J. Ind. Geophys. Union (October 2004)
Vol.8, No.4, pp.311-317

Basement characteristics of Papaghni Basin of Eastern Dharwar Craton (Inida) - An inference from Aeromagnetic study

R.K.Kishore and Ch.Rama Rao
National Geophysical Research Institute,Hyderabad-500 007, India.

ABSTRACT
Analysis of the aeromagnetic map of a part of granite-green stone terrain west of the Precambrian Cuddapah Basin (2000-600Ma) has been made to delineate possible lithological variations with in the basement of the oldest Papaghni sub-basin. Three magnetically different zones with in the basement have been inferred where each zone is separated by deep fault/contact. The northern part of the basement (A) is of more felsic nature compared to the middle part (B) which is occupied by older metamorphics. The southern part (C) of the basement is severely affected by mafic intrusions. Analysis of magnetic Profiles yielded a total thickness of 1300mts for the Papaghni rocks and 5.3km for the entire suite of Papaghni & Chitravati group of rocks which is in aggrement with the earlier studies.
Key words: Aeromagnetics, basement characteristics,granite-green stones, Fault/Contact

INTRODUCTION

The Proterozoic Cuddapah basin which appeared between the Eparchean interval and the Cambrian period (2000 to 600Ma) is a mosaic of sub basins with complex structure and occupies an important place in Indian geology. The sub basins include (i) The Papaghni (ii) Nallamalai (iii) Srisailam (iv) Kurnool and (v) Palnad (Fig.1). The Archaean crystalline basement surrounding the western, northern and southern parts of the Cuddapah basin is also complex with four varieties of Archaean rocks. They include (a) The older metamorphic rocks comprising biotite schist, pyroxenite and amplibolites. (b) The peninsular geneissic complex with gray granites, gneisses and migmatites (c) Dharwar supra crustals and (d) Younger intrusive rocks which include quartz reefs, basic dykes, pegmites, quartz veins, pink granites and other ultra-basics.

NNW-SSE and N-S trending Archaean green stone belts belonging to Dharwar group namely the Kadiri and Veligallu shcist belts appear to stop suddenly at the southern boundary of the Papaghni sub basin (Fig.1). Similarly the E-W and ENE-WSW trending dykes in the western part of the sub basin also appear to terminate at the boundary. A small patch of NW-SE trending Jonnagiri green stone belt is located towards west in the northern part of the sub basin. Paralleling the western boundary, granite intrusions occurred at Singanamala, Gooty and at other places. The western part of the Cuddapah basin has not undergone any deformation and remained stable whereas the eastern part of the basin was severely deformed by folding and faulting.

Six episodes of intense igneous activity has a direct bearing on the evolution and development of the intracratonic Cuddapah basin (Naga Raja Rao et al.1987). The occurrence of its rich mineral resources like copper, lead, iron, barytes, asbestes, steatite and kimberlites had a direct bearing on the tectonic activity. The lithological variations with in the crystalline basement seen in the western part of the basin boundary are supposed to exist in the basement also under the sediment cover. The subtle variations in lithological constituents of the basement rocks are well reflected in the aeromagnetic anomaly map of this part of Eastern Dharwar Craton. The basement topography and its nature has been masked by intense igneous activity and deposition of non magnetic Papaghni and Chitravati group of rocks in the oldest Papaghni sub basin in SW part of Cuddapah Basin. So an attempt has been made to delineate the basement character under this sub basin taking clues from the aeromagnetic map of the exposed crystalline basement located towards west of the basin.

PAPAGHNI BASIN

The Papghni sub-basin has an arcute shape paralleling the western boundary of Cuddapah basin. The width

of the sedimentary strata in the northern part gradually increases towards south and attains maximum width between Parnapalle-Gandikota (Fig.1). The basement has gentle dips varying between 5°-15°. The rocks of Papghni and Chitravati groups have been deposited on the crystalline basement and attains a maximum thickness of 6.5Km near Muddanuru. The Vampalle and Tadipatri formations in the basin are associated with dolerite, picrite and gabbroic sills, basaltic flows, ignimbrite and ash fall tuff. Murthy et al. (1981) opines that the NNW-SSE trending Kurnool-Gadwal green stone belt in the north and the Kadiri schist belt in the south extend underneath the western part of the basin and constitute a part of basement. Intense igneous activity, uplift, erosion and subsidence caused due to mantle perturbations and thermal activitiy in the surrounding areas of this part of the basin initiated the basin formation (Bhattacharji & Singh 1982, Bhattacharji 1980, Murthy 1979). The uplifted southern and western provinces form the source areas for the sediments in the Papaghni basin.

GEOPHYSICAL STUDIES

A wealth of geophysical data comprising gravity, aeromagnetic, deep seismic, megneto telluric and ground magnetic data is available over this basin. Aeromagnetic data at 1km line spacing at a flight height of 150mts (Fig.2) has been collected by the National Geophysical Research institute (NGRI) for the Geological Survey of India (GSI) as a part of later's mineral exploration program.

A gravity high of about 45 mgals amplitude cover the entire Papaghani basin. This anomaly has a N-S trend. Mishra et al. (1987), Balakrishna & Paul (1970), Kailasam, (1976), Krishna Brahamam (1989), Verma & Satyanarayan (1990), Ram Babu (1993), Grant (1983) and many others unanimously agree that a high density, basic body having basaltic/grabbroic

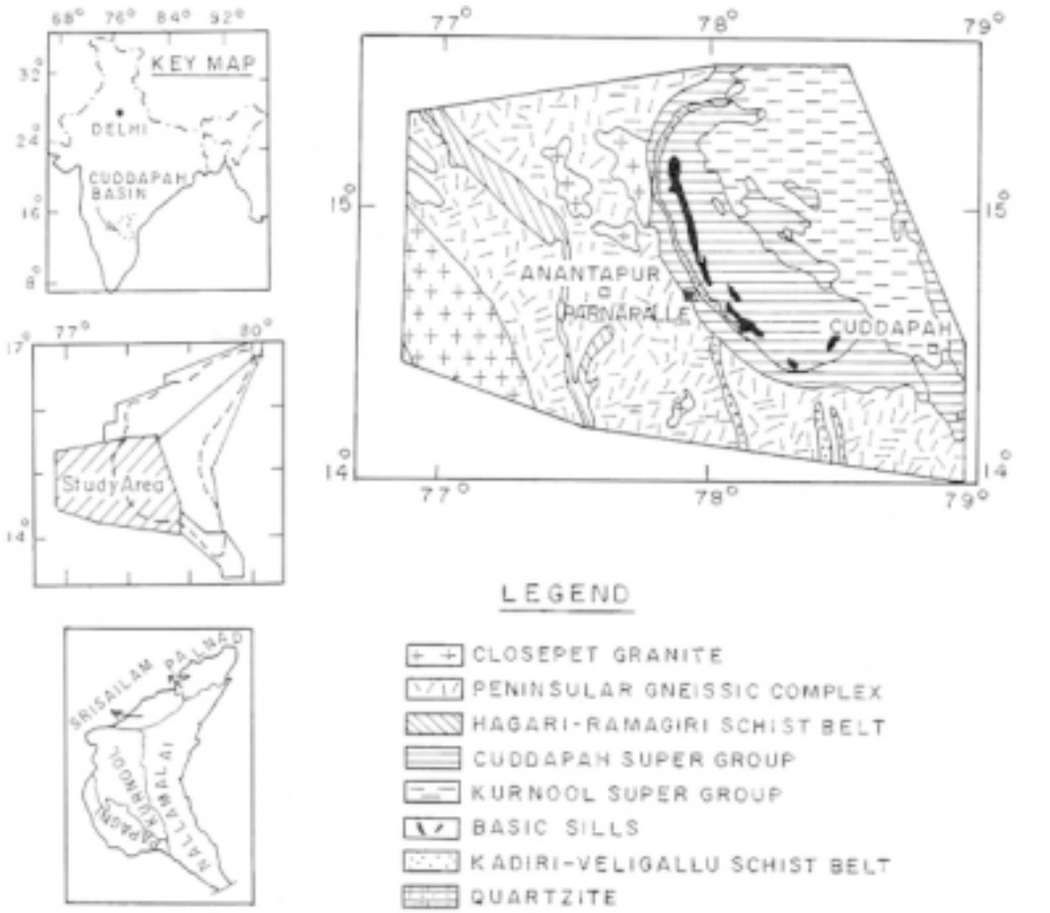

Figure 1. The Precambrian Cuddapah Basin and varoius sub basins. Unclassified crystallines and the greenstone belts form the basement towards west.

composition underlies the sediments. Thus the gravity picture completely masks the subtle variations with in the under lying basement. Krishnabrahamam (1989) and Ram Babu (1993), have interpreted the gravity map and delineated two faults west of Tadipatri coinciding with the gradient of the gravity high.

The aeromagnetic anomaly picture is no different from the gravity except a conspicuous positive magnetic anomaly at Yadiki at 15°N Lat and 78° E long on the Tadipatri formations. The high intensity anomaly of more than 600nT between Parnaepalle and Muddanuru is associated with a mafic intrusion as was inferred from gravity and the estimated depth to its top is 7.6 km. (Babu Rao 1991).

Short wave length magnetic anomalies in an oval shape define approximately the Papaghni basin boundary and these are associated with the sills and flows with in the sediments at shallow depths. The average depth estimated for these shallow sources is about 620mts (BabuRao 1991).

In order to understand the basement characteristics of this oldest sub basin, analysis of aeromagnetic map of the crystalline basement located towards west between 14° N and 15° 30′ N latitudes and 77° E and 77° 45′ E longitudes has been made.

INFERENCES FROM AEROMAGNETIC ANOMALY MAP:

Fig 2. is the aeromagnetic anomaly image of the crystalline basement and SW part of the Cuddapah basin. The prominent magnetic high in the northeastern part of the image represents deep seated nature of the basement. The high intensity short-wave length anomaly clusters (with 200nTand above) oriented in N-S to NNW-SSE on the exposed crystalline basement in the western and southern part of the basin are associated with the Ramagiri and Kadiri Veligallu schist belts.

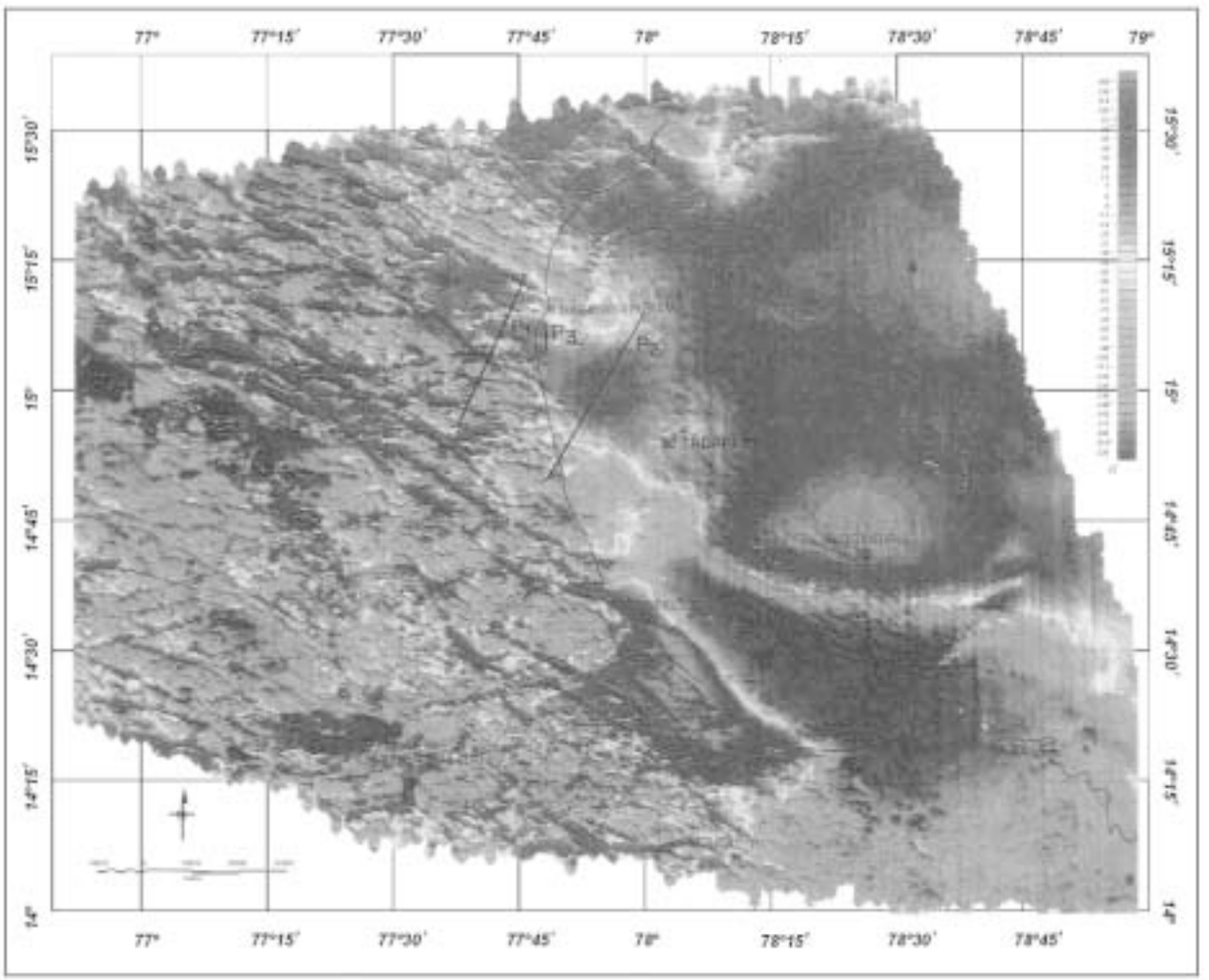

Figure 2. Total intensity Aeromagnetic anomaly map of the exposed basement complex and the Papaghni sub-basin.

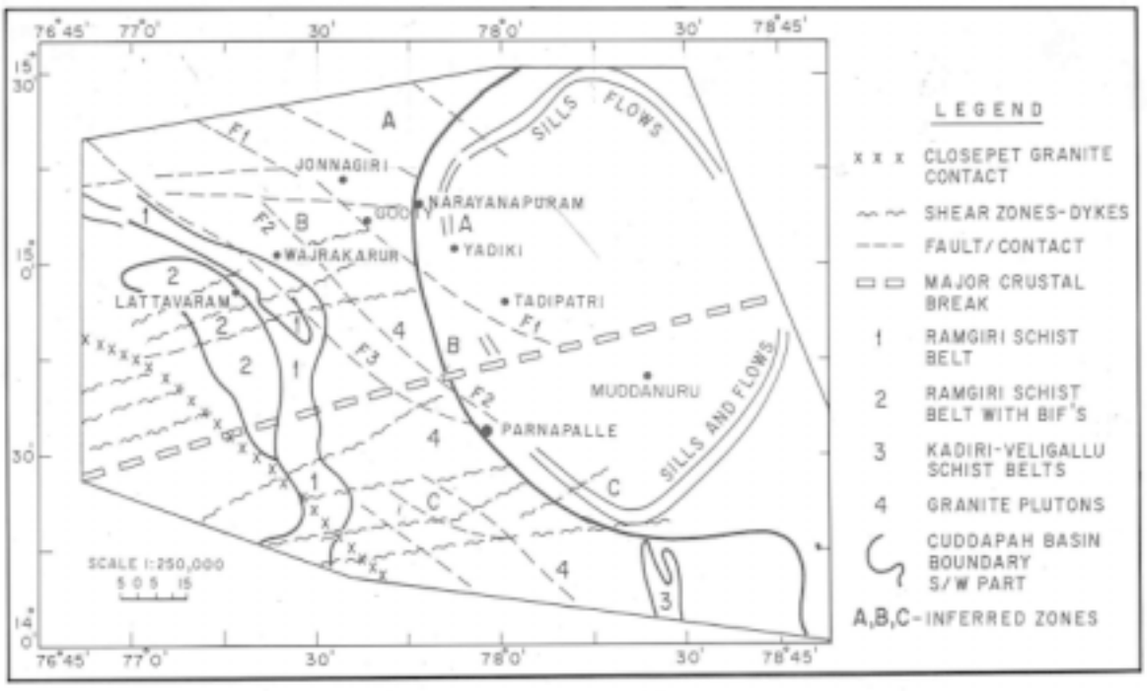

Figure 3. Inferred magnetic lineaments, zones of green stone belts and fault/contacts.

The ENE-WSW trending linear anomaly bands are associated with shear zones and faults, where, in most of the cases were intruded by dolerite dykes ranging in age form 2100-600Ma (Murthy et al. 1979)

The NW-SE trending high intensity anomaly zone (B) south of Jonnagiri is associated with older metamorphic rocks containing more magnetic minearals. The amplitudes of the magnetic anomalies in this zone range from 100to200nT. This zone has been traversed by E-W and ENE-WSW trending basic dykes and is bounded by the faults F1 and F2 (Fig.3). A zone of sparsely distributed magnetic anomalies (A) with amplitudes of less than 100nT is separated by the Gooty-Tadipatri fault F1 towards north. This zone is occupied by more felsics rocks compared to the zone B. Thus, the NW-SE trending fault/contact traversing along Gooty-Tadipatri seems to have been extending into the basin and divides the basement into two parts.

The positive magnetic anomaly at Yadiki, in the basin, thus is associated with a fault contact between two magnetically different blocks and represents the basement below the Papaghni sediments.

The high intensity magnetic anomaly zone (C) in the extreme south traversing in ENE-WSW direction on the basement complex around Parnapalle is associated with dolerite dykes and shear zones and represent more mafic composition. This zone appears to have been divided into a mosaic of blocks with rhombic pattern. Deep Seismic Sounding (DSS) studies of Kaila et al. (1979) brings out detailed crustal structure which shows an uplift in the Moho and associated up warp in the crustal column possibly resulting in a tensional tectonic environment. Their study has also indicated deep faults through which magmatic material has invaded the granite-green stone basement in this part of the basin.

Fig.3 is the diagram showing the inferred magnetic lineaments representing the fault/shear/ contact zones, dykes, magnetic zones and areas of granitic intrusions.

MODELING OF THE GOOTY-TADIPATRI FAULT CONTACT

Two magnetic anomaly profiles across the inferred Gooty-Tadiparti fault are modelled using the MAGMOD soft ware of Paterson,Grant& Watson, Ltd.,Canada (1982).Profile 1 is taken along N30° E direction on the exposed crystalline basement near Gooty, where the fault trace is exposed and the contact is inferred to be near vertical. Profile 2 is taken along N30°E in the basin part, where a thick pile of sediments have been deposited and masked the trace of contact between zones A & B. A comparison of the observed profiles P1 and P2 indicates that the amplitude of P1 is about 300nT and is associated with a sharp gradient and low towards south. Whereas the anomaly profile P2 has an amplitude of 150nT with broad and subdued low towards south. This indicates

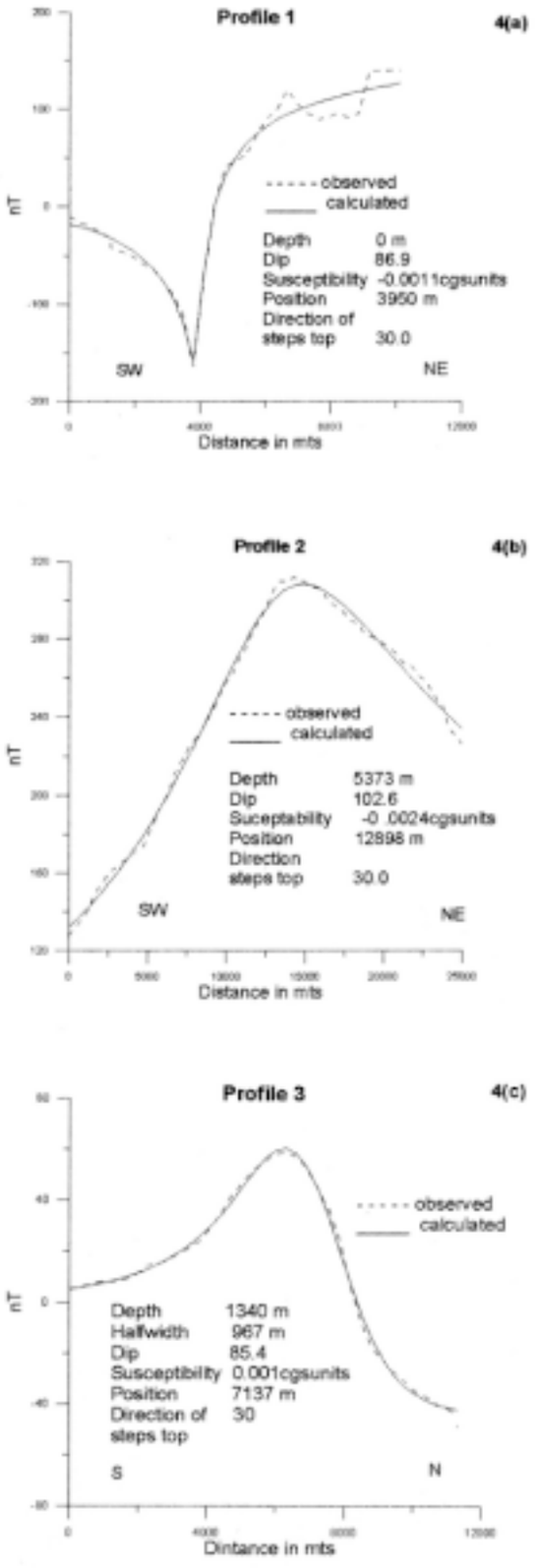

Figure 4. Interpreted anomaly profiles across Gooty-Tadipatri fault/contact and profile at Narayanapuram. (4a,4b,4c)

that the trace of the contact is deeper on profile P2. In both the cases a negative susceptibility is assigned to the contact which indicates that the target is less magnetic towards north-east as the formations are more felsic in nature compared to the older metamorphics towards south of the contact. Modeling of anomaly profile P2 yields a depth to the top of the contact as 5.3 Km located near Yadiki with a near vertical contact (Fig.4). The estimated thickness of Papaghni and Chitravati group of rocks piled up on a basement dipping at an angle of 15° is approximately 6.1 km far SE of Yadiki. Another anomaly, P3, at Narayanapuram located towards NW of Yadiki has also been modelled to derive the basement depth. This anomaly is located on the Papaghni rocks. The calculated depth of 1300 mts matches well with the total thickness of Papaghni rocks.

Continuation map

Upward continuation field of the aeromagnetic map (Fig.2) has been prepared. The upward continuation of anomaly field will suppress the effects of high frequency shallow features and brings out clearly the deeper contacts of differently magnetized crustal blocks. Fig.5 is the upward continuation map at a level of 5km.

The continuation of the NW-SE trending positive anomaly zone of 60nT along Yadiki – Jonnagiri is associated with a possible less magnetic felsic contact at depth, where as the 200nT anomaly zone between Wajrakarur and Guntakal is related to older metamorphic terrain (B). The Gooty-Tadiparti fault contact seems to penetrate deep into the crustal layer and terminates against the Owk-Gandluru fault which represents the boundary between Papaghni and Kurnool sub-basins.

CONCLUSIONS

Analysis of aeromagnetic map of the exposed crystalline basement region of the Cuddapah basin gave sufficient clues to infer the possible lithological variations with in the basement of the oldest Papaghni sub basin.

The analysis clearly brought out three zones of lithological variations with in the granite-greenstone basement rocks, each zone being seperated by fault/ contact. The zone (A) towards north of Yadiki is seperated by Gooty-Tadipatri fault (F1) and is associated with more felsic rocks. The zone (B) towards south of Yadiki bounded by faults F1 and F2 is associated with older metamorphics and intrusions of dolerite dykes.

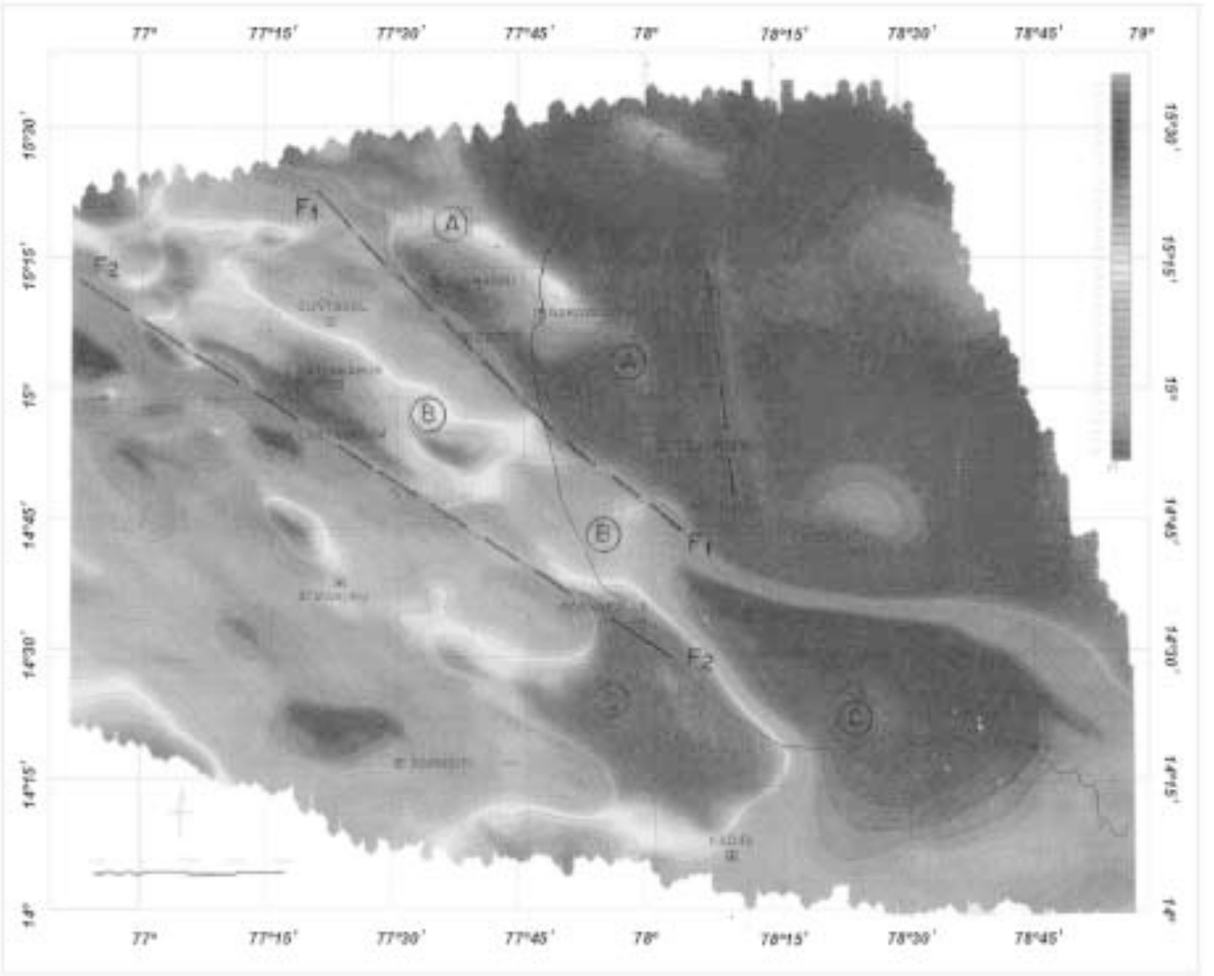

Figure 5. Upward continued map of the study area.

The third zone (C) south of Parnapalle is severely affected by intense magmatic activity and uplift of crustal layers and resulted in a possible assimilation of the granite green stone rocks.

ACKNOWLEDGEMENTS

The authors thank the Director, NGRI for his permission to publish this paper. They express their sincere thanks to Dr.H.V.Ram Babu , Head, AirBorne Surveys division of NGRI for his encouragement and interest.

REFERENCES :

Babu Rao, V., 1991. Geological significance of magnetic depth estimates over western part of Cuddapah basin, South India. Jour. Geol. Ind., 33, 605-614.

Bala Krishna, S., Paul., 1979. Magnetic studies on the Igneous rocks in the SW region of the Cuddapah basin and in the adjoining granitic courtry, IIPG, Hyderabd, 2nd Workshop, 18-40.

Bhattacharji, S., 1980. Evlolution of an intracratonic Proterozoic Basin, Institute of Indian Peninsular Geology, 7-28.

Bhattacharji, S., Singh, R.N., 1982. Mantle Perturbations, Thermal Episodes and origion of intracratonic Proterozoic Cuddapah Basin on south Indian shield, Monograph – on Evolution of the intracratonic cuddapah basin south India Published by Institute of Indian peninsular Geology 107-132.

Geosoft, Oasis Montaj., 1997. Data processing and analysis (DPA) system for earth science application, Version 1.4, User Guide.

Grant, F.S., 1983. Report on a visit to NGRI, Hyderabd, regarding Project IND/79/047 (unpublished).

Kaila,.L., Roy Chowdhury, K., Reddy, P.R., Krishna, V.G., Hari Narian, Subbotin., S.S., Sollogub. V.B., Chekunnov, T.V., 1979. Crustal structure

along Kavali – Udipi Profile in the Indian Peninsular Shield form Deep Seismic Sounding, Jour. Geol. Soc.Ind., 20, 307-333.

Kailasam, L.N., 1976. Geophysical studies of the major Sedimentary basins of the Indian Craton, their deep structural features and evolution, Tectonophysics, 36, 225-245.

Krishna Braham., 1979. Gravity and Seismicity of the cuddapah basin and surrounding places. Jour. Geol. Soc. Ind., 34, 373-384.

Mishra, D.C., Babu Rao, V., Laxman, G., Rao, M.B.S.V., & Venkartarayudu, M., 1987. Three dimensional structural model of Cuddapah bain and adjacent eastern part from geophysical studies. In: B.P.Radhakrishna (Editor), Purana Basins of Peninsular India, Geol.Soc.Ind. Mem., 6, 313-330.

Muthy, Y.G.K., 1979. The Cuddapah Basin – Areview. Proceedings of 3rd Workshop on Status, Problems and programmes in Indian Peninsular Shield. IIPG, Hyderabad, 34-43.

Murthy, Y.G.K., Babu Rao, V., Gupta Sarma, D., Rao, M.N., & Bhattacharji, S., 1981. Tectonic and petrochemical and geophysical studies of mafic dyke swarms around the peterzoic Cuddapah basin, south india. Mafic dyke swarms, GAC, Special paper 34, 303-303-316.

Naga RajaRao, B. K., Raj Kumar, S.T., Ramalinga swamy, G., & Ravindra Babu, B., 1987. Sratigraphy, structure and evolution of the Cuddapah Basin Puran basins of Peninsular India. Jour. Geol. Soc. Ind, Mem., 6, 33-86.

PWG., 1982. Program Documentation – MAGMOD version 1.4. Magnetic Interpretation Software library, Paterson, Grant and Watson Ltd., Toronto Canada.

Ram Babu, H.V., 1993. Basement structure of the Cuddapah Basin form gravity anomalies. Tectanophysics, 223, 411-422.

Verma, R.K., Satyanarayana, A., 1990. Gravity field, deep seismic sounding and crust-mantle structure over the Cuddapah bain and Dharwar craton of India., Techtonophysics, 178, 337-356.

(Accepted 2004 April 30. Received 2004 April 4; in original form 2004 January 28)