Available online at www.pelagiaresearchlibrary.com

Pelagia Research Library

Advances in Applied Science Research, 2015, 6(8):189-198

ISSN: 0976-8610
CODEN (USA): AASRFC

Emplacement of Lamproites in North Western margin of Cuddapah Basin (EDC), Nalgonda district (TS)-regional gravity evidence

G. Ramadass[1], K. Satish Kumar[2] and G. Sri Ramulu[1]

[1]*Center of Exploration Geophysics, Osmania University, Hyderabad, India*
[2]*CSIR-National Geophysical Research Institute, Uppal Road, Hyderabad, India*

ABSTRACT

The present studies emphasize the significance of gravity anomalies in particular, the change in gradients of contours for understanding of geology and structural details. Regional Bouguer gravity anomaly map of Nalgonda district, Telangana State exhibits a range of 30 m Gal from a low of -75 m Gal to a maximum of -45 mGal, in the Eastern Dharwa craton to evaluate the structural configuration of the region, from qualitative analysis of, residual gravity, horizontal and analytical signal map brought out, eight conspicuous gravity lows (L1-L8), Nine gravity highs (H1-H9) and seven (F1 to F7) deep seated faults were identified. While the highs are attributed to basement undulations and/or the presence of basic rocks, dykes, the lows are attributed to variations in the peninsular gneissic complex. In addition, seventeen linear gravity trends, seven running NW-SE (L5, L6, L8, H3, H5, H7 & H8), three N-S (L3, L7 & H4), four trending in the NE-SW (L1, L2 ,H1, H6 & H7) and two E-W (L3 & H9) were delineated from qualitative analysis of Bouguer gravity data.

Quantitative analysis from GM-SYS modeling inversion of eight profiles in the region brought out the subsurface layers configurations. The average depth of Peninsular gneissic layer varies from 8.25 to 11.66 Km, upper crustal layer ranging between 18.4 to 24.55 Km and bottom of the deeper crustal layer (Moho) is 34.35 to 37.45 Km The association of reported lamproites in the Vattikod, Ramadugu and Somavarigudem field with the subsurface topographic configuration of each of the layers taken separately as well as together was used to develop a plausible structural subsurface topographic criterion for their emplacement. The criterion for emplacement consist of margins of upwarps in the mantle combined with shallow occurrence of the peninsular gneissic basement in the region, and the zones of intersection of structural trends, resulting in circular to oval shaped structural features, which could have acted as potential sites for lamproites emplacement, four potential zones A-C are identified, as D zone merit for further detailed investigations.

Key words: Gravity, Dharwar Craton, Lamproites, Nalgonda and Ramadugu

---

INTRODUCTION

-

The Dharwar craton within the Precambrian Indian peninsular shield has been attracting the attention of geo scientists for several years now. Though many workers have studied it, there are still many aspects that need to be addressed in deep crustal configuration in the region. The crustal thickness in the region has been obtained seismically through Deep Seismic Sounding (DSS) investigations (Kaila et, al, 1979; Kaila & Krishna, 1992; Sarkar et al. 200; Reddy et al. 2003), gravity studies by Ramadass et al. (2006); Mishra and Ravi Kumar (2014) extensive efforts have also been made to determine the thickness of the crust using Bouguer gravity field in the Eastern Dharwar craton.

Anil Kumar et al. (2001); Reddy et al. (2003); Chalapathi Rao et al. (2004); Sridhar and Rau (2005); Chakrabarti et al. (2007); Joy et al. (2012); Kumar et al. (2013); Chalapathi Rao et al. (2014) and Geological Survey of India were conducted exploration studies for identification of new diamondiferous Lamproites/ Kimberlites near Krishna river basin, western margin of Cuddapah basin and Eastern Dharwar Craton. Reddy et al. (2003) postulate, emplacement of Krishna Lamporites controlled by the cratonisation of Dharwar craton near Eastern Ghat Mobile Belt and mantle up warping due to uplift of Nallamalai sub basin. The present study is motivated from the above studies; we relooked into the regional bouguer gravity of the Nalgonda district (Mishra et al.2008, 2011; Mishra and Ravi Kumar, 2014; GSI-NGRI (2006) to understand the crustal configuration of Nalgonda area which is related to the emplacement of Lamproites near Ramadugu, Vattikudu and Somvarigudem.

2.0. Geology of the Area:-

From the information of the geology in the study region collected from various sources in the 1:250,000 scale map of the area (GSI, 1999) an updated map of the same was prepared to serve as a guide for the analysis of ground geophysical data (Fig.1a). The Nalgonda district is located in the north eastern part of the Proterozoic Cuddapah basin is located between latitudes 16^{o}15'N to 17^{o}45'N and longitudes 78^{o}45' E to 80^o E. The district covers an area of 17,170 Sq.Km and is bounded on the north by Medak and Warangal districts, on the east by Khammam and Krishna districts, on the south by Guntur and Mahabubnagar districts.The geological formations in the area include unclassified granites and gneisses of Archaean age, Cumbum shales, Phyllites, Srisailam quartzites of the Cuddapah super group, and shales of the younger Kurnool group of rocks. The hornblende schists and amphibolites (Older Metamorphics) which are oldest rocks occur, as rafts, enclaves and discontinuous linear bands, within the Peninsular Gneissic Complex. The distinct comprises migmatities, granites granodiorite, tonalitic-trondhjemite suite of rocks and hornblende-biotite schist, metabasalts, meta-rhyolite and banded hematite quartzite and Dharwar super group are exposed as linear belts near Peddavurau on the Hyderabad-Nagarjuna sagar road and also around Fatepur of Miryalgudamandal.

In the southern part of the district along the northern bank of Krishna river the rocks of Archaean Peninsular Gneissic complex are unconformable overlain by sedimentary rocks of 1100-600 Ma, constituting the Cuddapah super group and Kurnool group. The Cuddapah super group in the district is predominantly made up of erinaceous and argillaceous sediments respectively, represented by quartzite and shale of Cumbum formation and Srisailam quartzite. The Kurnool group of rocks comprised calcareous sediments and quartzite.

3.0. Gravity Investigations:-

Fig. 1b shows the color shaded of Bouguer gravity in the Nalgonda district obtained by digitizing the corresponding maps of Mishra et al. (2008, 2011); Mishra and Ravi kumar (2014); GSI-NGRI (2006) and re-contoured, Bouguer anomaly map of the region between the latitudes 16^{o}15'N to 17^{o}45'N and longitudes 78^o 45' E to 80^o E is prepared. The north-eastern part of the Bouguer anomaly map shows a prominent gradient paralleling the NW-SE trend of the peninsular gneiss complex and shows several distinctive features of gravity anomaly in the Nalgonda district. A prominent feature of the map is the NW-SE trend of the gravity signatures from significant (gravity highs) anomalies mark the Northeast and northern parts of the areas. In addition, various E-W, ENE-ESW trend alignments are observed, which are attributable to structural features within the peninsular gneisses.

The Bouguer gravity data was filtered using a low pass filter. This filter retains the large wavelengths or low wave-number components (cut off wavelength of 0.005 cycles/second) of the signal, which correspond (Fig. 1c) to deep seated sources and features of large areal extent, and suppresses the short wavelength components corresponding to shallow (Fig. 1d) features. Thus analysis of low pass filtered signals in understanding regional geological features (Chakraborty and Agarwal, 1990).

From Fig.1c it is evident that the maxima in the low pass filtered response correspond to relatively deeper occurrence of the gravity basement. The gravity value of -75 m Gal observed near the Nagarjuna sagar south-western part of the study area. The extent of the negative anomaly (gravity low) is in fact not limited to any specific geological formation but is spread out well over peninsular gneiss, schist and sedimentary rocks as well.

The north-western part of the study region of Bouguer gravity anomaly map shows a prominent NW-SE gradient which trend in suddenly changing toward east form Nalgonda to Suryapet onwards and continued up to Halia to Miryalguda region**.**

4.0. Residual Gravity:-

Fig.1d is the residual gravity anomaly map of the Nalgonda district study region, clearly shows the eight gravity lows (L1 to L8) and nine gravity highs (H1 to H9), the residual Bouguer anomaly map represents many closures around gravity highs and lows. Some of the Bouguer anomalies do not appear to have been caused by surface geology. The iso anomaly lines generally follow a NW- SE trend is in accordance with general geologic lineament pattern of study area. The residual anomaly over the basin is a minute low, with amplitude of about -0.3 to 0.6 m Gal when compared to its surroundings, these lows appears to be caused by a down warp in the basement and can be attributed to the crustal thickening. As the density of granites is less than the Precambrian rocks of the surrounding area, the huge thickness of these granites gives rise to a low gravity anomaly. This explanation corroborates with the geological explanation of eastern Dharwar Craton in this study area. The south central part of this low is faulted as the contour show a steep gradient with its downthrown side southwestwards, Northwestern and eastern sides of this lows are represented by disturbed pattern of anomaly contours and details of highs and lows were are furnished in Table.1. There might be a possibility for extrusive/intrusive activity in these area causing localized density variations.

The gravity highs (H1 to H9) anomalies with minute magnitudes of 0.6 to 0.8 m Gal equal amplitudes in the study region suggests the presence of high density material in the region and caused by a up-warp in the basement and might be attributed to the crustal thinning or of magmatic activity. The gravity high over greenstone belt extending into the areas under the sediments.

5.0. Horizontal and Analytical gradients:-

Gravity data are often useful in defining the lateral extent of geological bodies such as plateaus and sediments filled valleys. For near surface bodies with near vertical contacts the maximum/minimum horizontal gradient of gravity as measured along a profile will occur nearly over the contact (Dobrin and Savit, 1988), gradients of the observed anomalies help in estimating the depth of the source body and the location and dip of its edges. The horizontal gradients along the (Fig.2a) x direction represents the rate of change of the gravity field in the corresponding direction. From Fig. 2a it is evident that the study area is characterized by a sharp gradient minimum horizontal gradients F1 at southern part, which is separates the predominantly sediments negative anomalies. F2 separates the southern and northern part of the region. A broad zone along the western part with F4 fault trending NW-SE suggests that there exist fault along the western side of the study region. There are many faults represents the dislocation the narrow belts of high gradients are observed. These dislocations can be interpreted as originating from some major or minor strik-slipe faults with horizontal movements.

Fig.2b is the analytical signal map gives finer resolution of anomaly trends and locations and dispositions of causatives (Ramadass et al. 1990).Being the square root of the sum of the squares of the horizontal and vertical components of the anomalous field (Nabighian, 1972), it encompasses information of the gravity field variation along the orthogonal axis completely defining it, Consequently, structural features and boundaries of causative sources can be determined more precisely.

From the analytical signal of Bouguer gravity in the Nalgonda study area, four clusters are marked A, B, C and D. Cluster A (In between Chandur to Somavarigudem), B (south of peddavura, in between Yellapur to Adavidevarapalli), C (between Chintapalli to Miryalguda) and D (Between Bibibnagar to Raigir) trends roughly NW-SE. From the geology of the area it is evident that the cluster A, B, C and D corresponds to younger granitic intrusion within in the peninsular gneissic basement. Three geological boundaries also marked evident in the N-S directions, (Fig.2b) .Thus the NW-SE faults as well as the several E-W, NE-SW and N-S cross structural features constitutes the major trends.

For comparative analysis, structural features inferred from gravity data for the Nalgonda district region have been presented in Fig.2c.The Peddavura schist belts and its faulted contact with the peninsular Gneisses, gravity high low linear features as also the fault between its NW-SE and E-W are clearly indicated on the structural map derived from gravity data

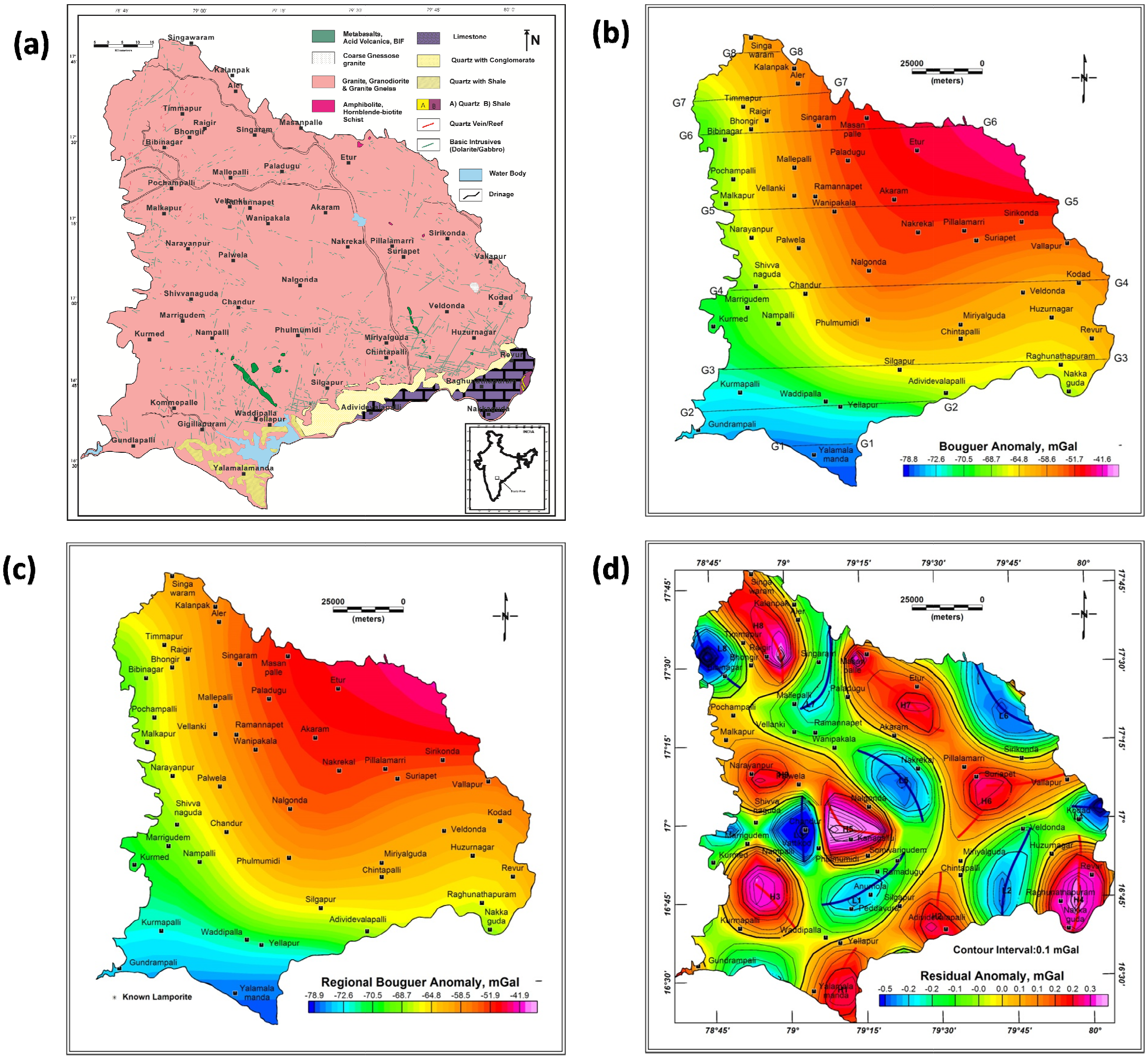

Figure 1. (a) Geological map of the study area (after GSI, 1999), (b) Bouguer gravity anomaly map of the Nalgonda district, Telangana (Mishra et al.2008, 2011; Mishra and Ravi kumar, 2014; GSI-NGRI, 2006) with locations of interpreted profiles G1to G8, (c) Regional gravity anomaly map of the Nalgonda district, Telangana (Low pass Filtered) and (d) Residual gravity anomaly map of the Nalgonda district, Telangana (High Pass filtered) shows gravity Highs (H1-H7), gravity lows (L1-L8)

6.0. Quantitative analysis:-

The objective of quantitative analysis of the Bouguer gravity data of Nalgonda district areas was to study the crustal structure along chosen profiles (Fig. 1b) and to obtain a detailed depth section extending up to the Moho. The subsurface configuration of the Nalgonda district area was obtained by regional gravity modeling. Using inversion package GM-SYS (2000) eight (G1 to G8) E-W profiles, digitized from Fig.1b. were modeled assuming a three-layer earth model consisting of a top layer of peninsular gneisses, overlying the upper and deeper crustal layers with corresponding densities of 2.67 gm/cc, 2.72 gm/cc and 2.85 gm/cc (Ramadass et al. 2002; Veeraiah et al. 2009) respectively. The configuration of the layers of the model was iteratively modified for best fit between observed and computed anomalies for the gravity profile. The user interactively initiates the subsurface model in terms of layered earth using known geology as a control. For the present study a four layered model was assumed with densities (Ramadass et al. 2006) of 3.3 gm/cc for the Moho, 2.85 gm/cc for the deep crustal layer, 2.72 gm/cc for the upper crustal layer and 2.67 gm/cc for the top layer of peninsular gneiss and modeled on eight representative profiles,G1 to G8 (Fig.1b), cutting across latitude from 16°30' to 17°45' in the region digitized from the Bouguer gravity image map (Fig. 1b). The locations of faults along the profiles are marked from the first horizontal derivative of the Bouguer gravity. The details of the interpreted subsurface layers are tabulated in Table 1 and Fig 3a to Fig. 3h.

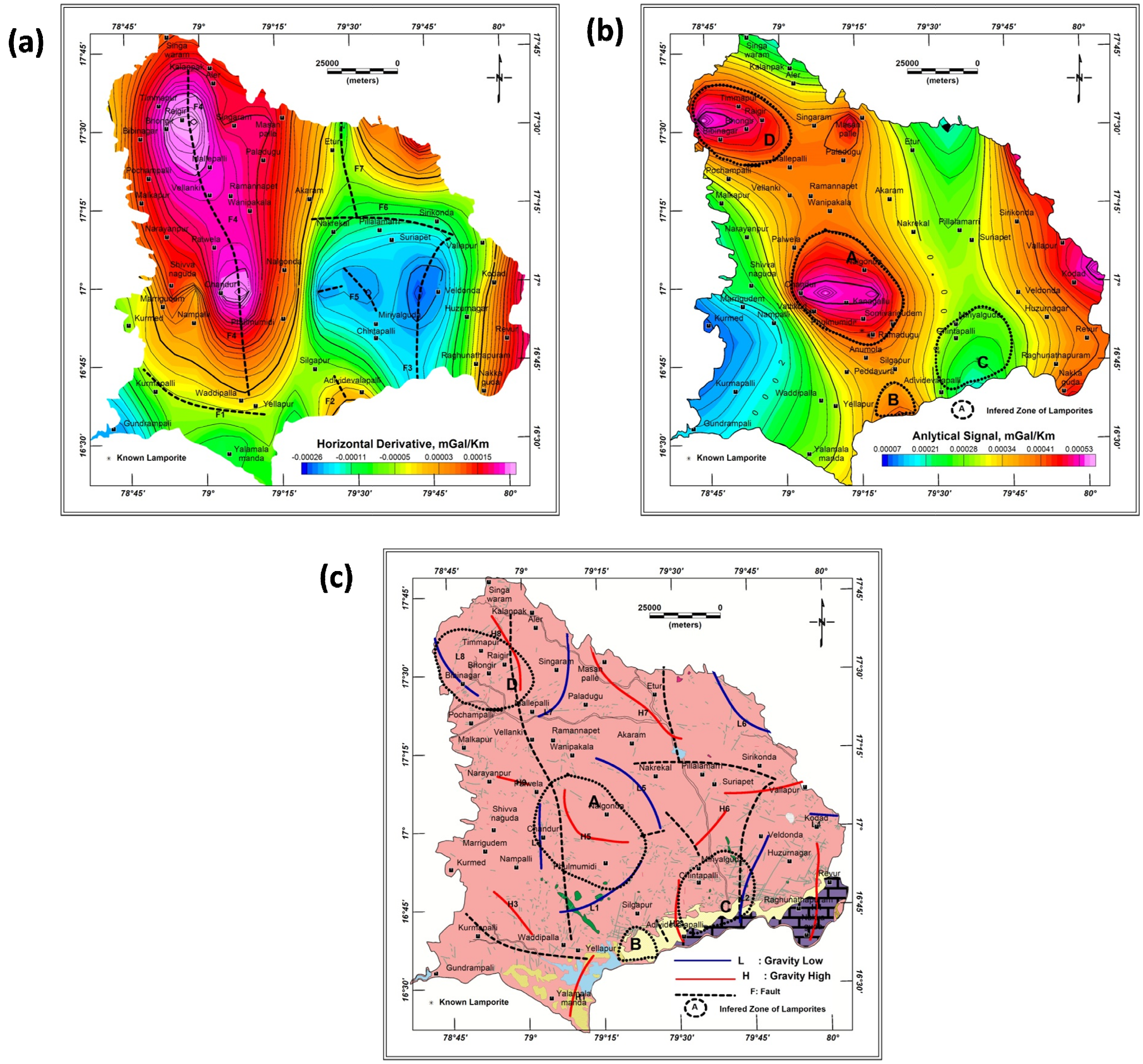

Figure 2. (a) Horizontal derivative map (X direction) of the Nalgonda district, Telangana (shows location of inferred gravity faults (F1to F7), (b) Analytical Signal map of the Nalgonda district, Telangana (shows locations of known Lamproites and three circular clusters A, B, C & D), (c) Integrated structural map of Nalgonda district, Telangana from the gravity qualitative analysis superimposed on Geology

Profile No.	Figure No.	Length of the Profile (Km)	Peninsular Gneess Range/ Average (Km)	Upper Crustal Layer/ Average (Km)	Deeper Crustal Layer/Average (Km)	At Latitude	(Inferred Structural Features at distance (Km))
G1	3a	25	10.76 - 12.56 / 11.66	23.47-26.24 / 24.85	35.71-39.2 /37.415	16° 30'	-
G2	3b	80	7.6-8.9 / 8.25	22.2-23.74 / 22.97	34.4-36.46/35.43	16° 38'	F4 (22.69), F2 (73.12)
G3	3c	130	9.4-11.2 / 10.3	19.2-21.8/ 20.5	33.68-36.33/35.00	16° 45'	F4 (37.14), F3(99.05)
G4	3d	130	5.3-11.49 /8.39	15.05-21.75 /18.4	31.8-35.82/33.81	17°00'	F4 (32.6), F5 (75) & F3 (9
G5	3e	120	8.54-9.38/8.96	20.45-21.7/21.08	35.68-39.15/37.41	17° 15'	F4 (26.4), F6(76)
G6	3f	100	9.2-10.9/10.05	21.05-22.64/21.84	35.4-38.16/36.78	17° 30'	F4 (26.69), F7(99.15)
G7	3g	45	8-10 /9	18.7-23.4/21.05	31.5-36.2/34.35	17°38'	F4 (27.5)
G8	3h	12	10-12.75/ 11.37	21.3-23.0/22.15	31.4-38.6/35.0	17°45'	-

Table 1: Crustal Configuration of the Nalgonda Districts

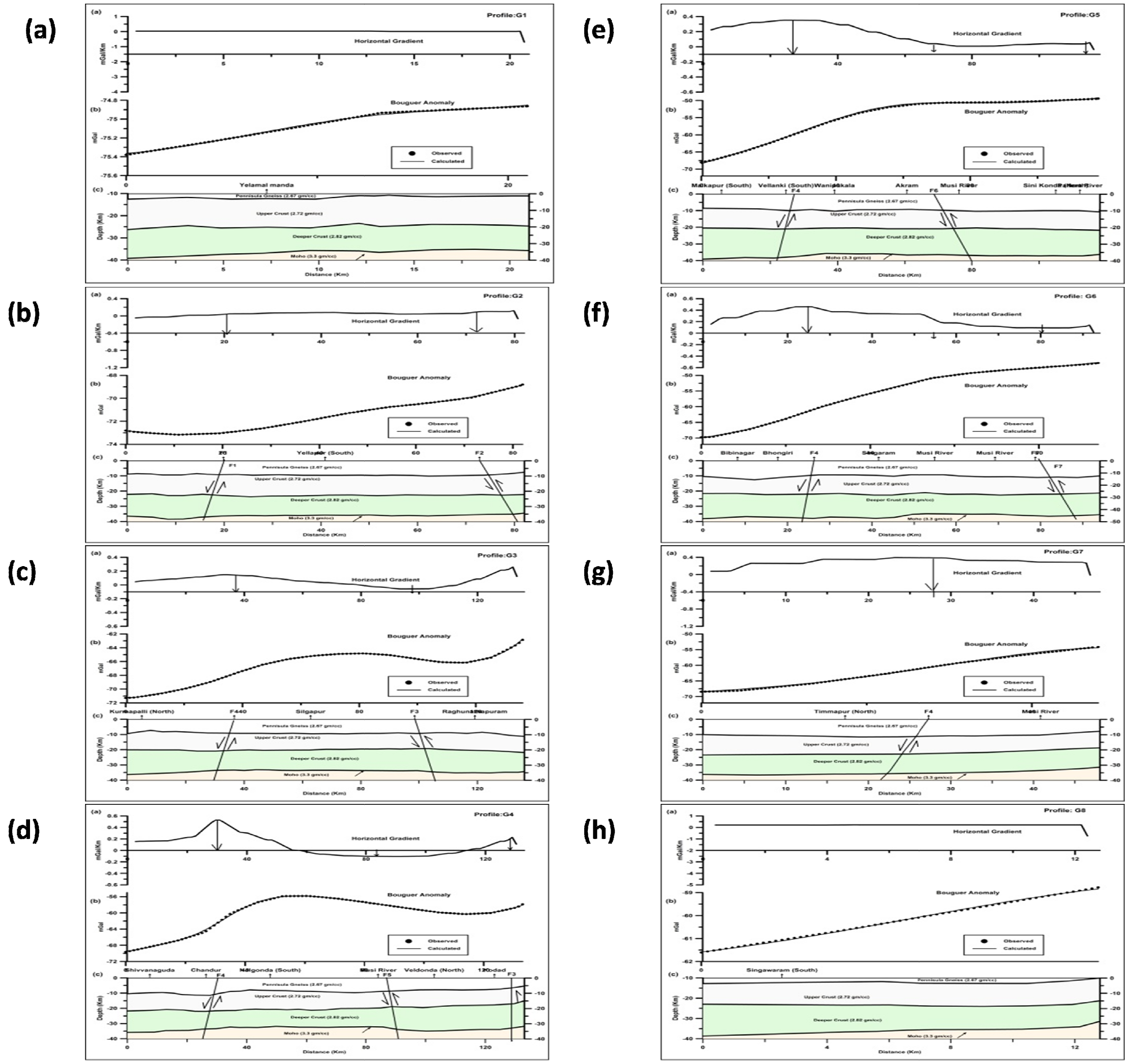

Figure 3. (a) Interpreted section of gravity profiles G1 at 16°30' latitude, (b) Interpreted section of gravity profiles G2 at 16°38' latitude, (c) Interpreted section of gravity profiles G3 at 16°45' latitude, (d) Interpreted section of gravity profiles G4 at 17°00' latitude, (e) Interpreted section of gravity profiles G5 at 17°15' latitude, (f) Interpreted section of gravity profiles G6 at 17°30' latitude, (g) Interpreted section of gravity profiles G7 at 16°38' latitude, (h) Interpreted section of gravity profiles G8 at 16°45' latitude

7.0. Subsurface topography:-

The configuration of the layers of the model was iteratively modified for best fit between observed and computed anomalies for the gravity profile. The depths to each of the layers along all the profiles in study area were digitized and contoured and are presented as surface plots (Fig. 4a, 4b & 4c). The peninsular gneissic layer (Fig.4a) is very uneven in geometry; its thickness varies from 5.3 to 12.5 km. The thickness of the upper crustal layer (Fig. 4b) varies from 17 to 25 km and 31 to 39 Km thickness variation observed over deeper crustal layer Table -1. The folded nature of the subsurface terrain, especially in the upper crustal layer is evident.

From the 3-D contour image of the younger granites exposures appear to be concentrated as circular features with a maximum depth of 12.75 Km. The peninsular gneissic layer (Fig. 4b) is very uneven in geometry, its thickness varies from 5.3 to 12.56 Km .Broadly, the gneissic basement occurs at shallow depths 5.3 to 11.49 Km in southern part of the areas as compared to northern part (10 to 12.56 km). While variations in this layer by themselves give only depth to basement when taken in conjunction with the configuration of the Upper crustal layer, the presence of shallow faults can be inferred, and when taken in conjunction with the upper as well as deeper crustal layers, the presence of deep seated faults (F1 to F7) can be inferred.

The relief in the subsurface topography of the bottom of the Upper crustal layer (Fig. 4c) is marked, varying between 15.05 to 26.24 Km as compared to the peninsular gneissic layer and that of the Moho, which range from 31.4 to 39.2 Km respectively. The northwestern low and the highs near, Ramadugu, Munugodu and the south eastern part of the study area in the upper crustal layer more or less mirror the corresponding subsurface topography in the peninsular gneissic layer. However, the high in the southwestern region in the latter does not have similar expression in the underlying layer, which is characterized by moderate lows.

From the above it is evident that the northwest low reflects a deep-seated faults F1, But the folded nature of the subsurface terrain, especially in the upper crustal layer is evident plunging folds trending primarily NW-SE and secondly NE-SW suggest correspondingly, at least two different episodes of deformation. Though it is more difficult to infer the disposition of the shallow faults, from the profusion of NW-SE trending faults/ in the region build-up stresses and subsequent faulting and upwelling of magma along the fold axes is inferred.

Up warps in the Moho are seen at Halia to Munugodu and east of Kanigal, while crustal thickening is seen at Ramadugu, Somavarigudam and Vattikod. The significance of mantle processes and subsequent localization of lamproites at intersections of prominence linear and second order trends and peripheries of younger granites intrusions are evident. Thus, plausible criterion for prognostication of lamproites is inferred. Region of mantle up warps combined with shallow depths surrounding deep lows in the subsurface topography of the first layer beneath the surface with associated intersecting lineaments in the vicinity. It exposes granites and gneisses of the peninsular genesis complex intruded by mafic dyke swarms with trend swerving between WNW-ESE and ENE-WSW. The lamproites occur as 0.5m-5m dykes, mostly as clusters and run for lengths of about 1 m to 400m in close association with dolerite dykes mostly emplaced along the contacts between granite gneiss and dolerite dykes (Kumar et al. 2013). This criterion is utilized to delineate potential lamproites zones in the Munugodu Alya region.

Support for the inferred configuration of the upper crustal layer in the region near Ramadugu established that lamproites confined to Archaean and Proterozoic Cratons are linked to upwelling mantle due to rifting or a mantle plume (Kullerud et al. 2011; Chalapathi Rao, 2014). Further the greenstone belts of EDC are generally regarded as representing composite tectono-stratigraphic terrains formed from accretion of plume-derived, as well as subduction derived, magmatic episodes (Manikyamba and Kerrich, 2012).

From the criterion for lamproites emplacement developed based on the structure of the crust, namely up warps in deeper layers related with deeply penetrating faults coupled with shallow occurrences of gneissic basement in the vicinity of intersecting lineaments, locations satisfying the criterion are delineated and three clusters are identified A to C. All the zones are characterized by gravity low/high, we inferred that these negative and positive anomalies correspond to subsurface topography lows of the peninsular gneissic layer and fringe the margins of up warps in the upper and deeper crustal layer. Zone A in the study area centered off Ramadugu to its east appeal to be continuous to the Chandur in the Ramadugu lamproites field, and Somavarigudem lamproites (ChalapathiRao et al. 2014).Therefore, it is readily inferred that the northern margin of the Ramadugu lamproites field extends further north of Ramadugu, up to Munugod and Vattikod. Which corresponds to a Younger granite intrusion and contact between granites and mafic dyke, is characterized by the intersection of NW-SE fault and a gravity low (L2) and gravity high (H5) trending NW-SE directions. Cluster B and C are falling in the zone of intersection of F6 fault and gravity low (L2) trending NE-SW and a gravity high (H2) trending NE-SW in the Yellapur and miryalguda block respectively. Cluster D consists of a gravity low (L8) and gravity high (H7) are trending in the NW-SW west of fault F4 and similar mafic dykes like Ramadugu regions exists in-between Bibinager to Raigiri regions merit further detailed gravity surveys for locating lamproites.

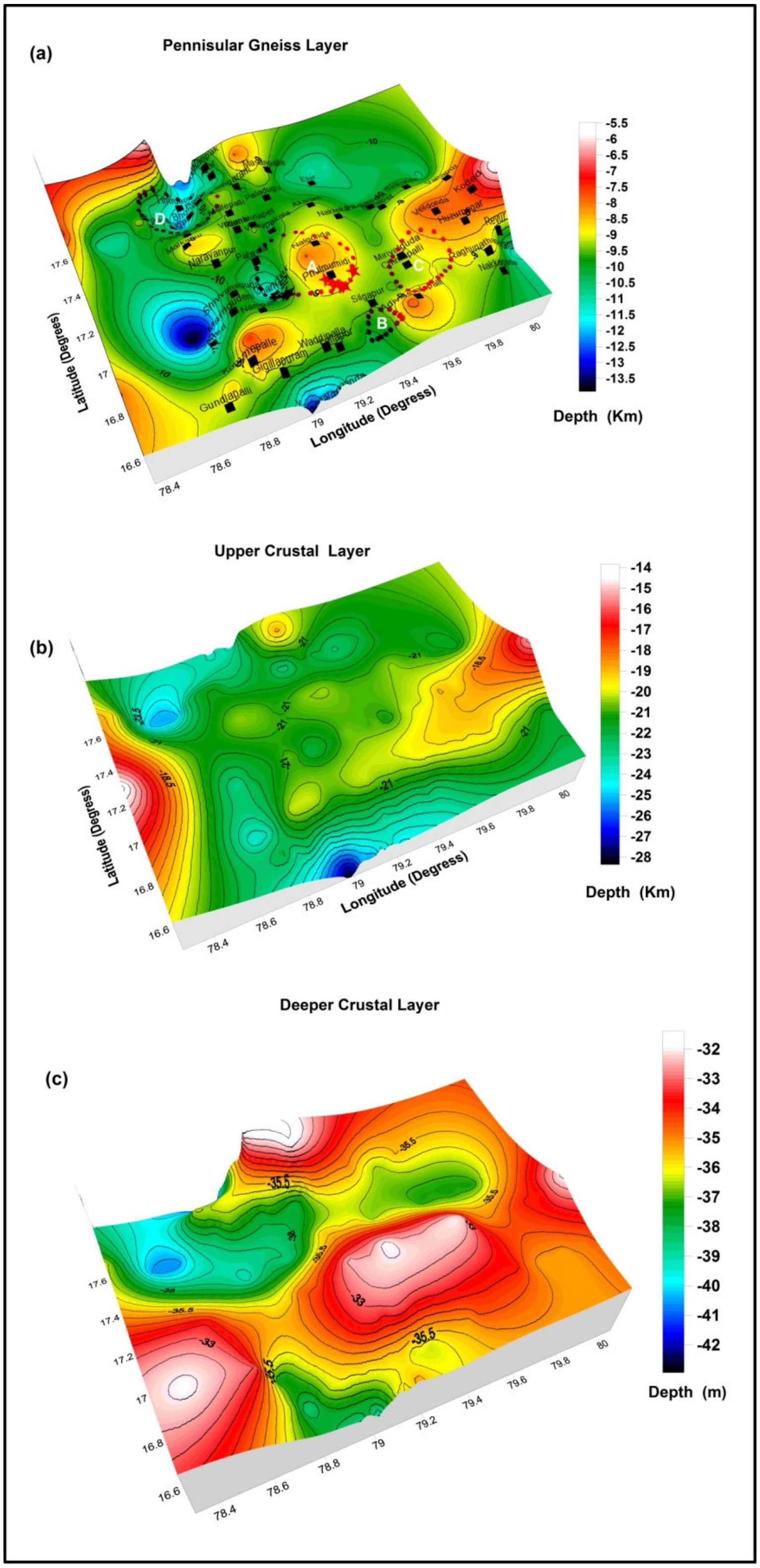

Figure 4.(a) 3D view of the Peninsular Gneissic layer (with density of 2.67 gm/cc) (b) 3D view of the Upper crustal layer (with density of 2.72 gm/cc) and (c) 3D view of the deeper crustal layer (with density of 2.85gm/cc) of Nalgonda district, Telangana

CONCLUSION

Analysis of Regional Bouguer gravity data in the Nalgonda District of Telangana State is to develop a plausible structural subsurface topography criterion for emplacement of lamproites from Bouguer gravity signatures. It was found that the region controls for lamproites emplacement and the measured marginal/contact by upwrap in the deeper layers with associated with structural features. Using these criterions four zones was delineated. However, none of the lamproites from the EDC have so far proved to be prospective and the primary source for these diamonds still remains elusive.

Acknowledgements
The authors gratefully acknowledge the financial support extended by the UGC New Delhi for granting Emeritus professor. The authors record their sincere thanks to Dr. Ch. Mohan Rao, Director NGRI for granting permission to publish this paper. The authors are sincerely thanful to Dr. R.K.Tiwari, Head Airborne-Engineering Geophysics for his encouragement.

REFERENCES

[1] Anil Kumar., Gopalan, K., Rao, K. R. P. and Nayak, S. S., **2001**. *J. Geol. Soc. India* 58, 135– 142.
[2] Chakrabarti, R., Basu, A.R., Paul,D.K., **2007**. *Chemical Geology*. 236, 291-302.
[3] Chakraborty., Agarwal., **1990**. *Geophysical prospecting*. 41,801-822.
[4] Chalapathi Rao, N.V., Gibson, S.A., Pyle, D.M., Dickin, A.P., **2004**. Petrogenesis of Proterozoic lamproites and kimberlites from the Cuddapah basin and Dharwar craton, *Southern India Journal of petrology*. 45, 907-948.

[5] Chalapathi Rao, N.V., Alok Kumar., Samarendra Sahoo., Dongre, A.N., Debojit Talukdar., **2014**. *Lithos*. 196-197, 150-168
[6] Dobrin, M.B., Savit, C.H., **1988**. Introduction to Geophysical Prospecting 4thEdition McGraw-Hill Book Co. pp867
[7] GM-SYS., **2000**.Geophysical processing and analysis module of Geosoft.Inc
[8] Geological Survey of India., **1999**. District Rsource map of Nalgonda District, Andhra Pradesh,1:250,000 scale.
[9] GSI-NGRI., **2006**. Gravity map series of India**,** Geological Survey of India and National Geophysical Research Institute, Hyderabad, India (2006)
[10] Joy S., Jelsma, H.A., Preston, R.F., Kota,S., **2012**. Geology and diamond provenance of the Proterozoic Banganapalle conglomerates, Kurnool Group, India Geological Society, London, Special Publications. 365, 197-218.
[11] Kaila, K.L., Krishna,V.G., **1992**. *Curr.Sci.,* 62,117-154
[12] Kaila, K.L., Roy Chowdhury, K., Reddy, P.R., Krisna,V.G., Harinarain., Subbotin, S.I., Sollogub, V.B., Chekunov, A.V., Kharetchko, G.E., Lazarenko, M.A. and Ilchenko.T.V., **1979**. *Jou.Geol.Soc.India*. 20, 307-333.
[13] Kullerud, K., Zozulya, D., Bergh, S.G., Hansen, H., Ravna, E.J.K., **2011**. *Lithos*. 126, 278–289.
[14] Kumar, A., Ahmed, S., Priya, R., Sridhar, M., **2013** *Journal of the Geological Society of India*. 82, 307–312.
[15] Manikyamba, C., Robert Kerrich., **2012**. *Geoscience Frontiers* 3(3), 225-240
[16] Mishra, D.C., Singh, B., Tiwari, V.M., **2008**. *Golden Jubilee Volume of the Geological Society of India*, 329e372.
[17] Mishra, D.C., **2011**.Gravity and magnetic methods for geological studies. Principles, Intergated Exploration and Plate tectonics. BS publications.net (Book).
[18] Mishra, D.C., Ravi Kumar.M., **2014**. *Geoscience Frontiers* 5, 25-41.
[19] Nabighian, M.N., **1972**. *Geophysics*. V. 37, pp. 507–517
[20] Ramadass,G., **1990**. *Terra Research*,.1, 2, 160-166
[21] Ramdass,G., RamaprasadaRao, I.B., Himbabindu, D., Srinivasulu, N., **2002**. Pseudosurface-Velocities (Densities) and psedudo-Depth densities 9velocities) along selected prolfites in the Dharwarcrton, India, Current Science, Bangalore, v.82, No.2, pp197-202.
[22] Ramadass, G, Ramaprasada Rao, I.B., Himabindu, D., **2006**. *Jour. Asian Earth Sciences*, USA, 26, 437-448.
[23] Reddy, T.A.K., Sridhar,M., Ravi,S and Chakrawarthy,V., **2003**. *Journal of the Geological Society of India*. v.61, pp.131-140.
[24] Sarkar, D., Chandrakala,K., Padmavathi Devi, P., Sridhar,A.R., Sain,K and Reddy, P.R., **2001** *J.Geodyn*., 31,227-241.

[25] Sridhar, M., Rau, T.K., **2005** Discovery of a new lamproite field- Ramadugu Lamproite field (RLF), Nalgonda district, Andhra Pradesh.Proceedings of Group Discussion on Kimberlites and related rocks. Geol. Soc. India, Bangalore, pp.55-57.
[26] Veeraiah, B., Ramadass, G. and Himabindu, D., **2009**. *Journal Geological Society of India*. v. 74, pp. 69-77.