Progress Report

for

"Geophysical Characterization of Some Terranes and the Geophysical Modeling of Candidate Suture Zones (NAG 5-3120)"

submitted to

Mildred Garner
~~Gloria R. Blanchard~~, Grants Officer
Space Sciences Directorate
NASA/GSFC Code 216
Greenbelt, MD 20771

Submitted by

D. Ravat, Principal Investigator
Dept. of Geology MS 4324
Southern Illinois University at Carbondale
Carbondale, IL 62901

July 1997

Progress Report for "Geophysical Characterization of Some Terranes and the Geophysical Modeling of Candidate Suture Zones (NAG 5-3120)" (P.I.: D. Ravat, SIUC)

Indian participation in this project was terminated during the last year by a sudden withdrawal of support by the Department of Science and Technology, India, to the Indian Institute of Geomagnetism, Bombay. As a result, significant changes in the project focus had to be undertaken. Much of the work carried out at Southern Illinois University at Carbondale during the first year of the project anticipated the Indian participation and included development of computer programs to be used on gravity and magnetic data from the Indian subcontinent and preparations for fieldwork, tutorials, and workshops in India. Despite these setbacks, which were beyond our control, a number of significant tasks have been accomplished during the project period. These include: *two presentations at the 1997 Spring meeting of the American Geophysical Union; completion of one M.S. thesis; and one publication in a reviewed journal.*

Indian Gravity and Magnetic Anomaly Maps:

During the past year, some of the first year's effort was salvaged. This has resulted in completion of digitization of the regional Bouguer gravity anomaly map of India (NGRI, 1978) (Figure 1) and the regional ground total intensity magnetic anomaly map of India (Chugh, 1976; Qureshy, 1982) (Figure 2) at an overdetermined spacing of 0.05 degrees (~ 6 km). These digital data sets are suitable for regional geophysical studies and are made available through this grant.

Utility and Limitations of the Euler Method:

Another aspect of the first year's effort was the implementation of the Euler method of magnetic interpretation and assessment of its limitations. Because detailed aeromagnetic maps of parts of India were not available for interpretation by this method, we investigated

and assessed the limitations of the method using environmental examples. These investigations were published in a reviewed article, cited as:

Ravat, D., 1996, Analysis of the Euler Method and Its Applicability in Environmental Magnetic Investigations, Jour. Environmental & Engineering Geophysics, 1, 229-238.

The Kenya Rift and the Pan African suture between the Nyanza Craton and Mozambique Belt:

During the project period, we also undertook an assessment of a suture zone between the Nyanza Craton (Archean) and the Mozambique Belt (Pan African) in the Kenya Rift, Africa, using gravity anomalies and the lithospheric seismological models. Recent gravity models (Nyblade and Pollack, 1992) of the Rift had hypothesized the presence of the gravity signature of the suture, applying the criteria specified by Gibb et al. (1983) for identification of sutured terranes. However, purely seismological models of the rift from the KRISP 85 and 90 experiments (Maguire et al., 1994; Braile et al., 1994) did not specifically identify the suture. To resolve the differences in these disparate models, we performed a detailed study converting seismic P-wave velocities to densities using velocity-density relationships, generated the gravity anomalies from these models, and compared the computed gravity anomalies to the observed anomalies. This process showed that the pure seismological models from the KRISP experiments are deficient in resolving near-vertical crustal-scale suture between the Nyanza Craton and the Mozambique Belt.

The gravity anomaly study of the Kenya Rift also addressed a number of other geophysically important topics. They are: 1) investigation of pressure-effects on the velocity-density relationships; 2) investigation of temperature-effects on the velocity-density relationships; and 3) investigation of the nature of the velocity-density relationships in the hot upper mantle region such as the Kenya Rift. The details of the study are included in the following Master's thesis completed at SIUC:

Lu, Z., 1996, Investigation of the crustal and uppermost mantle density structure of the Kenya Rift through velocity-density relationships, M.S. thesis, Southern Illinois University at Carbondale, 95p.

The results of part of the study were also presented at the 1997 Spring meeting of the AGU, cited as:

Lu, Z., and Ravat, D., 1997, Investigating Crustal and Upper Mantle Density Structure of the Kenya Rift Through Velocity-Density Relationships, EOS Trans. AGU, 78(17), Spring Meet. Suppl., S119.

A manuscript based on this study will be prepared during the next year of the project.

Wavelength Comparison of Canadian High-altitude aeromagnetic data and Magsat data:

During the award period, a preliminary study was also initiated comparing Magsat and high-altitude (~4 km) aeromagnetic data over Canada. The results indicate that upward-continued (to 400 km) high-altitude magnetic data and the Magsat data compare favorably between wavelengths of 700 to 2000 km. The preliminary study is cited as:

Ravat, D., Pilkington, M., Whaler, K., and Roest, W., 1997, Reliable Wavelengths in Magsat Data Determined From Comparison With the High-Altitude Aeromagnetic Data Over Canada, EOS Trans. AGU, 78(17), Spring Meet. Suppl., S113.

The import of this preliminary comparitive study to this project is that the Canadian high-altitude aeromagnetic data show a large number of linear magnetic anomalies corresponding to the boundaries of various terranes (i.e., sutures). But these linear aeromagnetic anomalies become semi-oval at the satellite measurement altitudes. The effect of the high satellite observation altitude on the resulting geologic interpretation needs to be studied (as opposed to the aeromagnetic interpretation).

Other:

In addition to the above aspects, various sutured terranes in the greater Ural region (Russia) are being studied from aeromagnetic and satellite magnetic anomaly maps.

# References

Braile, L.W., Wang, B., Daudt, C.R., Keller, G.R., and Patel, J.P., 1994, Modeling the 2-D seismic velocity structure across the Kenya Rift, Tectonophysics, 236, 251-269.

Chugh, R.S., 1976, Contribution of Geodetic and Research Branch (Survey of India) towards integrated national earth science policy - status report. In: Proc. Symp. on Integrated Earth Science Policy, Calcutta.

Gibb, R.A., Thomas, M.D., Lapointe, P.L., and Mukhopadhyay, M., 1983, Geophysics of proposed Proterozoic sutures in Canada: Precambrian Research, v. 19, p.349-384.

Maguire, P.K.H., Swain, C.J., Masotti, R., and Khan, M.A., 1994, A crustal and uppermost mantle cross-sectional model of the Kenya Rift derived from seismic and gravity data, Tectonophysics, 236, 217-249.

NGRI (National Geophysical Research Institute, 1978, Gravity map series of India, First Edition, 1:5,000,000.

Nyblade, A.A., and Pollack, H.N., 1992, A gravity model for the lithosphere in western Kenya and northeastern Tanzania, Tectonophysics, 212, 257-267.

Qureshy, M.N., 1982, Geophysical and Landsat lineament mapping - An approach illustrated from west-central and south India, Photogrammetria, 37, 161-184.

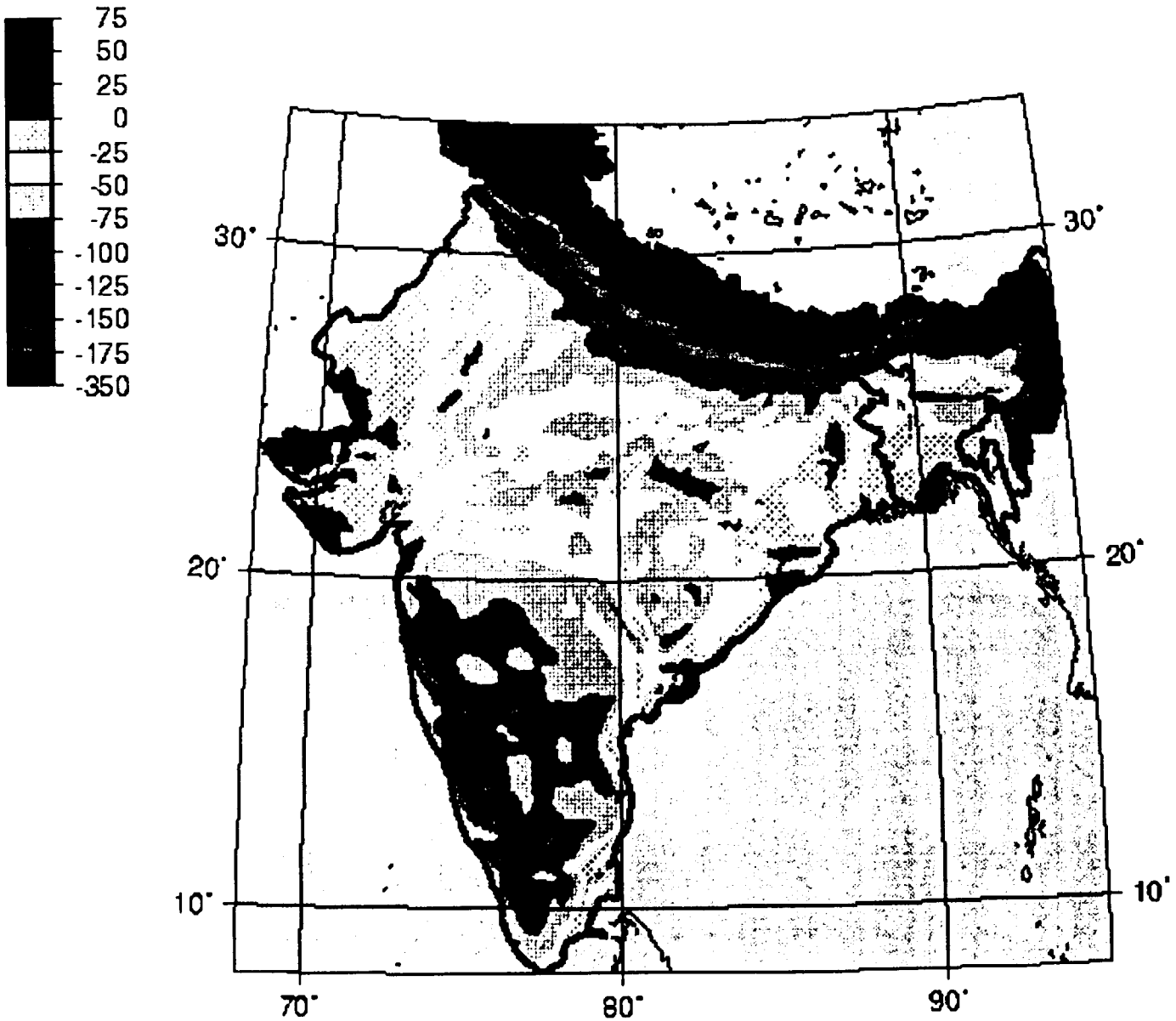


Figure 1. Digitized Bouguer Gravity Anomaly Map of India. Color interval in mGal.

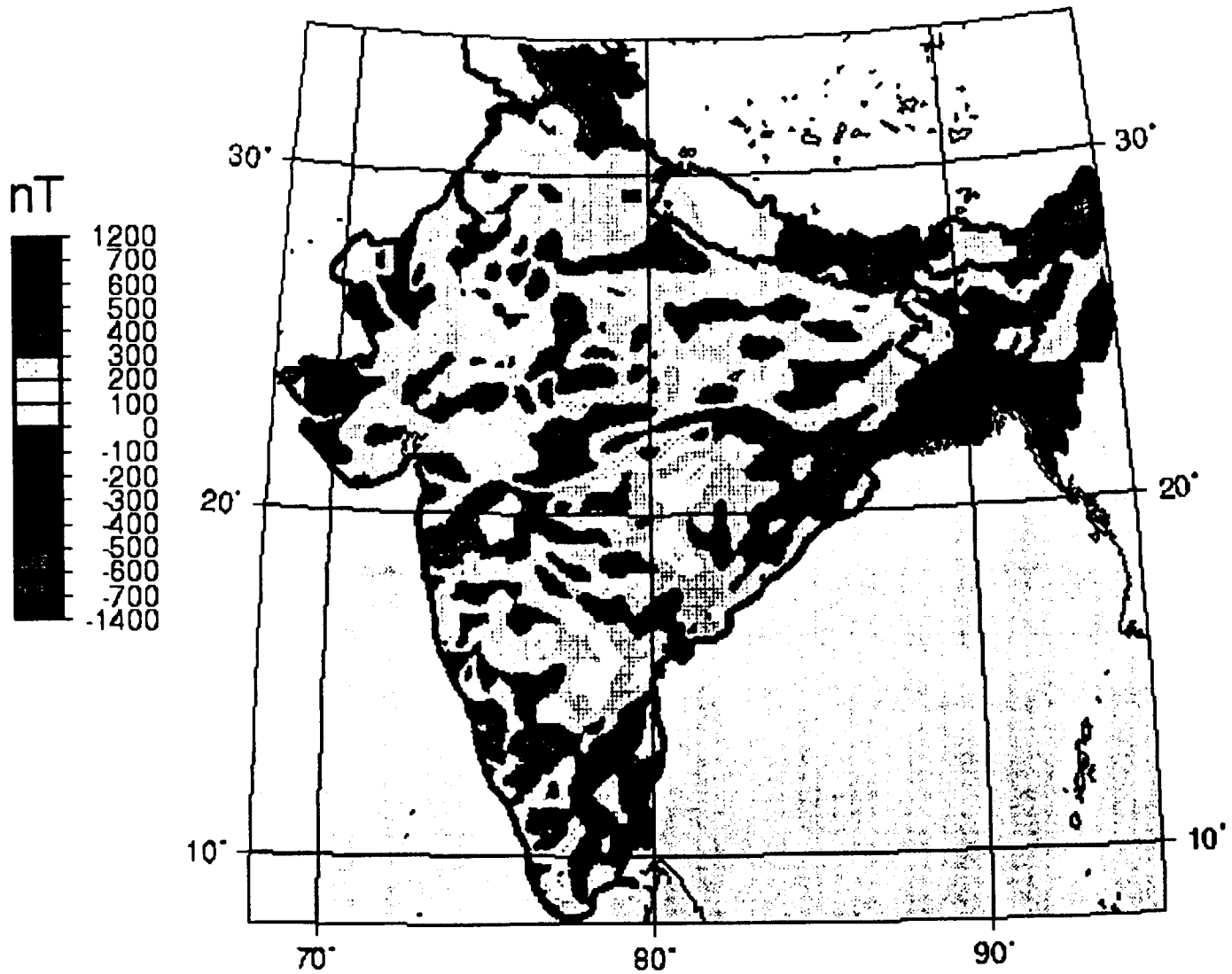


Figure 2. Digitized regional total intensity magnetic anomaly map of India. Color interval in nT.