perturbed by small contributions from oceanographic and other noise sources). Geoid features correlate strongly with bathymetric and tectonic features and SEASAT data has the capability of resolving such features with wavelengths as short as 30 km (Ref. 4). A spatial correlation is expected between geoid and magnetic anomaly features, and this will be shown qualitatively using the figures below. A direct comparison of individual SEASAT and Magsat profiles is not possible because of the difference in inclination of the orbits of the two satellites (Fig. 1).

Figure 2 shows a portion of SEASAT Rev 722 with a second order trend removed to emphasize features of interest. The Java Trench and the Southeast Indian Ridge are the major tectonic features, having geoid signatures characteristic of their type. Significant bathymetric features such as Wallaby Plateau, Broken Ridge, and Diamantina Fracture Zone are associated with geoid signatures up to several meters in amplitude.

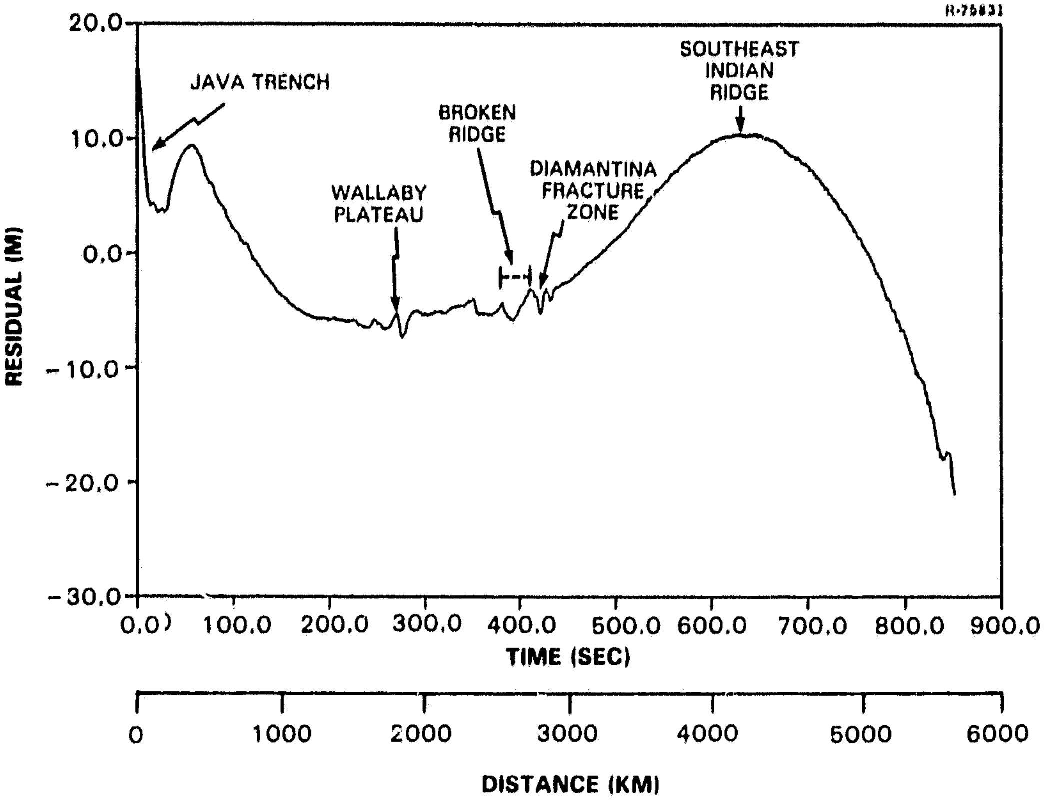


Figure 2 SEASAT Profile Minus Second-Order Trend, Rev. 722

This is shown more clearly in Fig. 3, which is an expanded view of a portion of Fig. 2. From this profile, it is clear that geoid features as short as 50 km can be resolved by SEASAT. The resolution limit of SEASAT data for observing geoid features has been shown to be about 30 km (Ref. 4) and was determined from study of SEASAT repeat tracks (tracks separated by less than 3 km in geographic location). Spectral coherence was computed for pairs of repeat tracks and the resolution limit was defined as being the wavelength at which there is no significant coherence between the two repeat tracks. This technique will be applied to Magsat data, although differences in altitude between Magsat "repeat" tracks will have to be taken into account. However, under certain approximations, a difference in altitude will not affect the spectral coherence. (Upward continuation is a linear operation on the spectrum.)

This approach to repeat-track analysis will be investigated during the next quarter, as a final item to check before changing the emphasis of the investigation from along-track geometries to two-and three-dimensions.

Figures 4 through 7 illustrate the repeatability of certain anomaly features in Magsat data. Shown is the anomaly in |B| relative to the MGS481#2 field model. Although the scales on the plots are different, there is good qualitative agreement in the form of the major anomaly features. (Linear trends have not been removed from any of the anomaly profiles shown.) These magnitude profiles are derived from the vector data, but the anomaly profiles of the individual vector components appear to be more noisy and show less visual correlation

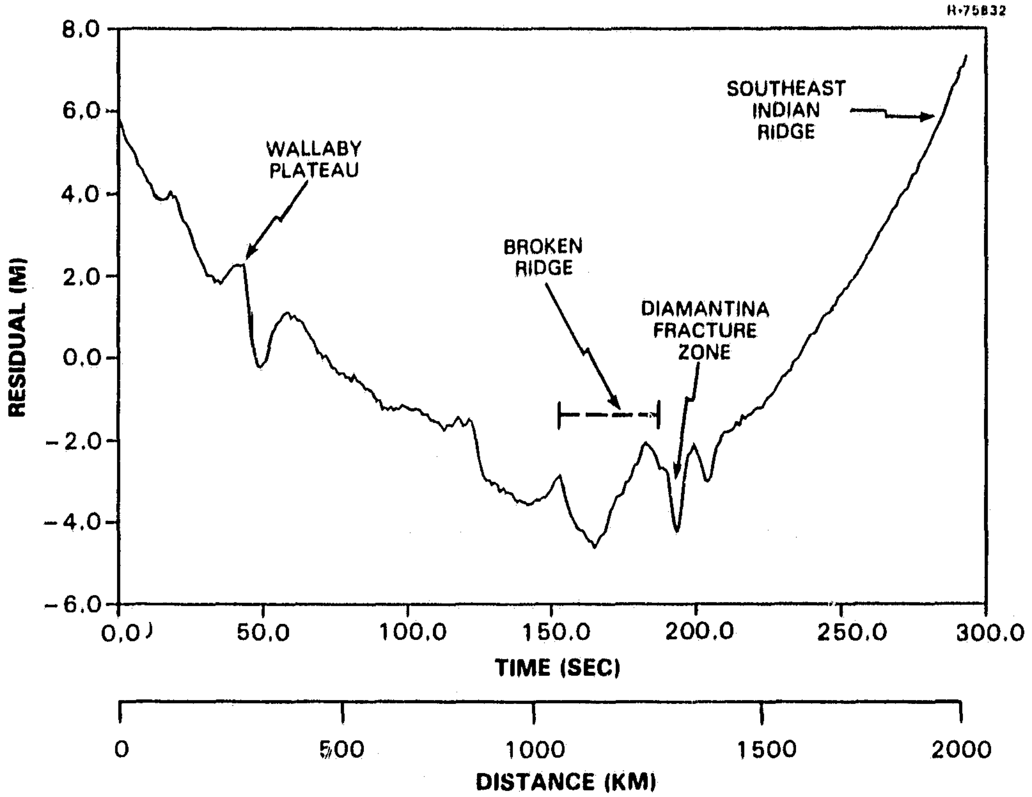


Figure 3 SEASAT Profile Minus Linear Trend, Rev. 722

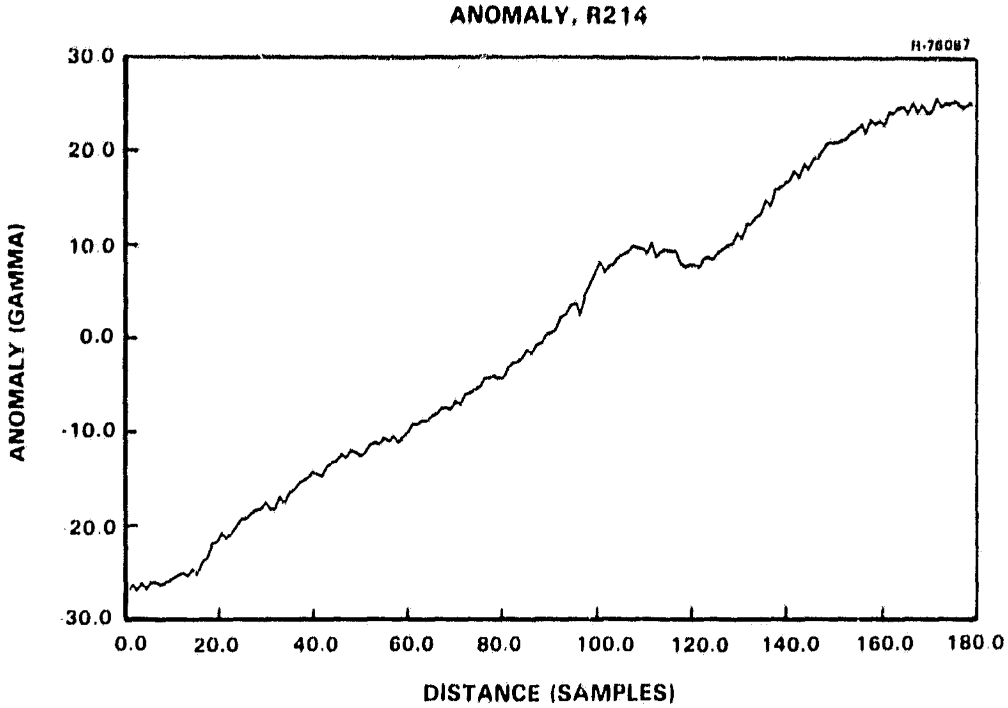
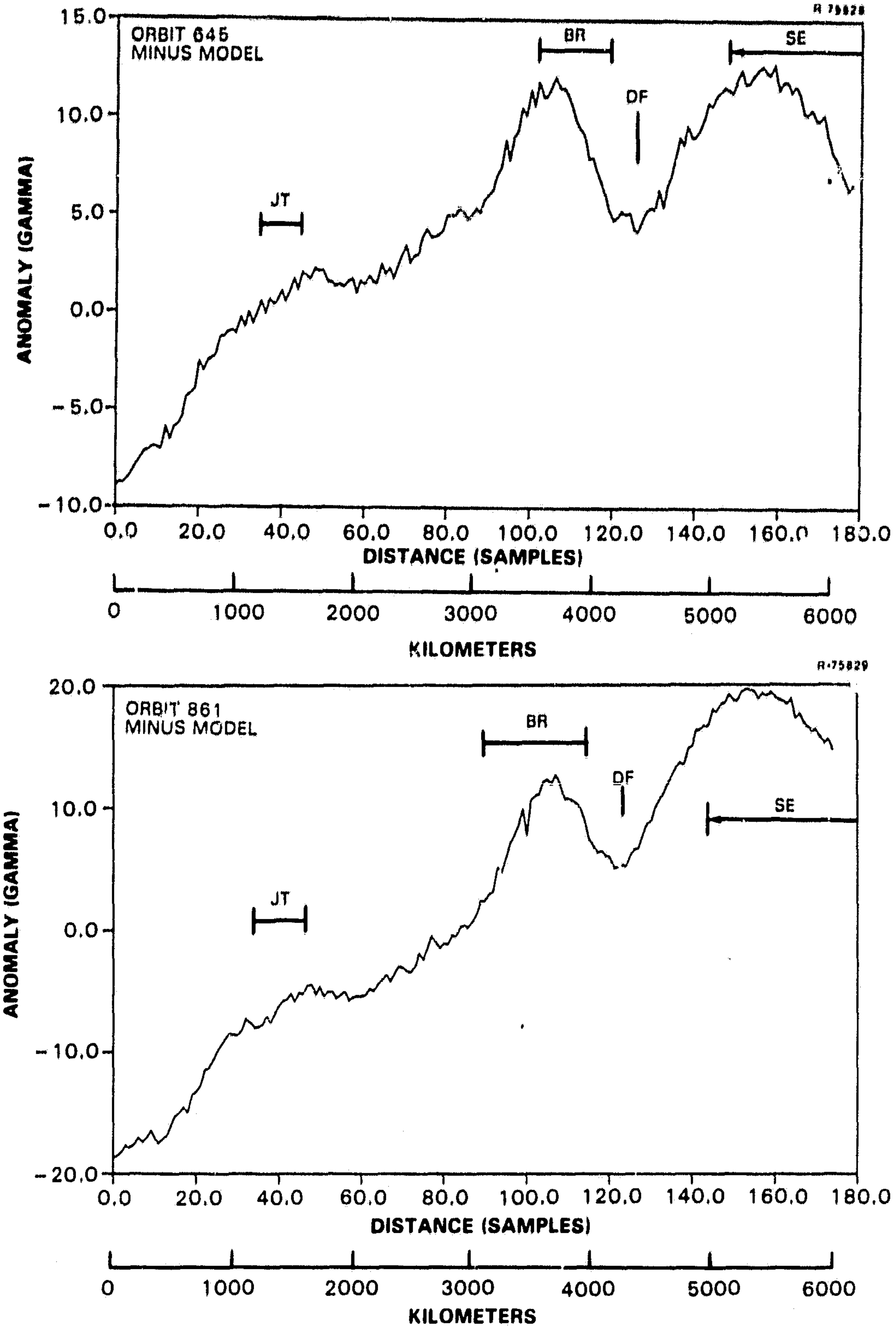


Figure 4 Anomaly in |B| for Orbit 214 (Paired with Orbits 645 and 861, See Figs. 1 and 5)

with the same component of the other "repeat" tracks. This is because the individual components are more sensitive to satellite position than the magnitude.

The most prominent anomaly feature in these tracks, associated with Broken Ridge and Diamantina Fracture Zone, has an amplitude of up to 10 γ. The anomaly features associated with the Java Trench and the Southeast Indian Ridge are not as consistent. It may be that anomalies associated with the latter features have longer wavelength components and thus do not show up as well against the background of the time-varying effects, which contribute long-wavelength trends to the profiles.

Comparison of Fig. 6 with Fig. 7 shows that the data on the older Investigator tape are noisier. This is confirmed



KEY: JT – JAVA TRENCH
BR – BROKEN RIDGE
DF – DIAMANTINA FRACTURE ZONE
SE – SOUTHEAST INDIAN RIDGE

Figure 5 Comparison of Field Magnitude Anomaly for Orbits 645 and 861

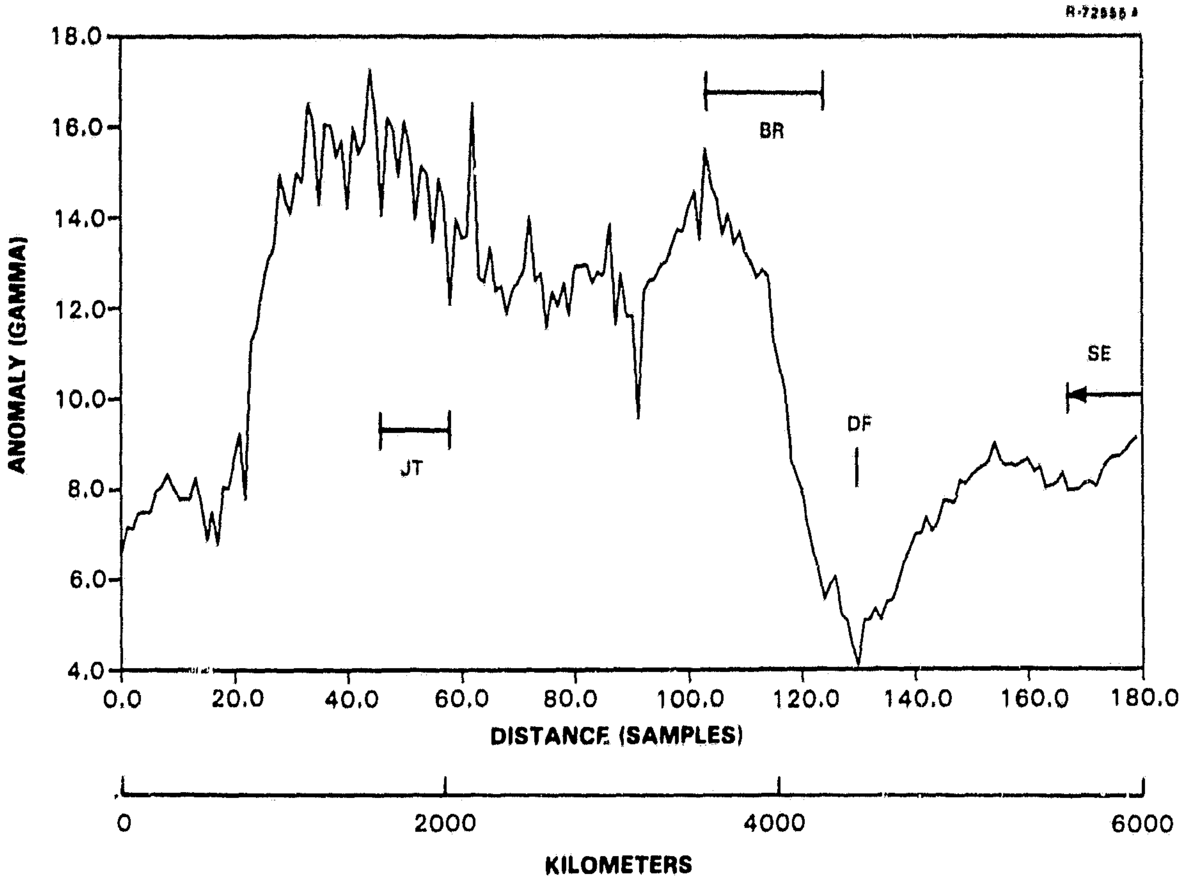


Figure 6 Anomaly Profile for |B| from (Old Tape) Vector Data of Pass #45. Average Sample Spacing is 35.3 km/sample. Physiographic features indicated are: JT-Java trench, BR-Broken Ridge, DF-Dimantina Fracture Zone, SE-Southeast Indian Ridge

from a comparison of the PSD estimates (Figs. 11 to 13), where the newer data has a lower noise floor, primarily due to better spike removal.

For the purpose of identifying noisy portions of data, it seemed appropriate to first look at the standard deviation of the 80-point running average, which is provided on the Investigator tapes. However, as Fig. 8 shows, this quantity mainly reflects the field gradient since the field changes significantly in the ≃36 km interval over which the 80 observations

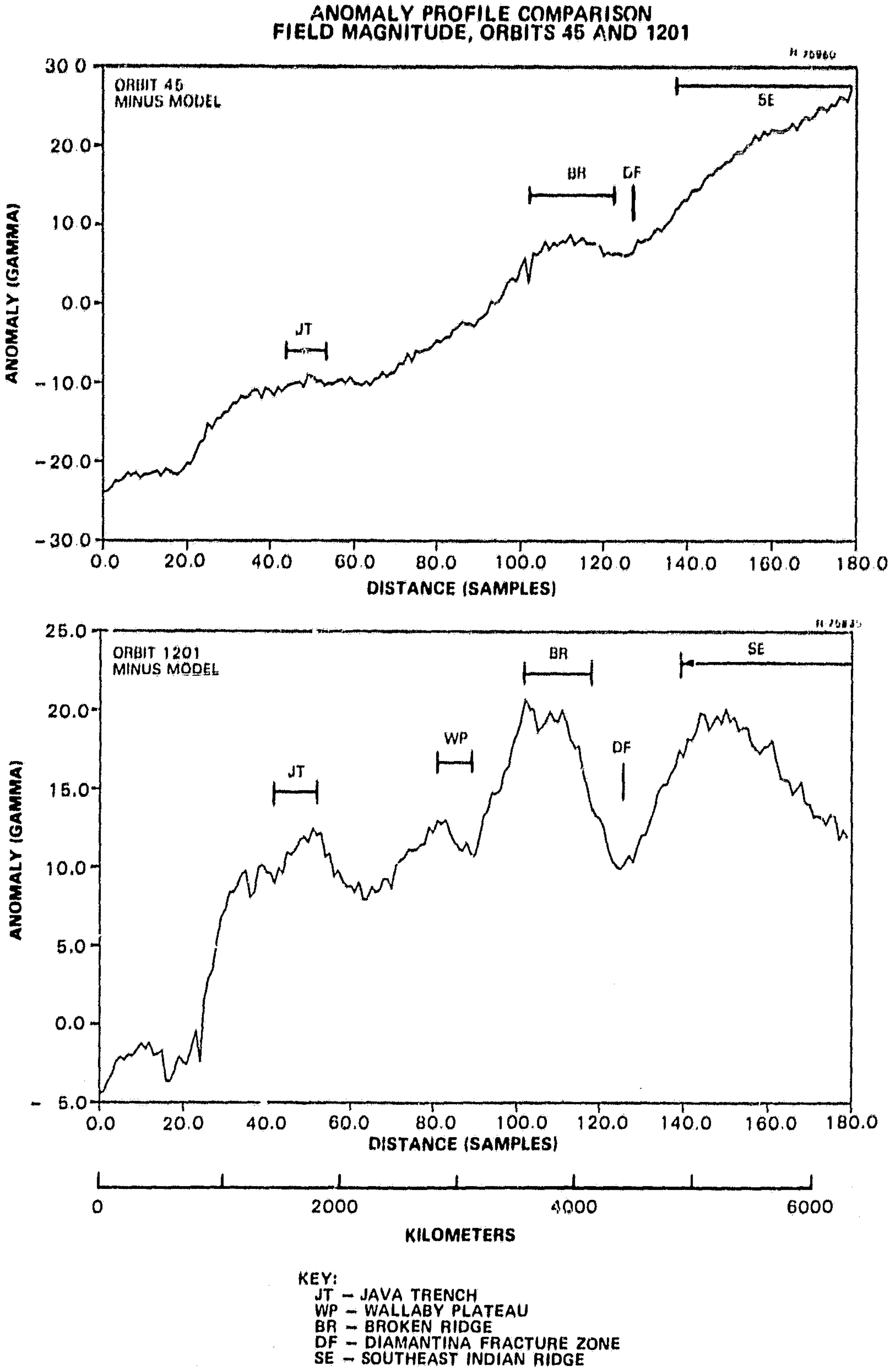


Figure 7 Comparison of |B| Anomaly for Orbits 45 and 1201. Although the long wavelength components are significantly different between these two orbits, qualitatively, the anomaly features correlate well.

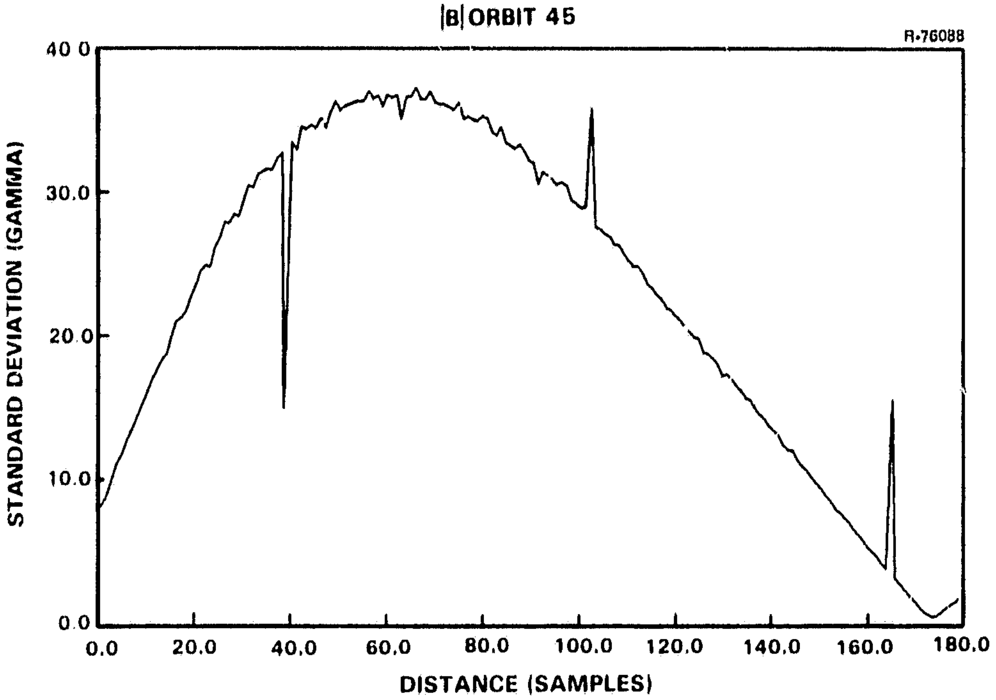


Figure 8 Standard Deviation of the Running Average Over 80 Observations

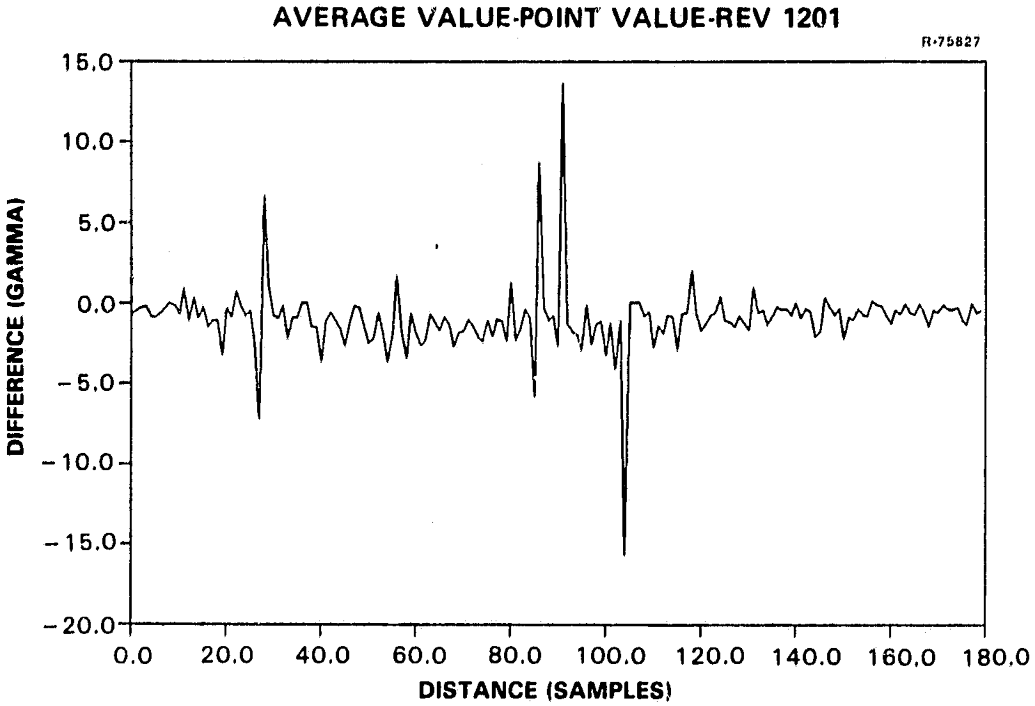


Figure 9 Field Magnitude Minus 80-Point (36 KM) Running Average

are averaged. Discussions with Dr. Langel led to the suggestion by TASC that this standard deviation quantity be replaced on future Investigator tapes, as it is not useful for showing short-wavelength noise. For example, for orbit 45, the field gradient in the Z component is large, and the standard deviation of the averages has the form of a ramp, with the standard deviation ranging from about 120 to 5 nT.

A more useful quantity for study of the quality of the Magsat data is formed by subtracting the 80-point running average from the observed values. This is plotted in Figs. 9 and 10, which show this quantity to be much less sensitive to the field gradient and shows more clearly the data spikes and the areas which are more noisy.

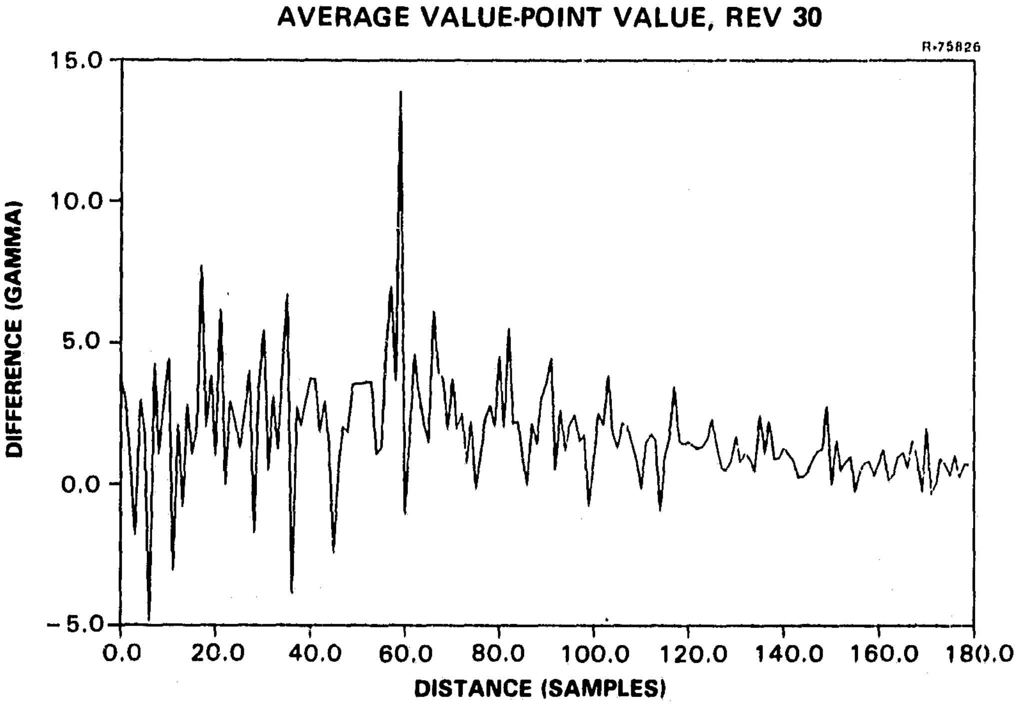


Figure 10 Z-Component Minus 80-Point Running Average

For example, for the z-component of Orbit 30 (Fig. 10), this quantity shows only a slight long-wavelength trend due to the field gradient. It is also apparent that the later part of this track has a lower noise level.

The overall noise level for any track is shown by its PSD, and since this noise level is sensitive to data spikes, most are removed by a running average spike-removal algorithm before fitting an autoregressive model for spectrum estimation. (Work in progress includes implementation of an autoregressive prediction-error data editor.) The newer data however, have a lower noise floor than the older data, as can be seen by comparing Figs. 11 and 12 -- the noise floor for orbit 45 was 0.7 γ

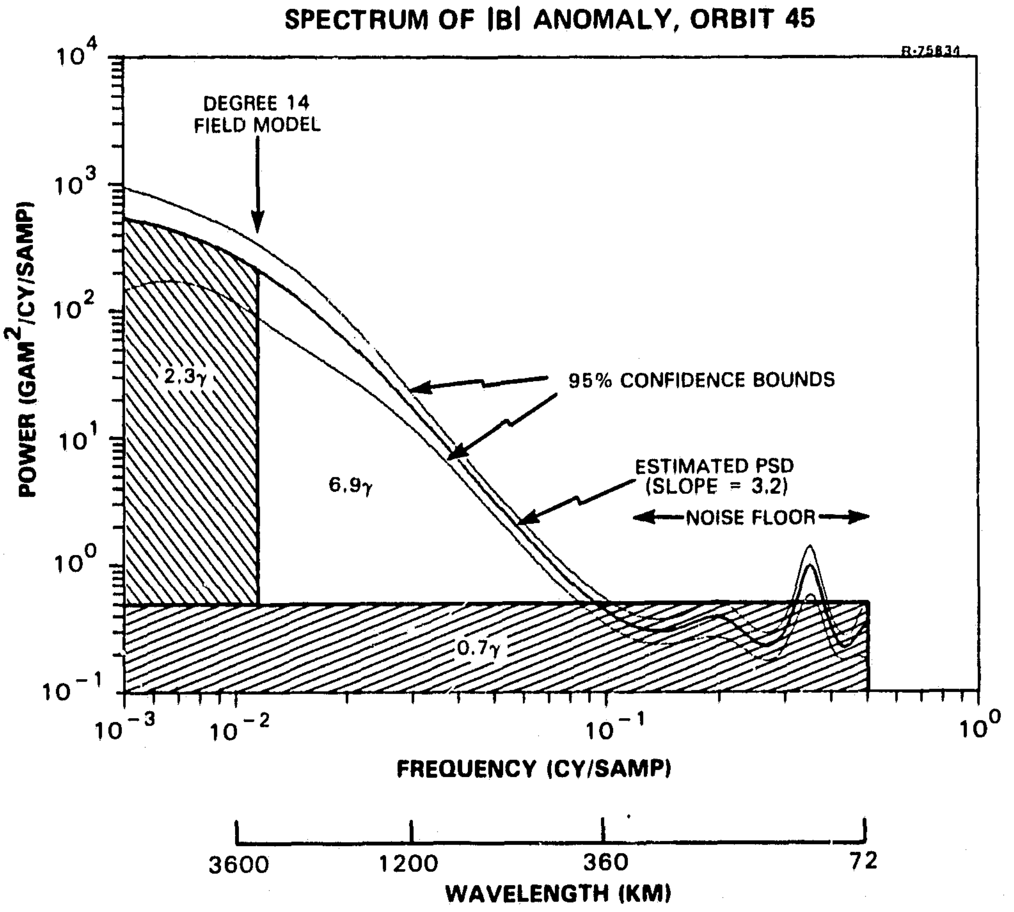


Figure 11 Spectrum Analysis of Magnetic Anomaly (Orbit 45, Old Tape)

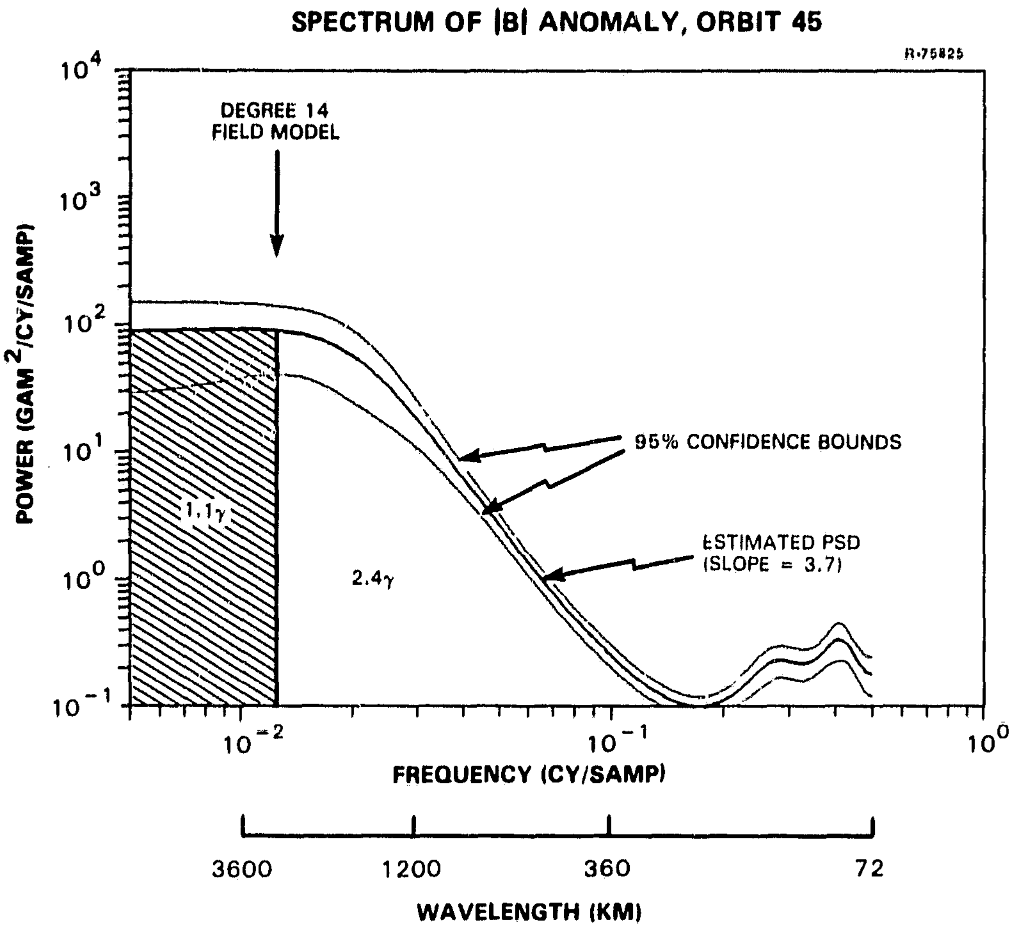


Figure 12 Spectrum Analysis for |B|, Orbit 45, New Investigator Tape. Noise Floor: 0.3 γ rms

for the old data (Fig. 11), and is 0.3 γ for the new data (Fig. 12). The slope of this spectrum estimate has also changed, due to the change in the field model (MGST 12/80 vs MGST 4/81) and the change in the noise floor. An effort has begun to explain the observed along-track PSD slope in terms of simple analytic models of the (spherical) anomaly spectrum. Preliminary results show that the observed Magsat spectra are roughly consistent with upward continuation of a spectrum model given by Lowes (1974, Ref. 6).

Figure 13 is a power spectrum estimate for Orbit 1201 (profile shown in Fig. 7). The noise floor for orbit 1201,

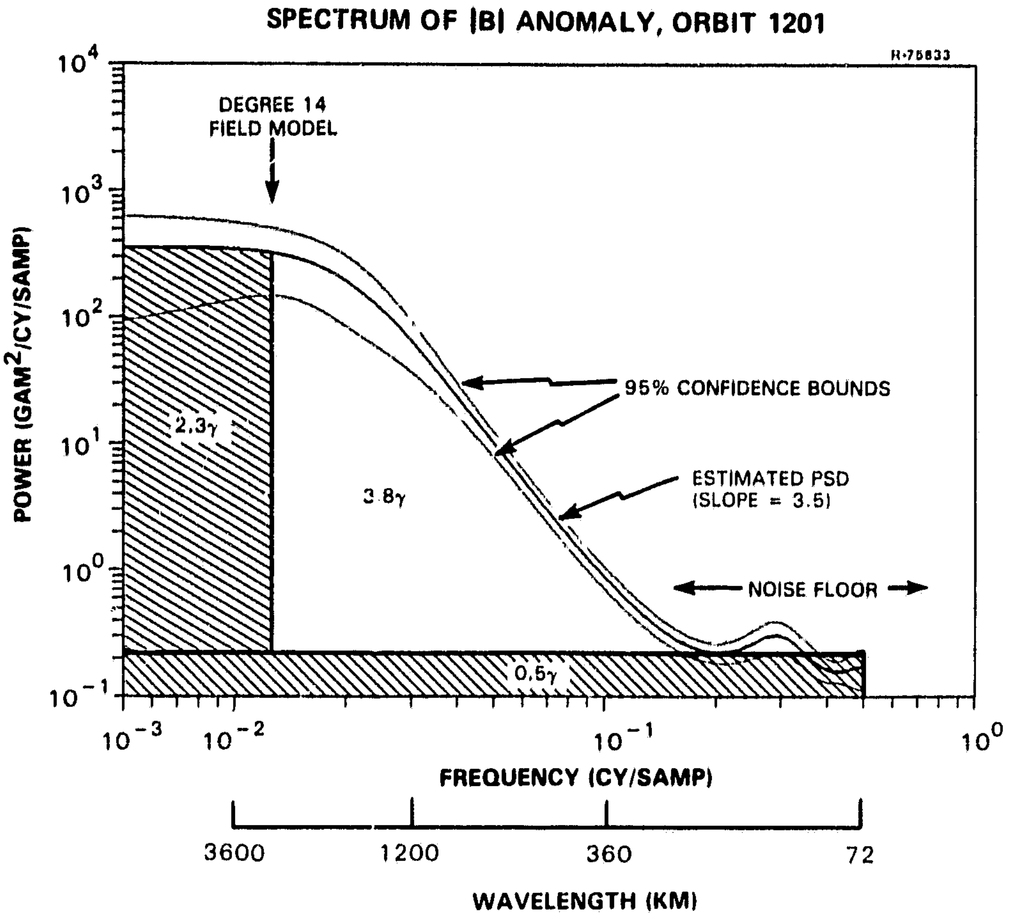


Figure 13 Spectrum Analysis of Magnetic Anomaly (Orbit 1201)

slightly higher than that for orbit 45, is reached in both of these cases at about 250 km. This is observed for other examples not included here, so the conclusion is that the resolution limit for lithospheric anomalies in the newer Magsat Investigator data is about 250 km. This result will be used in the process of filtering the data for producing anomaly maps.

4. PLANS FOR THE NEXT REPORTING PERIOD

The analysis of individual tracks will be concluded with verification of a reliable automatic data editor and better understanding of the along-track spectra. Spectral coherence between pairs of close tracks will be computed. Work will begin on editing and filtering the data for production of anomaly maps. Gridded geoid data will be obtained for study of the relationships to the gravity field.

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