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PROGRESS REPORT

MAGSAT FOR GEOMAGNETIC STUDIES OVER INDIAN REGION

Investigation Number M-38

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The investigation team consists of the following members:

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G K Rangarajan, R Rajaram, M Roy
and B R Arora

The following collaborators participated in data analysis during the investigation period:

S Srinivasan and L Carlo

I. Summary

The major activities of the period were: (i) to prepare software for removal of the external field due to the ring current and the associated induced part; (ii) to Fourier analyse the field of lithosphere with and without external current (+ induced internal current) component and (iii) the studies of features of equatorial electrojet from MAGSAT records.

II. Techniques

Since the MAGSAT data has significant contributions from the external field due to the ring-current and other magnetospheric currents and their associated induced field, a correction for these must be made to isolate components of lithological origin only. To suppress other magnetospheric currents one selects passes with low Kp values. Still correction for ring currents has to be made. Though these have been estimated and provided for by NASA, the values of E & I were estimated using the total field. Since MAGSAT data provides vector components, E & I could be estimated using X and Z separately. This has been done in the present investigation. The potential function used for the ring current effects is of the conventional form:

$$V = a\left[\left(\frac{r}{a}\right)E + \left(\frac{a}{r}\right)^2 I\right]\cos\theta$$

where $\theta = 90-\lambda$, λ being the dip latitude. r is radial distance to the data point and a is radius of Earth taken as 6371.2 km. E & I represent external and internal parts respectively of the potential function. By using X and Z to estimate E & I, the least squares problem incidentally remains as a linear one.

Over the Indian region where declination is very small ($\sim 1°$), the above correction does not give any contribution to the Y-field. The corrected X- and Z-fields were then subjected to a fast Fourier transformation (FFT) and the spectrum was compared with similar spectrum obtained for the same pass before correcting for the ring current effect. This was done to see how the ring current modifies the spectrum to get a feeling of the wavelengths which are affected most by the ring current correction.

The study for the features of the equatorial electrojet used the data from CHRONFIN tapes. The core field was removed using sub-routine FDG sent by NASA. In this work ring current contributions were removed using the E & I supplied by NASA.

Two sets of morning and evening passes were analysed. The passes in each set are such that they cross each other in the neighbourhood of geomagnetic equator. This was done so as to minimise the effects of crustal anomaly. The contribution of equatoial electrojet was then estimated in each of the three component X, Y & Z. These were subsequently used to investigate the ionospheric current distributions.

III. Accomplishments

1) A program to compute E & I using X- and Z-components have been developed and made functional.

2) Records from pass No. 46 & 47 for Indian region were selected. E & I estimates were made using the X- and Z-values in the latitude region 30°S to 30°N. Spectrum of both passes for both X and Z components were computed using FFT.

3) A vertical component in equatorial electrojet current system has been identified. This result is described in more detail in the following section.

IV. Significant results

1) For pass Nos. 46 & 47, the estimated values of I/E are 0.18 and 0.08 respectively. The corresponding values as supplied by NASA are 0.10 and 0.01. A plot of X and Z (only crustal + external) obtained for INVESTIGATOR-B tape (after correcting for core fields) are given in Fig. 1. The estimates of ring current effects are also given in the figure. The area covered is 10°S to 38°N. It is noted that in both the passes fit to Z-data is rather poor. This is partly because the fact that the functional form of ring current

contribution is such that Z must be zero at the dip equator.

2) X & Z (crustal + external) and X & Z (crust only) for pass Nos. 46 & 47 were analysed through FFT. Data for pass No. 47 is given in Fig. 2. The Fourier spectrum for the two sets are given in Fig. 3. The spectrum was taken after removing a linear trend and introducing cosine tapering. The data set was extended to 1024 pts. In spectrum one notes that the smaller wavelength components in both the passes are very little affected by the external current system; whereas for wavelengths around ($\simeq$2000 km) the spectral estimates are significantly different. The effect is seen in both X and Z and also in both the passes. These indicate that over the Indian region the contributions of lithological features and ring currents are of same spatial scales. This also explains why often a base level correction is needed in different passes over the same region. Being of same scale, the two causes will interfere with each other and their isolation is natural to be a problem.

A higher amplitude for X crust or Z crust against the value for X (crustal + external) or Z (crustal + external) suggests that the two components have a opposing tendency.

3) The contributions from equatorial electrojet are given in Fig. 4 for X, Y & Z components. The trajectories of the passes analysed is given in Fig. 5. The effect is distinctly seen in X and Y components. In Z-component too its contribution could be isolated. The results could not be accounted through a horizontal current component only in the equatorial electrojet. Indications are that the vertical component extends up to and beyond the MAGSAT heights.

V. Publications : Nil

VI. Problems : Nothing significant

VII. Data quality and delivery

The delivery has been extremely fast and our requests have been promptly attended.

VIII. Recommendations : Nothing for the present

IX. Conclusions

Now that the necessary software for reducing the data and separating the three components have been prepared, the various analysis could be completed expeditiously.

Figure Captions

Fig.1 Plots of X (crust + external), Z (crust + external) and Y (crust + external) for pass Nos. 46 & 47. External current component for X and Z are shown by dotted lines. In the model adopted for external currents contribution to Y is zero. Fig 1(a) is for pass No. 46 and 1(b) for pass No. 47.

Fig.2 X and Z (crust + external) and X and Z crust only are shown for pass No. 47.

Fig.3 Fourier spectrum for X (=H) and Z for pass Nos. 46 & 47. Fig. 3(a) is for pass No. 46 and 3(b) for pass No. 47. Continuous lines are for crust + external components and solid lines for crustal component only.

Fig.4 Contributions from equatorial electrojet in X,Y and Z components. In the upper plot X (solid) and Y (dotted) are shown and the lower curve is for Z variations.

Fig.5 Trajectories of passes analysed.

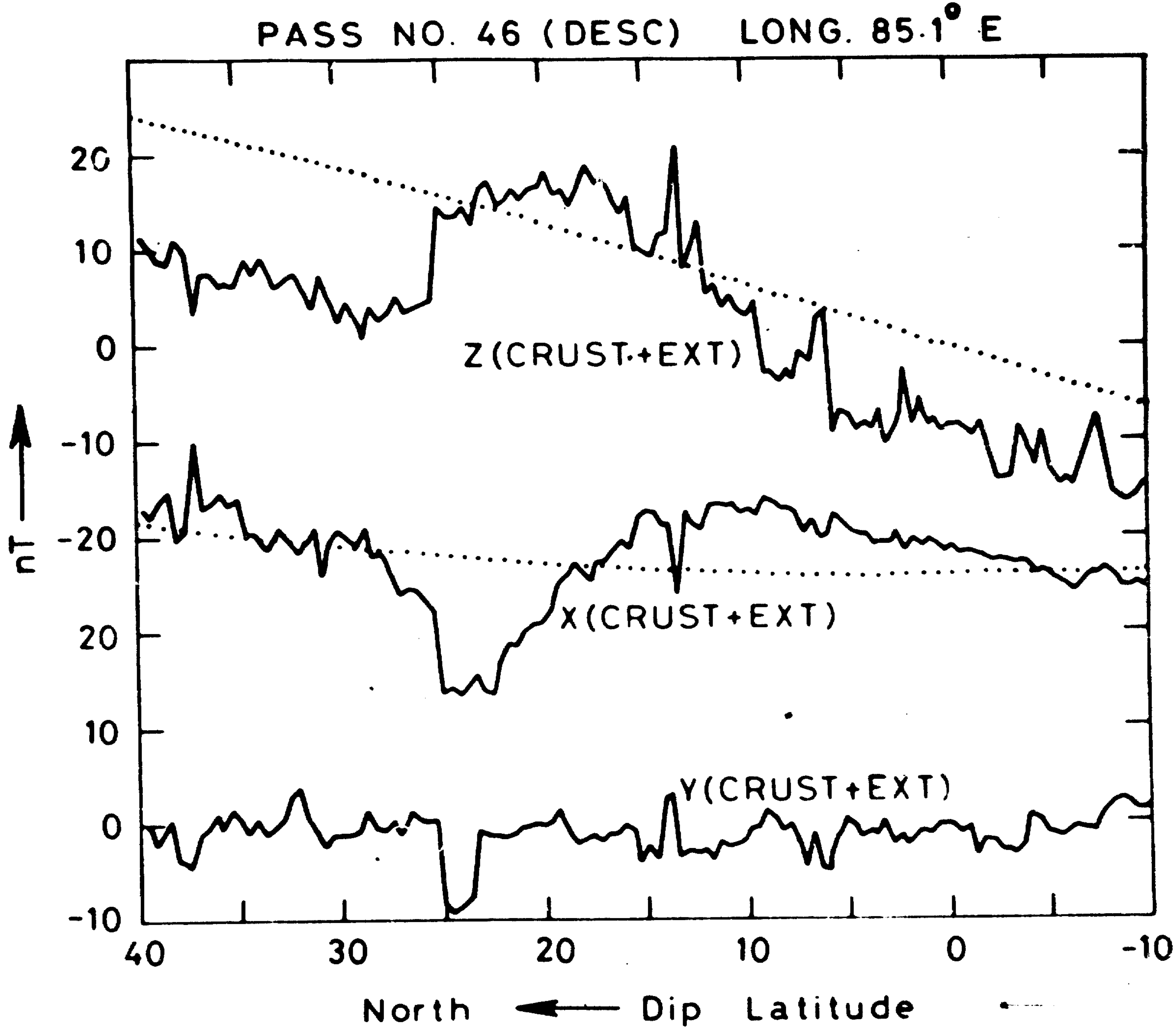

PASS NO. 46 (DESC) LONG. 85.1° E
20
10
0
-10
-20
20
10
0
-10
nT
Z(CRUST+EXT)
X(CRUST+EXT)
Y(CRUST+EXT)
40
30
20
10
0
-10
North ← Dip Latitude

Fig. 1(a)

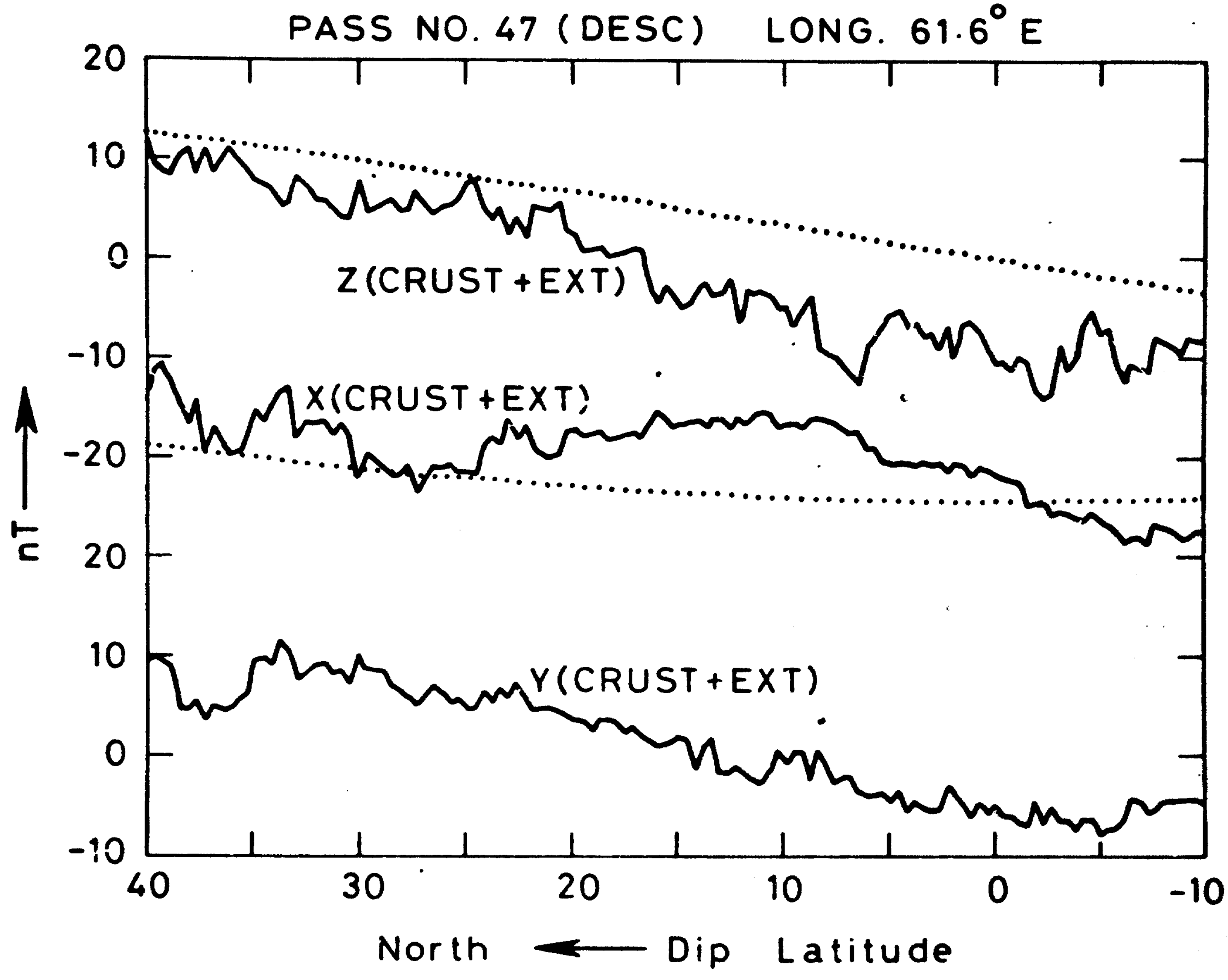

PASS NO. 47 (DESC) LONG. 61·6° E
Z(CRUST + EXT)
X(CRUST + EXT)
Y(CRUST + EXT)
nT
North ← Dip Latitude
20
10
0
-10
-20
20
10
0
-10
40
30
20
10
0
-10

Fig 1(b)

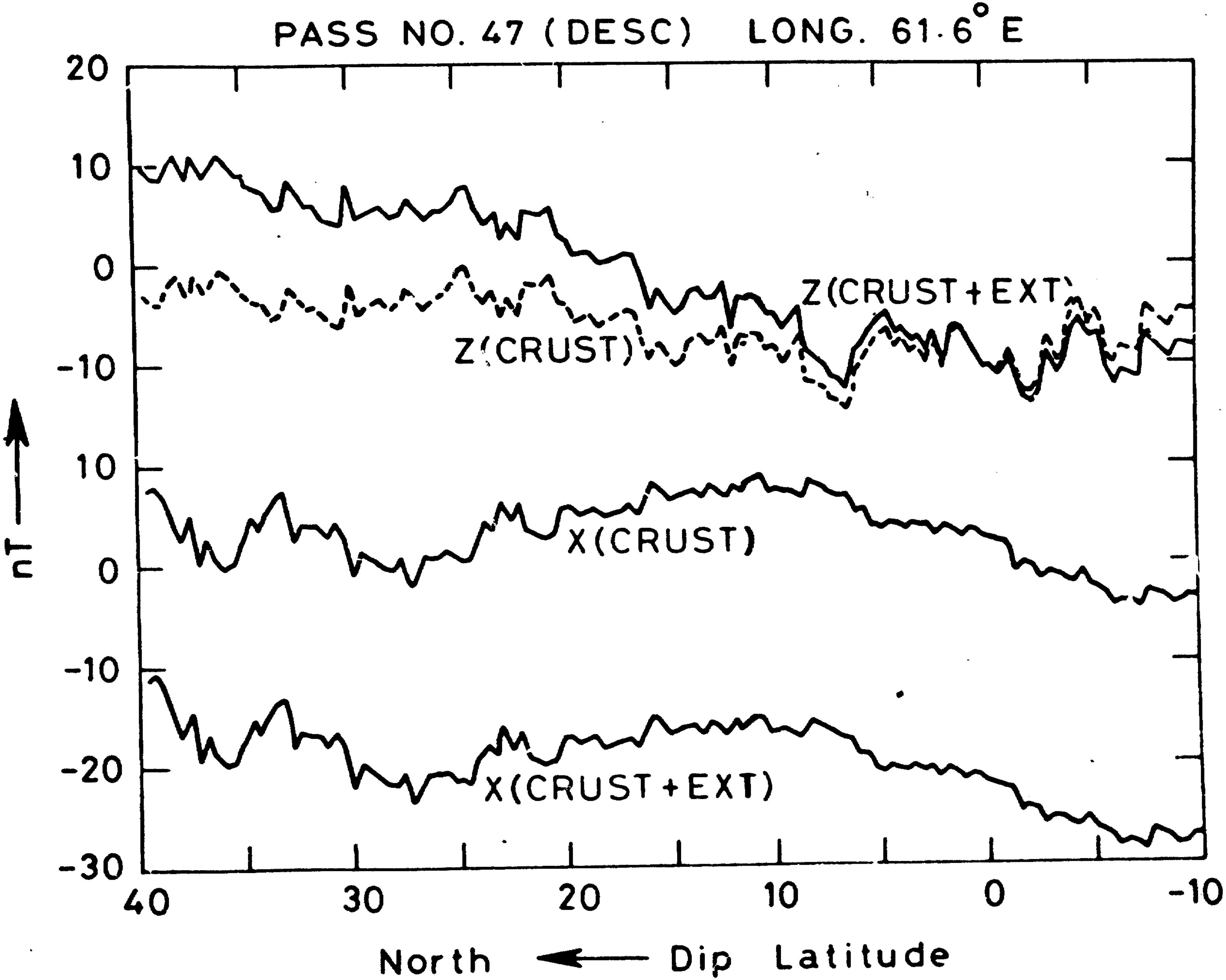
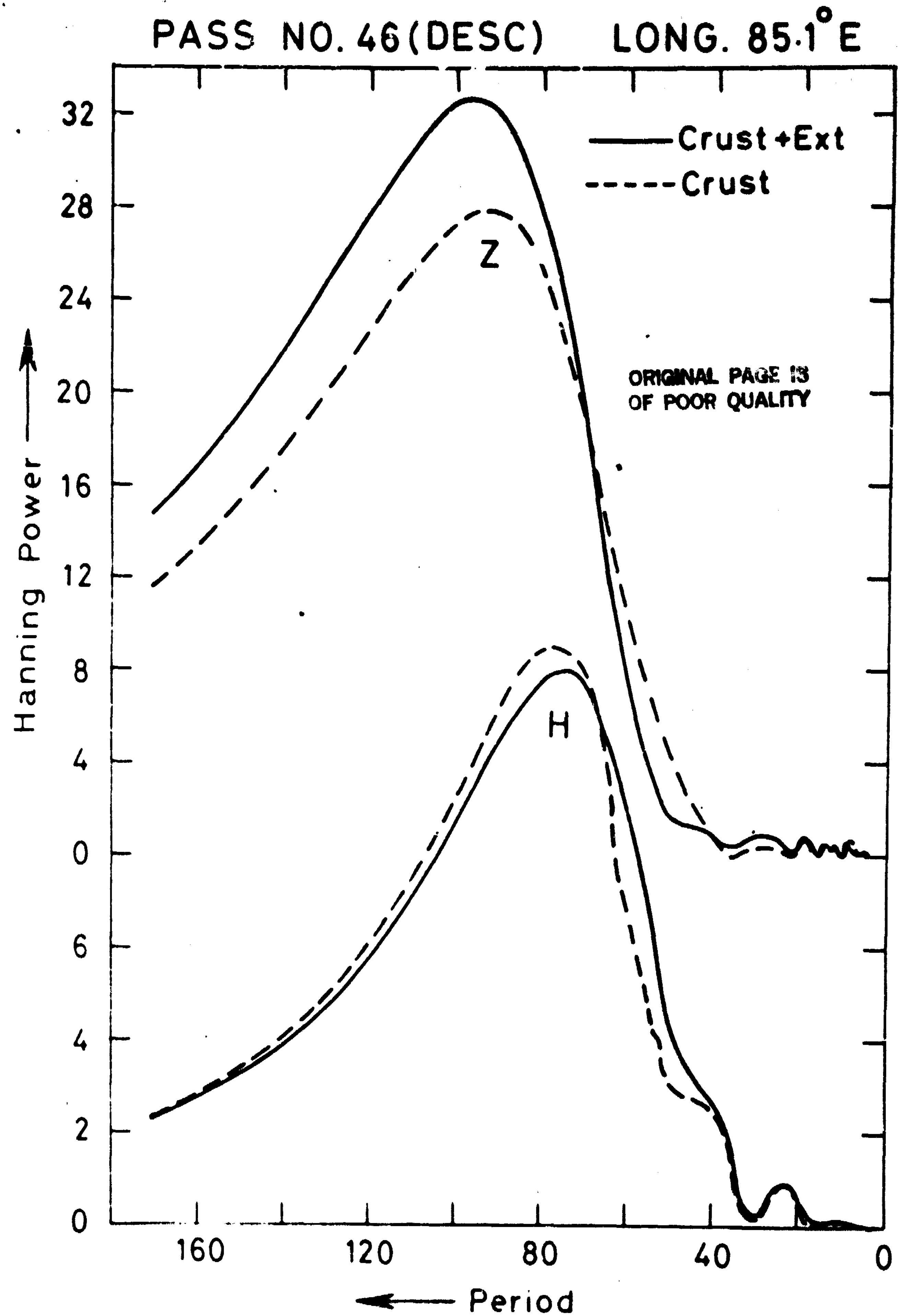

PASS NO. 47 (DESC) LONG. 61.6° E
nT
Z(CRUST + EXT)
Z(CRUST)
X(CRUST)
X(CRUST + EXT)
20
10
0
-10
-20
-30
40
30
20
10
0
-10
North ← Dip Latitude

Fig. 2



PASS NO. 46 (DESC) LONG. 85.1° E
Crust+Ext
Crust
Z
H
ORIGINAL PAGE IS OF POOR QUALITY
Hanning Power
32
28
24
20
16
12
8
4
0
6
4
2
0
160
120
80
40
0
Period

PASS NO. 47 (DESC) LONG. 61.6°E

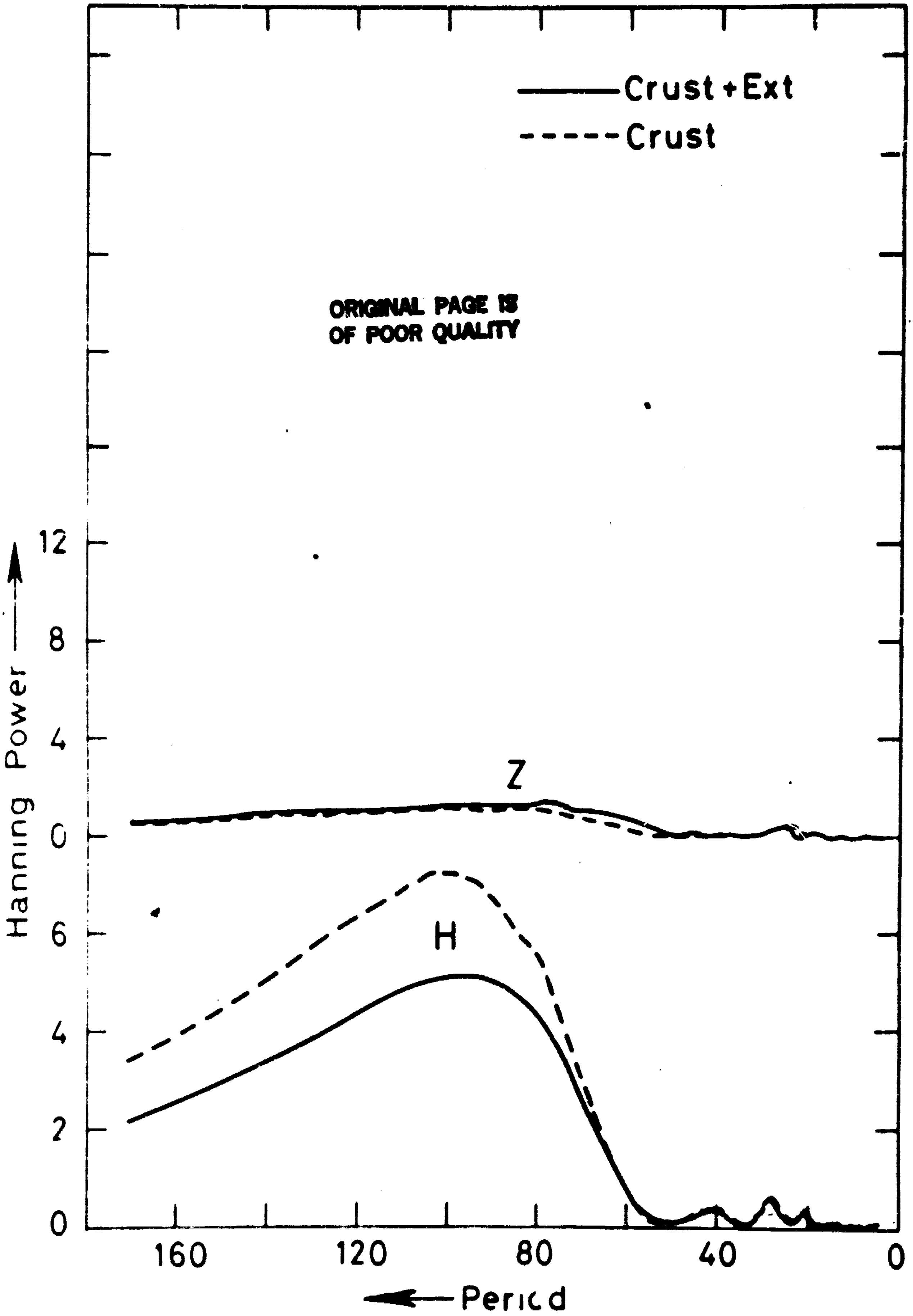
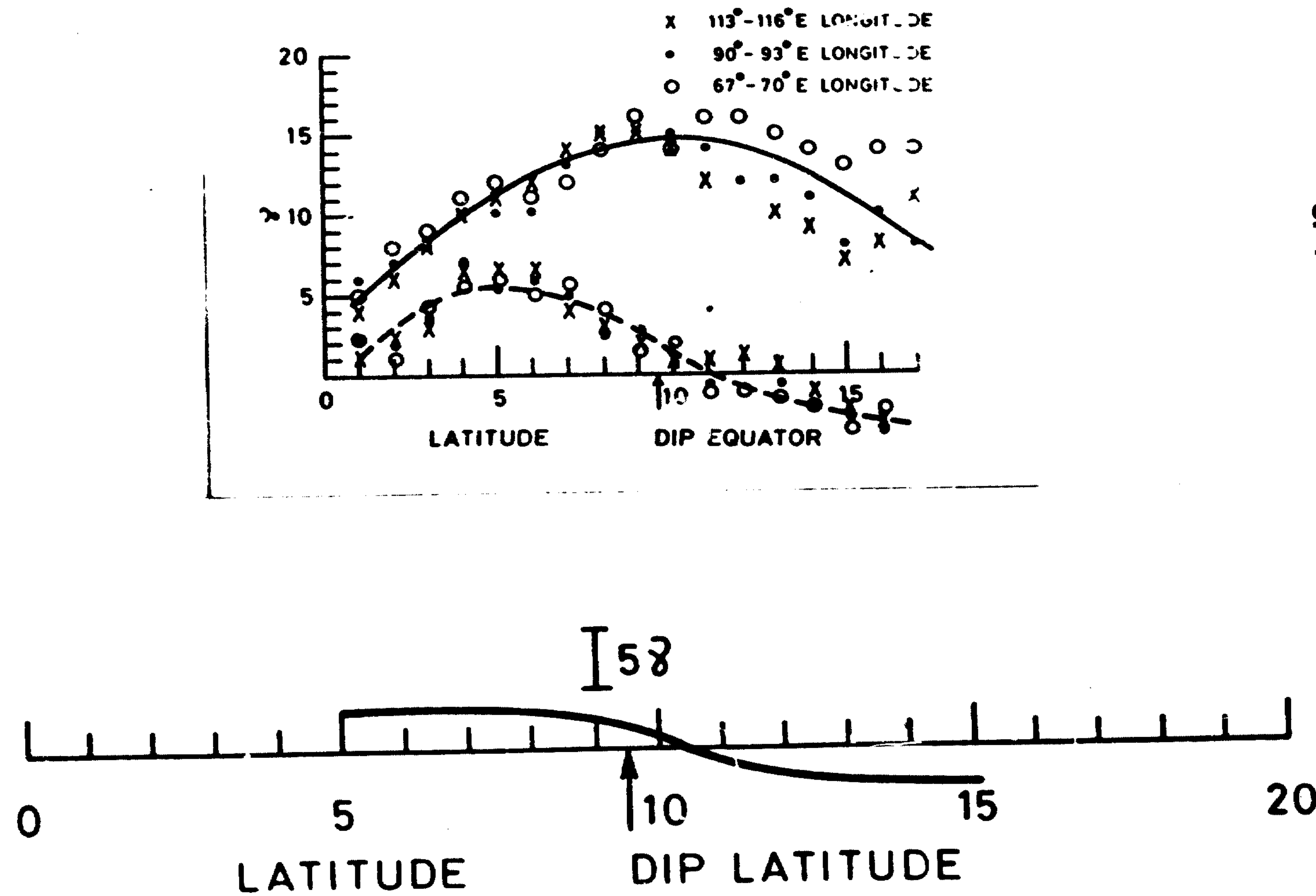


Fig 3(b)


x 113°-116°E LONGITUDE
• 90°-93°E LONGITUDE
o 67°-70°E LONGITUDE
20
15
10
5
0
5
10
15
LATITUDE
DIP EQUATOR
I 58
0
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LATITUDE
DIP LATITUDE

Fig.4

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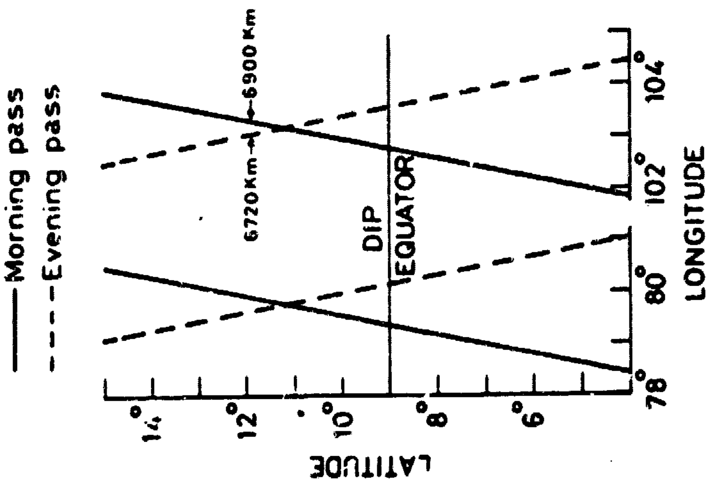

Fig.5