One or more of the Following Statements may affect this Document

- This document has been reproduced from the best copy furnished by the organizational source. It is being released in the interest of making available as much information as possible.

- This document may contain data, which exceeds the sheet parameters. It was furnished in this condition by the organizational source and is the best copy available.

- This document may contain tone-on-tone or color graphs, charts and/or pictures, which have been reproduced in black and white.

- This document is paginated as submitted by the original source.

- Portions of this document are not fully legible due to the historical nature of some of the material. However, it is the best reproduction available from the original submission.

E82-10197
CR-168624

PR-1325-1

QUARTERLY PROGRESS REPORT
FOR THE PERIOD
2 DECEMBER 1980 TO 31 MARCH 1981

7 May 1981

(E82-10197) [ANALYSES OF MAGSAT TRACKS CROSSING THE STUDY REGION IN THE INDIAN OCEAN] Quarterly Progress Report, 2 Dec. 1980 - 31 Mar. 1981 (Analytic Sciences Corp.) 15 p HC A02/MF A01 CSCL 05B G3/43

N82-23570

Unclas
00197

Prepared Under:

Contract No. NAS5-26424
(Magsat Scientific Investigation)

for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Goddard Space Flight Center
Greenbelt, Maryland

Prepared by:

Richard V. Sailor
Andrew R. Lazarewicz

Approved by:

Robert F. Brammer

THE ANALYTIC SCIENCES CORPORATION
One Jacob Way
Reading, Massachusetts 01867

SUMMARY

The main efforts during the first quarter of the TASC Magsat investigation have been in software development and preliminary analysis of Magsat tracks crossing the study region in the Indian Ocean. Tracks crossing the Java Trench, Broken Ridge, Southeast Indian Ridge, and Ninetyeast Ridge show that magnetic anomalies correlate with some of these features. Preliminary study of anomaly profiles indicates that tracks of anomaly data (observations minus a core field model) have a power spectrum decreasing as the inverse square of the spatial frequency. An apparent noise floor of about one to two gammas rms is reached at wavelengths of about 360 km, corresponding to approximately 10 samples of the decimated Investigator Tape data (sampling rate $\approx$4.9 sec/sample).

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 deg - 50 deg 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 the work will be a study of individual profiles of Magsat data in order to characterize the quality and resolution capability of the data and to locate major anomalies. Later, the analysis will proceed in two dimensions with gridded Magsat and gravity field data.

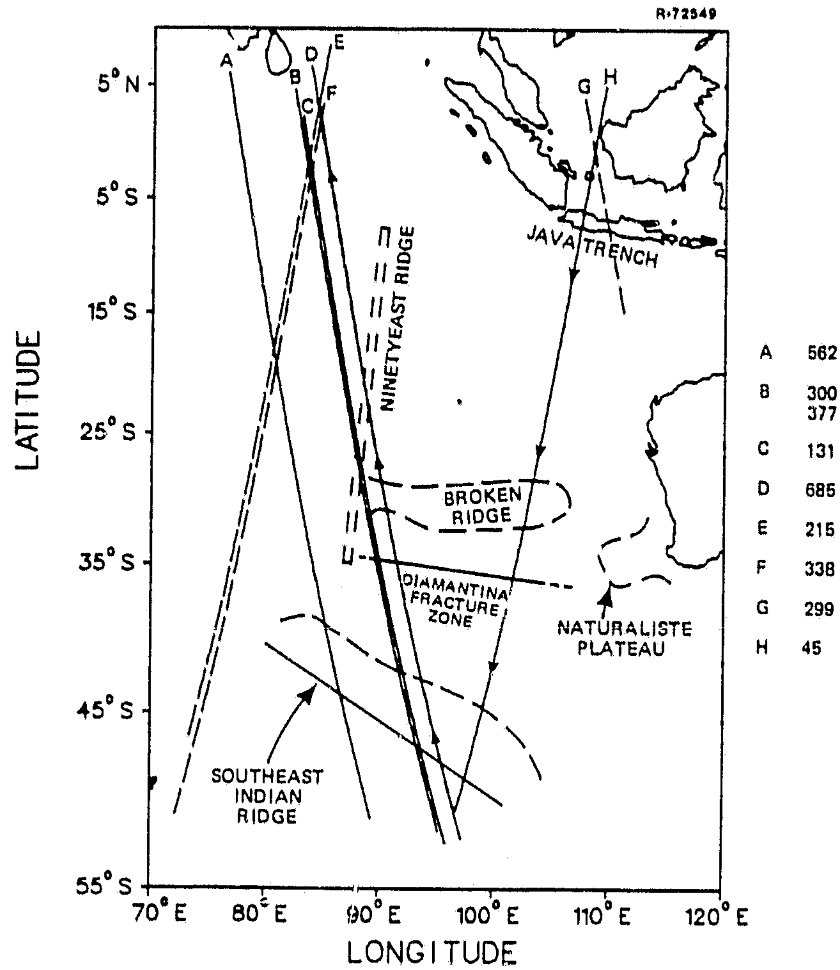

Figure 1 Study Area, With Selected Magsat Passes

2. PROGRESS

The main efforts during the first quarter of the TASC Magsat investigation have been in software development and preliminary analysis of Magsat tracks crossing the study region. The software developed includes routines for reading and selecting data from both the CHRONICLE and Investigator tapes, for plotting anomaly profiles and ground tracks, and for interfacing the Magsat data with existing TASC filtering and analysis software. When reading the CHRONICLE tapes, subroutines provided by NASA were used to compute spacecraft position and values of the magnetic field from spherical harmonic models.

Several tracks of data were extracted from the CHRONINT and Investigator tapes for preliminary analysis. Anomaly profiles were examined to determine whether major anomalies correlate with known tectonic features. Spectrum analysis using autoregressive model fitting was performed to determine the spectral characteristics of the lithospheric anomaly signal and of the noise.

3. RESULTS

The region of the eastern Indian Ocean covered by this investigation is shown in Fig. 1, which also shows several selected Magsat tracks. The major physiographic features of this area include the Southeast Indian Ridge, Java Trench, Diamantina Fracture Zone, Broken Ridge, and Ninetyeast Ridge. One objective of the first part of this investigation is to determine the characteristics of magnetic anomalies that might be associated with these features.

The results shown in this section are from the Magsat data provided in the Investigator-B tape format, having a sampling rate of approximately 4.9 sec/sample. Each data point represents the average value of 80 corresponding CHRONICLE data points. The anomaly profiles shown in Figs. 2 through 9 are derived by subtracting values predicted from the 1980 Magsat field model from corresponding averaged observations of the vector magnetometer.

Figures 2 through 5 are anomaly profiles for Magsat pass #45. Figure 2 is the residual total field magnitude, determined by subtracting the value predicted by the model from the observed field magnitude computed from the three vector components. The locations of the major physiographic features are indicated on the anomaly profiles (see also the map of Fig. 1). Some of the features in the anomaly profiles coincide with the locations of physiographic features. One of the most obvious features in the anomaly profiles is associated with the Broken Ridge and Diamantina fracture zone. This anomaly has an amplitude of about 10 gammas and its form depends on

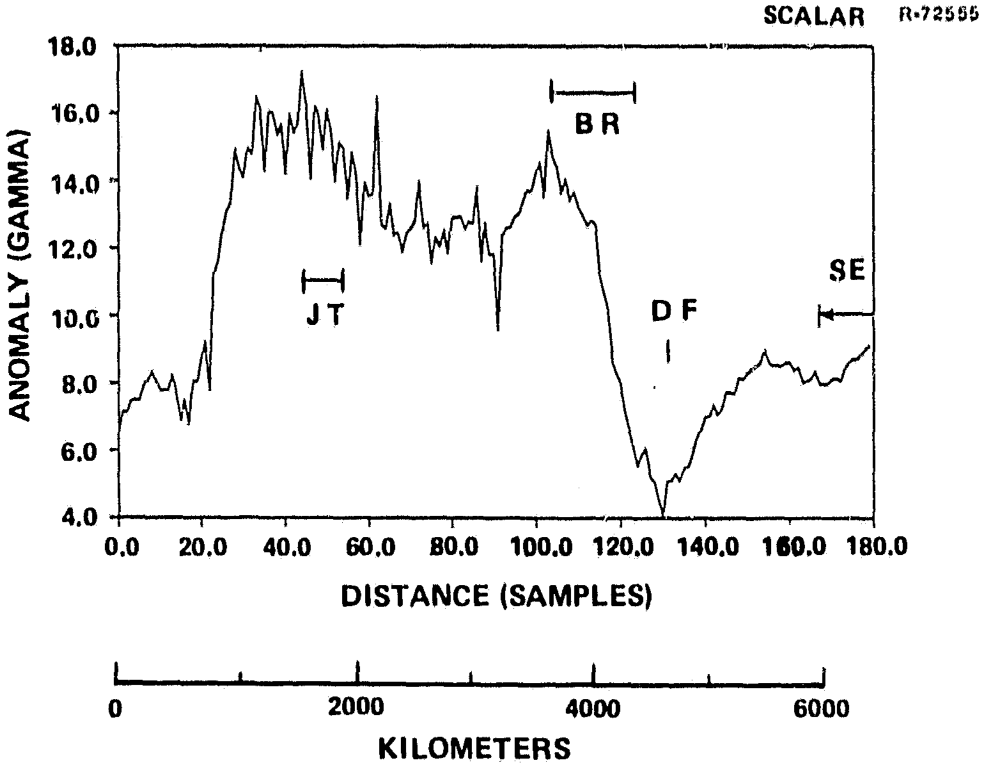

Figure 2 Anomaly Profile for |B| from Vector Data of Pass #45. Average Sample Spacing is 35.3 km/sample. Physiographic features indicated are: JT-Java trench, BR-Broken Ridge, DF-Dimantina Fracture Zone, SE-Southeast Indian Ridge

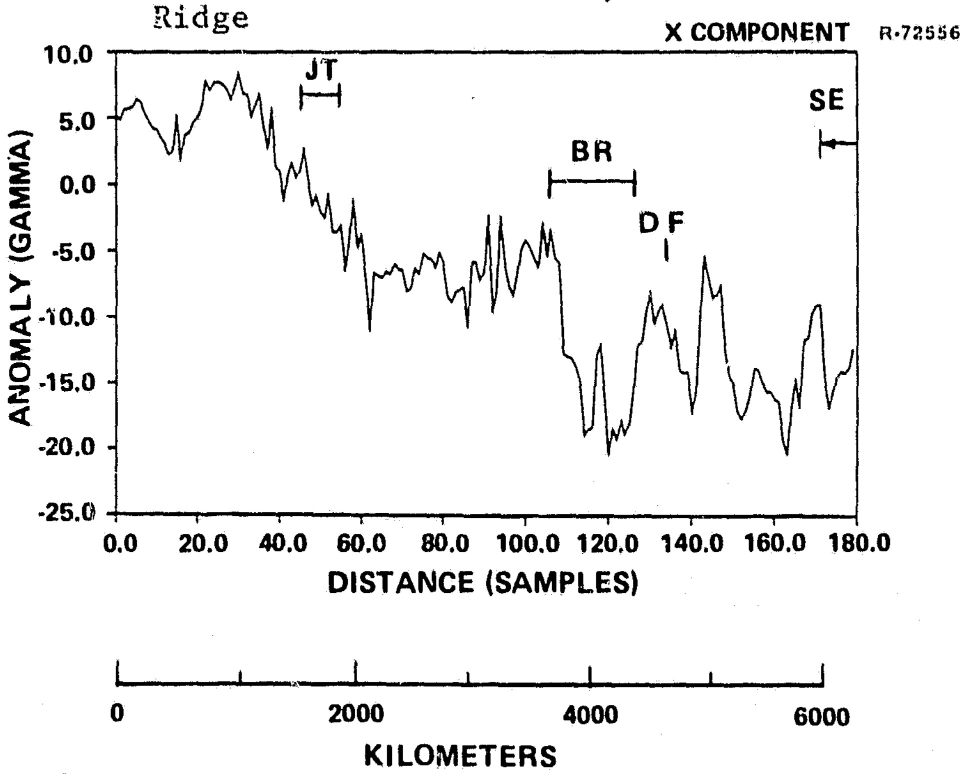

Figure 3 Anomaly Profile for X-Component, Pass 45. See Fig. 2 for Key.

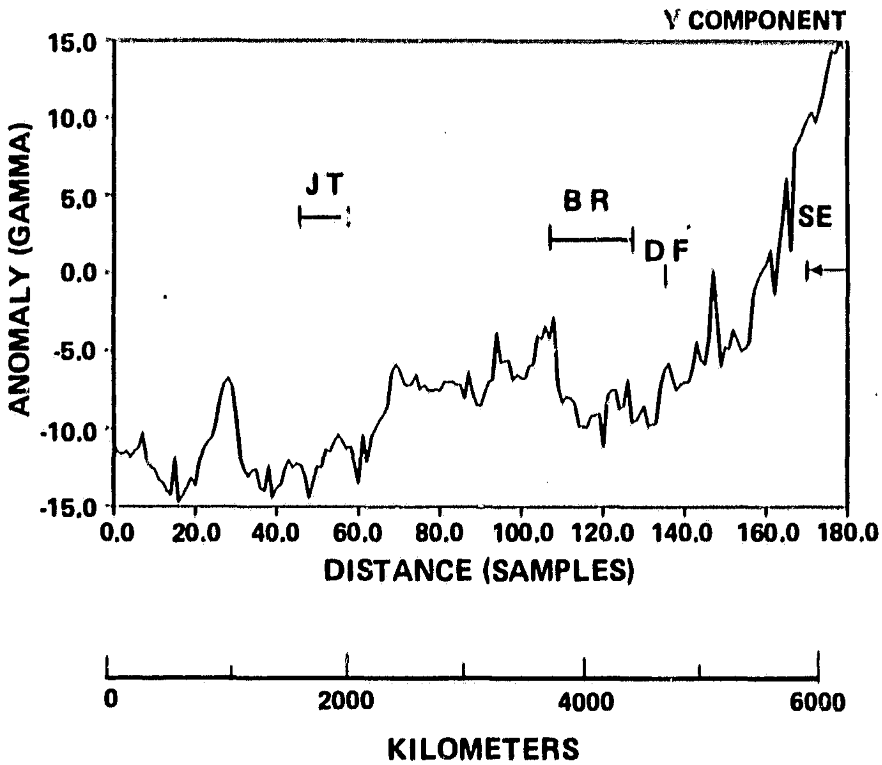

Figure 4 Anomaly Profile for Y-Component, Pass 45. See Fig. 2 for Key.

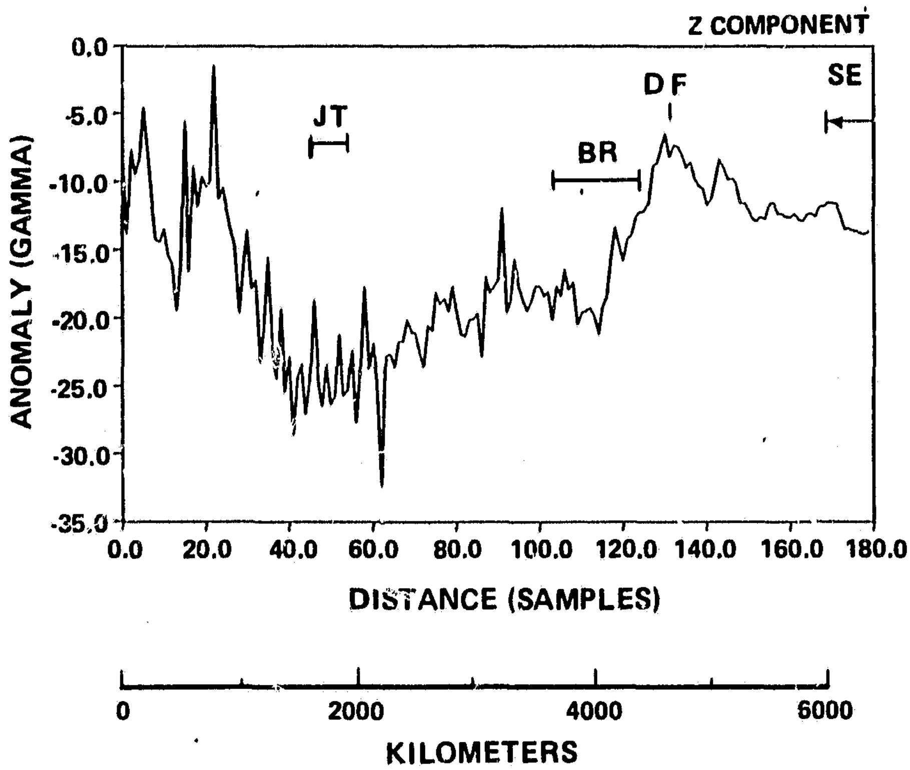

Figure 5 Anomaly Profile for Z Component, Pass 45. See Fig. 2 for Key.

the component. Equivalent source modeling will be necessary for further study of the origin and nature of this anomaly.

Figures 6 through 9 show the same type of anomaly profiles for pass #685 (see map of Fig. 1). Again, the locations of the major physiographic features are shown, and some of these are associated with features in the anomaly profiles. These profiles have more spikes then those for pass #45, but the Broken Ridge-Diamantina Fracture Zone anomaly is still apparent, particularly in $|B|$ (Fig. 6).

Figures 10 and 11 are typical power spectrum estimates from the anomaly profiles shown. These spectrum estimates were obtained by fitting autoregressive (AR) models to the anomaly time series. One-sigma confidence bounds for these estimates were computed from the AR model parameters and the residuals. The optimum order for the AR model was chosen by an information criterion. For the profiles analyzed thus far, the optimum order ranges between two and seven.

Figure 10 is the AR power spectrum estimate (of order 7) for the pass #45 total field magnitude profile in Fig. 2. The total power in this spectrum is about nine gammas rms.

As found for all of the along-track MAGSAT spectra, the spectrum may be divided into three portions. At low frequencies (wavelengths greater than 2900 km) the spectrum is flat, as the core-field model has removed most long-wavelength features. At intermediate frequencies, the spectra behave as a power law (f^{-b}), in this case (Fig. 10) with a slope (b) of about 3.2. At high frequencies there is an apparent noise floor, beginning at about 10^{-1} sample^{-1} (corresponding to a wavelength of about 360 km). If it is assumed that this represents a component of white noise, then this component contains

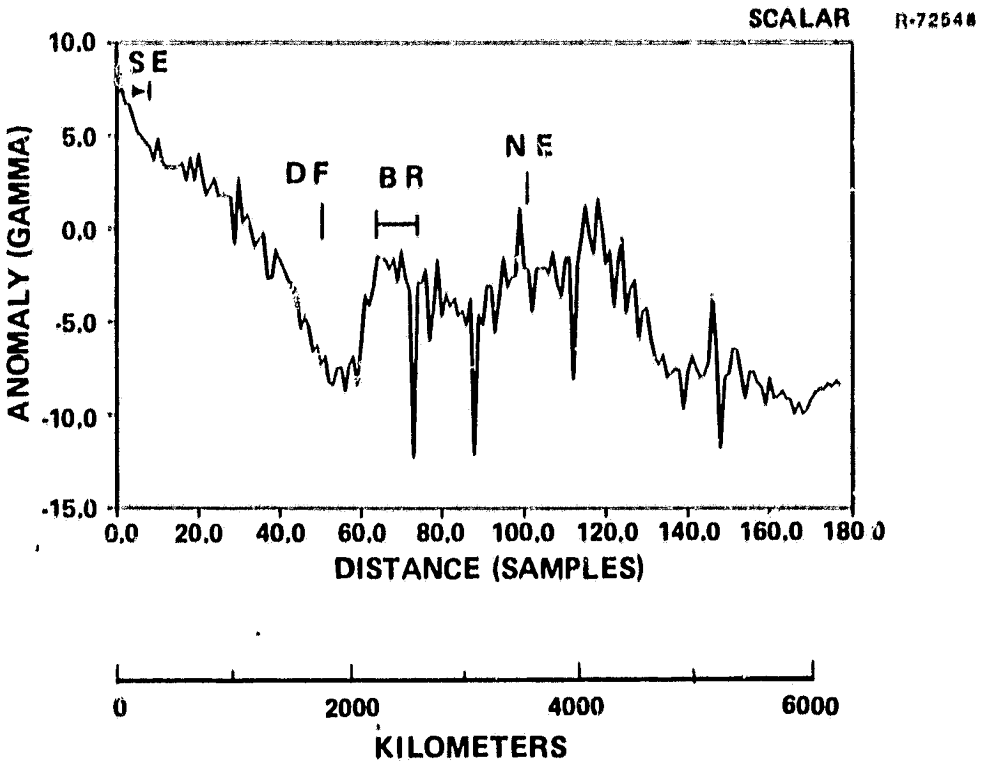

Figure 6 Anomaly Profile for |B| from Vector Data of Pass #685. Average Sample Spacing is 36.3 km/ Sample. Physiographic Features Indicated are: SE-Southeast Indian Ridge, DF-Diamantina Fracture Zone, BR-Broken Ridge, NE-Ninetyeast Ridge.

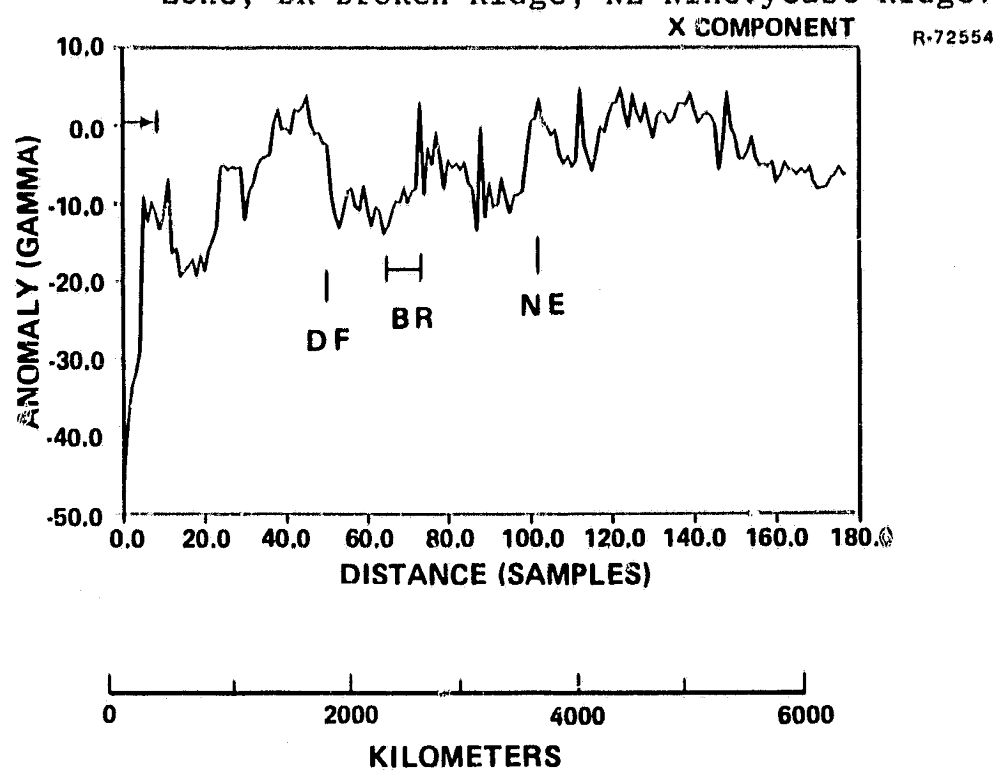

Figure 7 Anomaly Profile for X-Component, Pass 685. See Fig. 6 for Key.

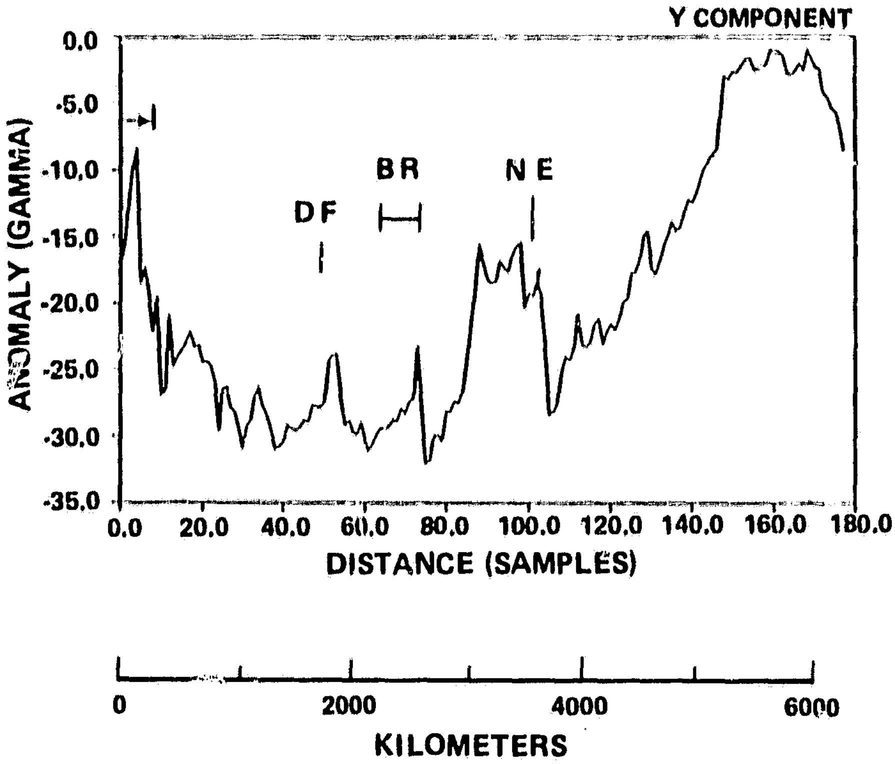

Figure 8 Anomaly Profile for Y-Component, Pass 685. See Fig. 6 for Key.

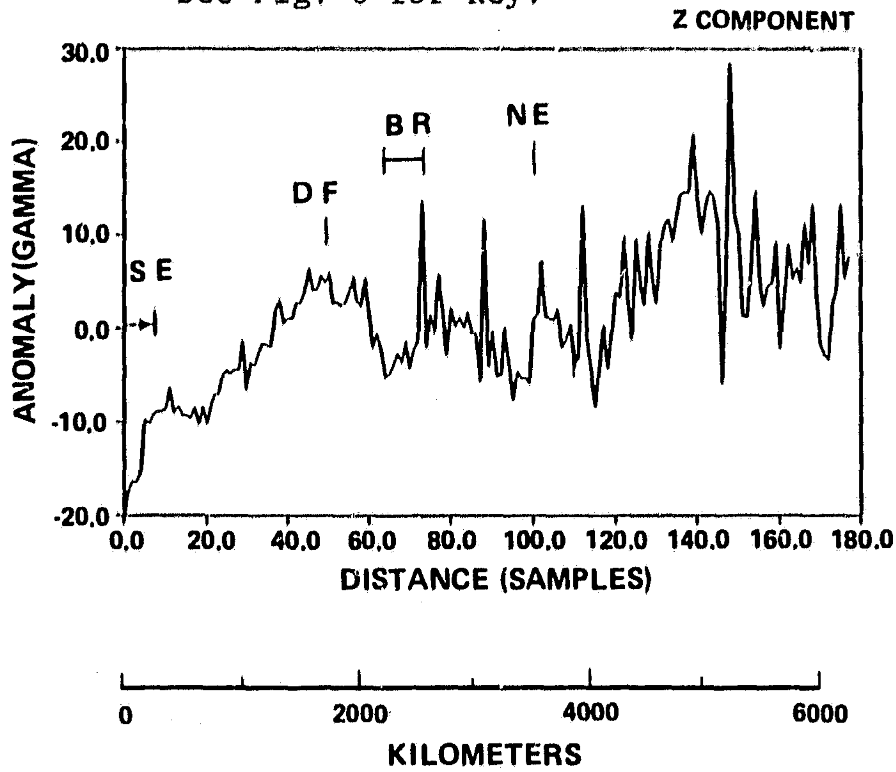

Figure 9 Anomaly Profile for Z-Component, Pass 685. See Fig. 6 for Key.

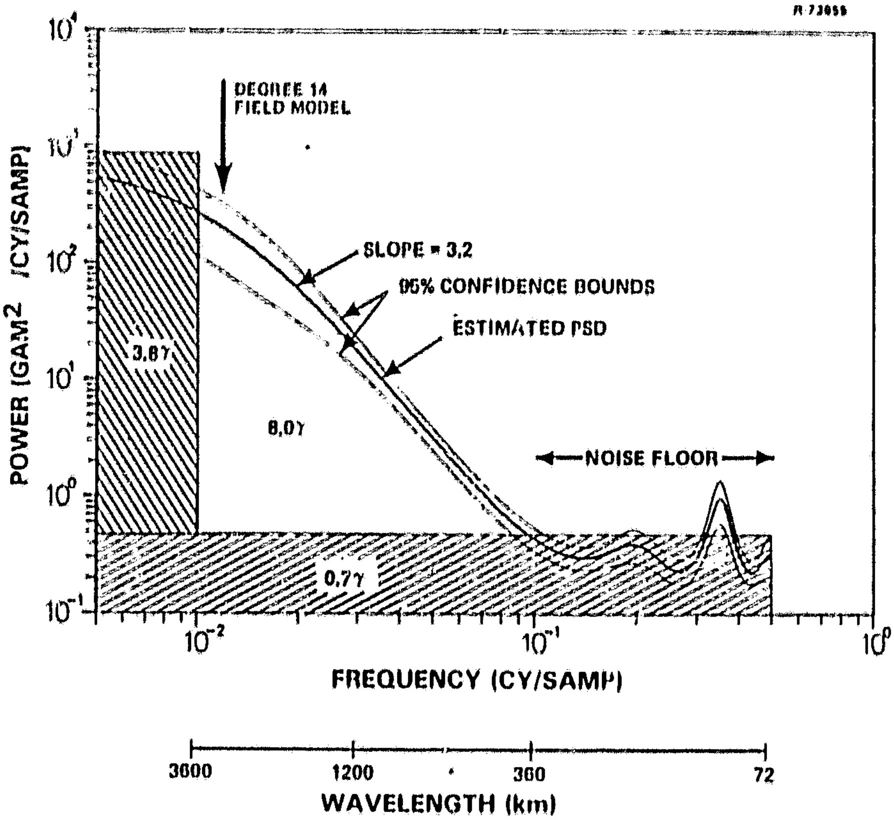

Figure 10 AR Spectrum Estimate With 95% Confidence Bounds for Pass #45, |B|. The Total rms Power is Approximately 9.2γ (including low frequencies not shown), with rms Power in Different Sections as Indicated. Dimensionless Frequency is Shown, Sample Spacing is ~35.3 km.

0.7 gamma rms. The preliminary interpretation is that this apparent noise floor represents instrument noise plus uncorrelated external field noise.

Figure 11 is the corresponding AR spectrum estimate for pass #685 (from the total field magnitude profile of Fig. 6). This differs slightly from the spectrum of Fig. 10, having a higher noise floor of 1.7 gamma (vs 0.7 gamma) and a less steep slope. (Most of the anomaly spectra studied thus far, with the exception of the one shown in Fig. 10, have power law slopes of approximately 2.)

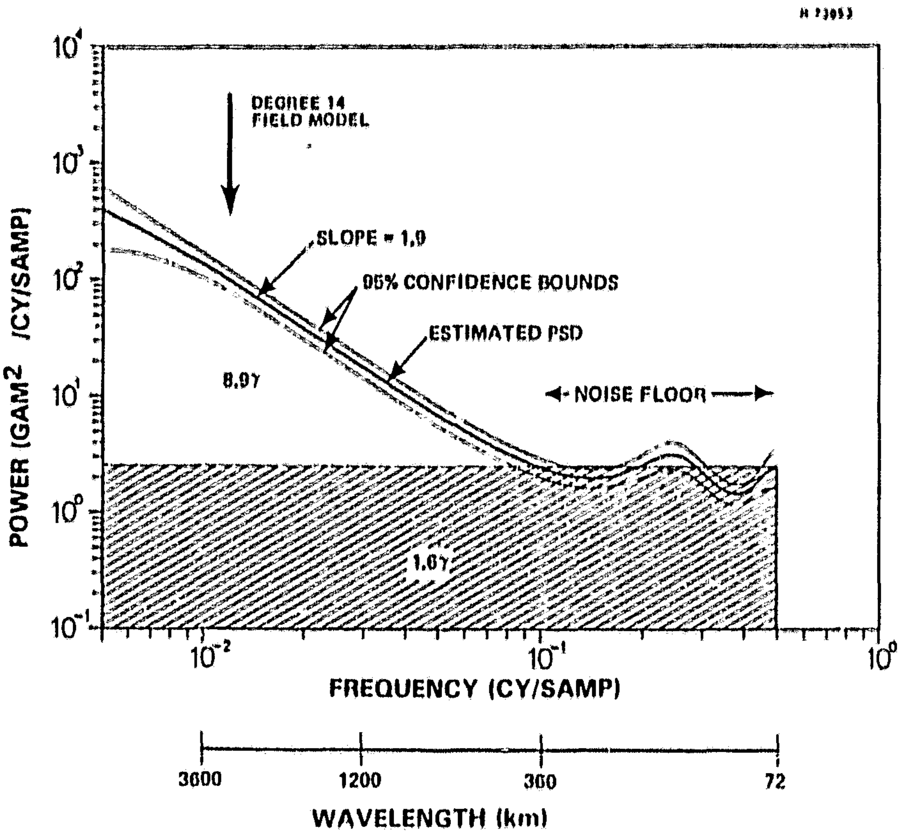

Figure 11 AR Spectrum Estimate with 95% Confidence Bounds for Pass #685, |B|. The Total rms Power is Approximately 10.2γ (including low frequencies not shown), with rms Power in Different Sections as Indicated. Sample Spacing is ~36.3 km.

The difference in the noise floor levels of Figs. 10 and 11 may be due to differing number of spikes, which can be seen by comparing the anomaly profiles: orbit 685 (Fig. 6) has more and larger spikes and also has a higher noise floor than orbit 45. Spike removal routines have already been applied to the anomaly profiles shown, but further adjustment of their parameters is necessary. The future work will investigate proper smoothing of the data.

Table 1 lists the values for total rms power and noise level for spectra of all of the anomaly profiles of Figs. 2 through 9. The total rms power ranges between 9 and 29 gammas

TABLE 1
RESULTS FROM SPECTRAL ANALYSES

PASS #		FIELD COMPONENT (gammas)			
		|B|	X	Y	Z
45	Total rms Field*	9.2	9.5	19.9	19.6
	rms Noise*	0.7	1.2	0.9	2.5
685	Total rms Field	10.2	56.3	29.4	11.1
	rms Noise	1.7	2.0	1.1	4.1

*The values given for |B| are the difference in magnitude between the observed field and the model field. These values are not equal to the magnitude of an anomaly vector formed from the x, y, z anomaly components.

with one spectrum having 56 gammas. The rms noise level is between 0.7 and 2.5 gammas, with one case having 4 gammas. For all of the spectra, the noise floor is reached at a wavelength of about 360 km. These preliminary results can be compared with the pre-Magsat mission specifications, i.e., a resolution limit of about 300 km for lithospheric anomalies and a noise level of about 3 gamma for the vector magnetometer measurements.

It should be emphasized that these results are preliminary and that the noise level and resolution capability for lithospheric anomalies must be determined from analysis of more tracks. Furthermore, the spectra shown represent a one-dimensional analysis of the along-track power for individual tracks, and are appropriate for short wavelengths. For wavelengths longer than about 1000 km, spherical harmonic analysis should be used. Future work will consider anomalies over a spatial grid, two-dimensional spectra, and degree variance spectra. An issue not yet addressed is the degree and order of the core field which is subtracted from the Magsat observations to compute anomalies. For these preliminary calculations, a degree and order 14 field has been used, but use of a lower order field should be considered if it can be demonstrated that features of this wavelength might originate in the crust.

4. PROBLEM AREAS AND RECOMMENDATIONS

No significant problems have been encountered.

5. PLANS FOR THE NEXT REPORTING PERIOD

Analysis will continue on individual Magsat tracks, extracted from both CHRONICLE and Investigator tapes. The tracks will be studied for repeatability of anomaly features and the relationships of these features to tectonic and gravity field features. Further studies in spectrum analysis will help to characterize the anomaly signal, the noise level, and the resolution that can be obtained from Magsat data in the study region. The relationship of these results to the D_{st} index, and to the degree and order of the removed core field, will also be considered.