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# Application of Magnetic and Remote Sensing Methods to Delineate the Ramadugu Lamproite in North-Eastern Dharwar Craton, India

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*Abstract:* **Lamproites are mantle-derived ultramafic rocks and primary source rocks for hosting diamond apart from kimberlites. The present study area, Ramadugu lies in the North-Eastern part of Dharwar craton, along the NE margin of Cuddapah basin. These Lamproites are tube or pipe like structures and emplaced with a NW–SE trend. LISS-IV imageries were utilized to demarcate the drainage pattern, lineaments and hydro-geomorphology of the area. Ground Magnetic surveys were conducted using a Proton Precession Magnetometer (PPM) to delineate the Ramadugu Lamproite body. The magnetic anomaly maps were based on about 800 observation points along nine profiles of 500 m in length. The observation interval was 5m. The results of the present study have helped in a better understanding of the lineaments and the geological litho-units associated with the occurrence and emplacement of the Lamproite body in Ramadugu, Cuddapaha Basin, Andhra Pradesh and surrounding regions, where there is an occurrence of several Lamproites.**

*Index terms*: **Lamproites, Magnetic method, Remote Sensing, Lineaments, Dharwar craton, LISS-IV.**

## I. Introduction

Lamproites and Kimberlites are primary source rocks for diamonds. Lamproites are basic mantle-derived volcanic rocks formed from partly melted mantle at depths greater than 150 km. The molten material from the mantle is forced to the surface thus forming as volcanic pipes. Lamproites are widespread, unlike Kimberlites that uniquely originated in Archean cratons. Lamproites of Archean age have been discovered in different regions in India. These include the Ramadugu (Sridhar, 2005), Vattikode (Alok Kumar, 2013), Chelima and Zangamarajupalle (Chalapathi Rao and Madhavan, 1996; Chalapathi Rao, 2007) in the northwestern margin of the Cuddapah Basin, Eastern Dharwar Craton (Mukhopadhyay et al. 2004). Ramadugu Lamproite relates to avatar Lamproites (Alok Kumar 2013). The present study has mapped the Ramadugu Lamproite, formed as a volcanic dyke, using remote sensing and ground magnetic methods.

## II. Geological Setting

The study area Ramadugu Lamproite Field (Fig. 1) falls under the North Eastern Dharwar, Nalgonda District of Telangana State, India. The geology of the present study area falls under the Archean Dharwar of age 3.4 to 2.7Ma. This craton is divided into Western Dharwar Craton (WDC) and Eastern Dharwar Craton (EDC) separated by the Closepet Granite of 2.518 Ma (Naqvi and Rogers, 1987; Jayananda et al., 2000; Moyen et al., 2003; Ramakrishna and Vaidyanadhan, 2008). The EDC consists of recent Archean and Paleo to Neoproterozoic supercrustal sequences enclosed by Late Archean to Paleo-Proterozoic granite-gneiss. These rocks primarily are phyllite, schists and slates. Granite-greenstone part of ground is overlain by basins of Meso to late Proterozoic intracratonic basins (Radhakrishna 1990, Drury et al, 1984). With the Archean formations several Kimberlites are distributed in two major fields, particularly Wajrakarur Kimberlite Field (WKF) and the Narayanpet Kimberlite Field (NKF) among the granite-greenstone formations, whereas the Lamproites are distributed in two fields, particularly the Nallamalai fold belt and in Jaggayyapeta of the Cuddapah Basin. The study area consists of Intrusive type rocks like Dolerite dykes, Quartz, Biotite Gneiss and Granite gneiss of Peninsular Gneissic Complex, Meta Basalt and Banded Iron Formations of the Peddavura schist belt.

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## III. Remote Sensing method

The Remote sensing data was acquired using LISS-IV (Hebbar, 2014) with 5.8m resolution spectral bands0.52-0.59(green), 0.62-0.68(red), 0.77-0.86 (near IR) and LISS-III. The LISS-III sensor covers a 140-km orbital swath at a spatial resolution of 24 meters with a 24-day repeat cycle (Hebbar, 2014) as acquired by NRSC-Hyderabad, India. The methodology which was used to demarcate lineaments, drainage, hydrogeomorphology is shown in the flow Chart, Fig. 2.

### a) Lineaments

Lineaments are natural, linear fractures like faults, joints and fractures which can be interpreted directly from satellite imagery. By visually interpreting the satellite imagery, the lineaments of the study area are picked up and traced on the basis of tonal, textural, soil tonal, vegetation, topographic and drainage linearity, curvilinear ties and rectilinear ties (Drury, 1990; Gupta, 1991; Lillesand Kiefer, 1994). By using LISS-III data with the help of Arc-GIS Software 1:50,000 Lineament Map (Fig. 3b) was generated.

Lineament ineractions are faults or fractures which are relted to Crustal weak zone (Chernicoff, Carlos & Richards, 2002) in the Craton. In the Ramadugu Lamporite Field lineamenant interactions are observed in NW-SE. Peridotite or Lamproite diatremes emplaced on zones of basement weakness among or on the margins of stable cratons (Dawson, 1971, 1980).

### b) Drainage and Hydrogeomorphology

The Hydro geomorphological map, Fig. 4 has been processed using LISS-IV data. The geomorphological map shows the lineaments and streams of Halia River. Drainage corresponds to rapid tectonic changes and thus it is a potential parameter for tectonic geomorphological analysis. The majority of drainage pattern shows the NW-SE flow direction (Fig. 4) that may be structural lineaments due to Lamproite emplacement through a major zone of weakness in the basement.

## IV. Magnetic Method

### a) Magnetic Data Acquisition

Detailed ground geophysical surveys can usually map the surface extent of kimberlite or Lamproite pipes, and may identify separate intrusions within one kimberlite or Lamproite (Macnae 1995). Magnetic methods are excellent tools to detect the Lamproite bodies in the certain environment where they are not weathered in contrast with surrounding rocks and are clearly identified. A detailed magnetic survey has been conducted to identify the Lamproite body in the present study area. IGIS Proton Precession Magnetometer was used to measure Magnetic data. It measures the total field with accuracy 1nT and portable to use. The magnetic data acquired perpendicular to strike direction of these known Lamproite bodies. These Lamproites are along SE-NW, hence the profile direction was NW-SE. The profile interval is 20 m and observation interval along the profile is 5 m. The magnetic data was acquired along 9 such profiles of about 500 m in length. Nearly 800 observations were recorded using the Proton Precession Magnetometer (Fig. 5). To account for the Diurnal correction a base station was established near the survey area away from the profiles. The base station observation was repeated after making 8-10 observations at approximately 30-minute intervals. Using A prismatic compass profiles are planned and with help of GPS latitude and longitude are recorded.

### b) Magnetic Data Processing

### c) Diurnal correction

The recorded change in Earth's magnetic field on a yearly time scale is called secular variation. However, as the magnetic surveys are for short periods only diurnal correction (Telford, W., Geldart, L 1990), i.e., change in the Earth's magnetic field from sunrise to sunset during the period of the survey on a daily basis is recorded. This diurnal correction, reading ($F_{dc}$) is given as:

$$(F_{dc}) = F_{obs} - ((F_{base2} - F_{base1}) / (t_{base2} - t_{base1})) * (t_{obs} - t_{base1}))$$

Where $F_{obs}$ is observed magnetic field at the point of observation recorded at time $t_{obs}$, $F_{base1}$ and $F_{base2}$ are two consecutive base point observations recorded at times $t_{base1}$ and $t_{base2}$ respectively. To Process the magnetic data of the study area Ramadugu Geo-Soft software was used. The magnetic data was plotted after diurnal correction and IGRF correction. The International Geomagnetic Reference Field (IGRF - field strength, inclination and declination) can be calculated from a geographic coordinate channel or a single geographic point (Telford, W., Geldart, L 1990).

### d) Reduction to Pole

The Reduction to pole (RTP) was computed after all corrections were applied. The reduction to the pole operation is a data processing technique (Baranov, V., and Naudy, H., 1964) that recalculates total magnetic intensity data as if the inducing magnetic field had a $90^o$ inclination. This transforms dipolar magnetic anomalies to monopolar anomalies cantered over their causative bodies which can simplify the interpretation of the data. Reduction to the pole makes the simplifying assumption that the rocks in the survey area are all magnetized parallel to the earth's magnetic field. Fourier domain migrates the observed field from the observed magnetic inclination and declination, to what the field would look like at the magnetic pole. This aids in interpretation since any asymmetry in the reduced to pole field can then be attributed to source geometry and/or magnetic properties. The study area Magnetic map fig .6 shows on isolated magnetic anomaly, it is observed that this might be due the vertical dyke like structure.

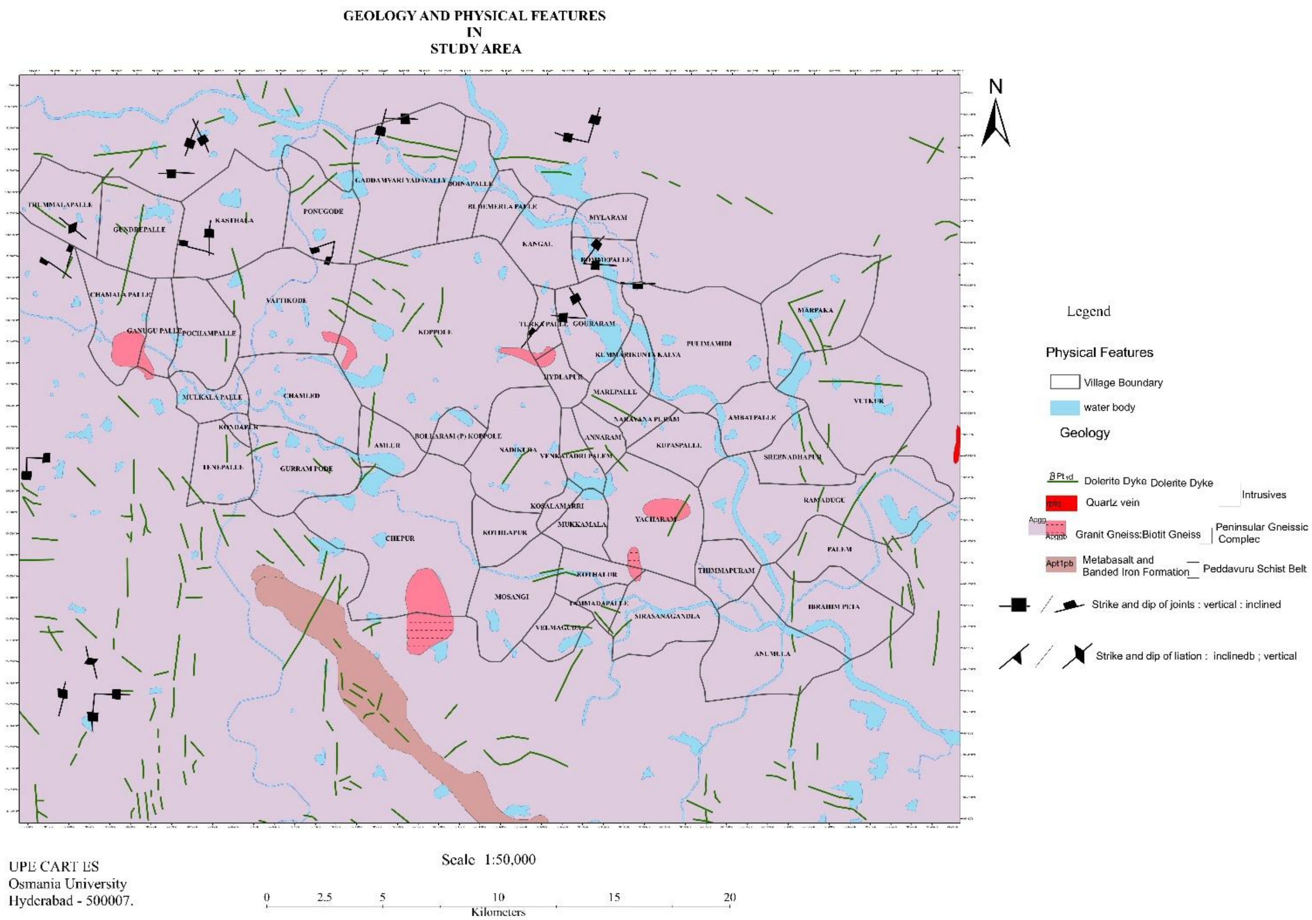


Fig. 1. Geology map of the study area

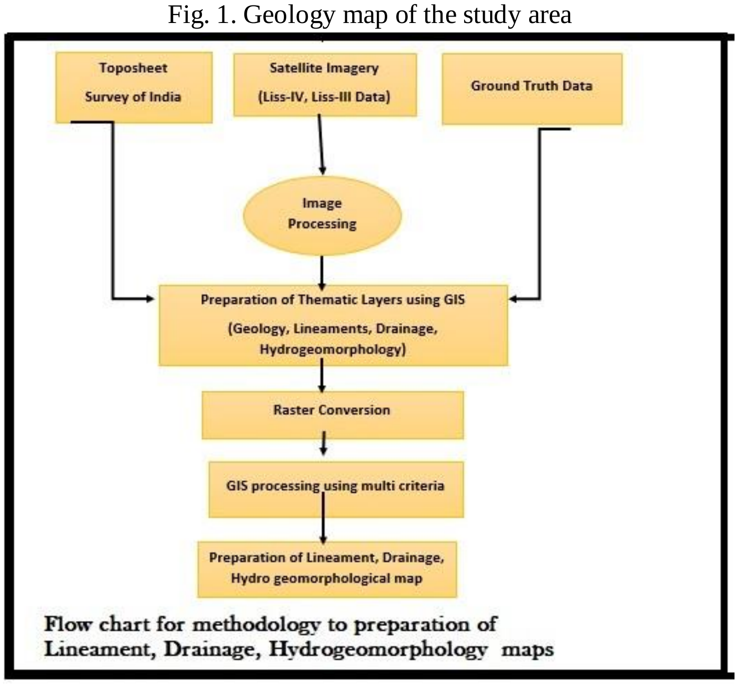


Fig. 2. Flow chart for the preparation of lineament, drainage and hydrogeomorpholgical maps from LISS-III data

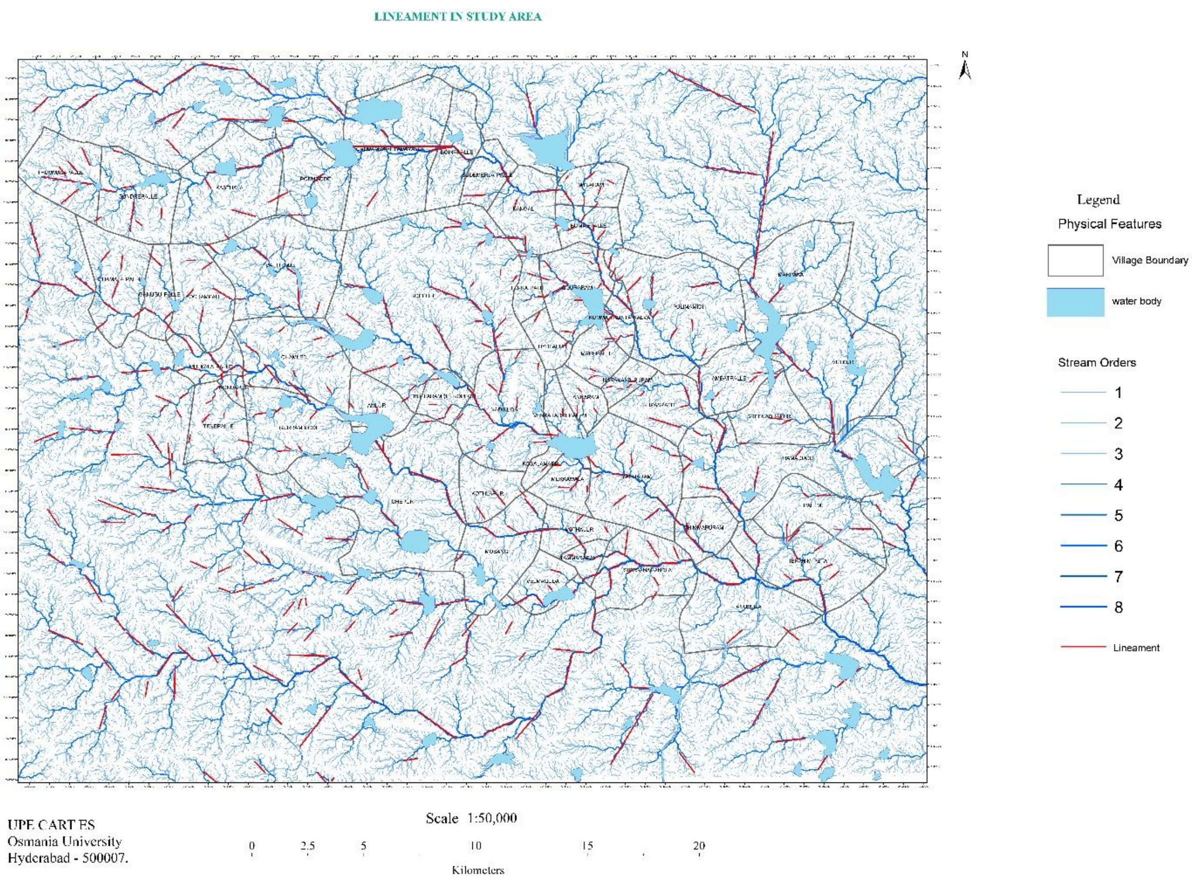


Fig. 3a. Drainage map of the study area

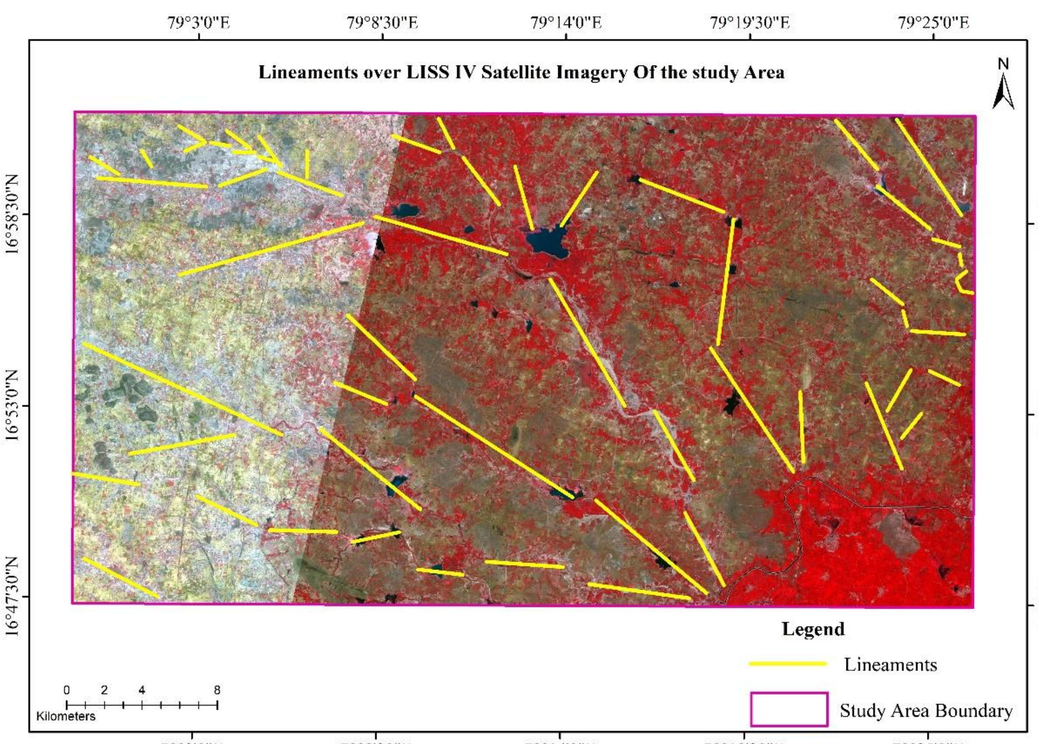


Fig. 3b. Lineament/Map of the Study Area

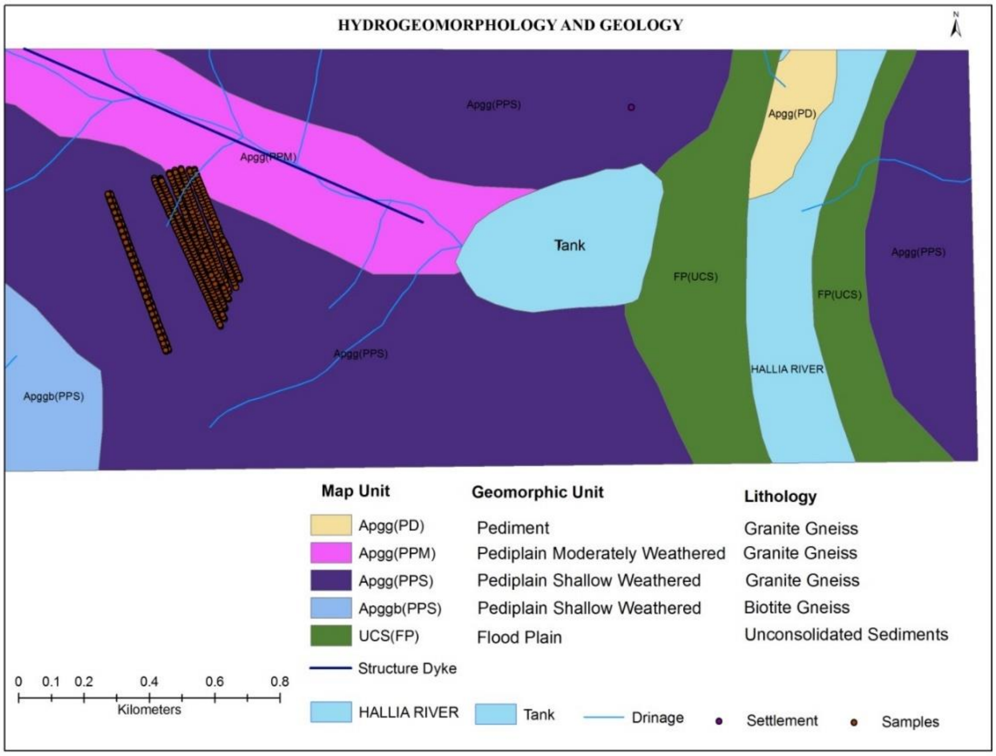


Fig.4. Hydrogeomorphoogical map of the Study area

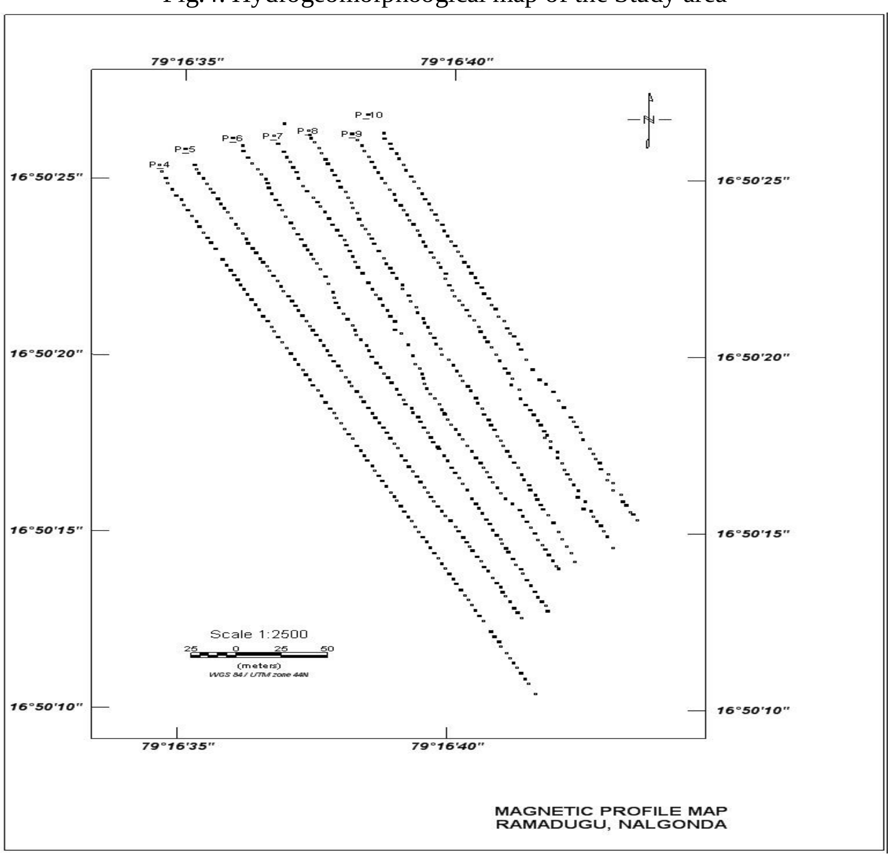


Fig. 5. Magnetic profile map

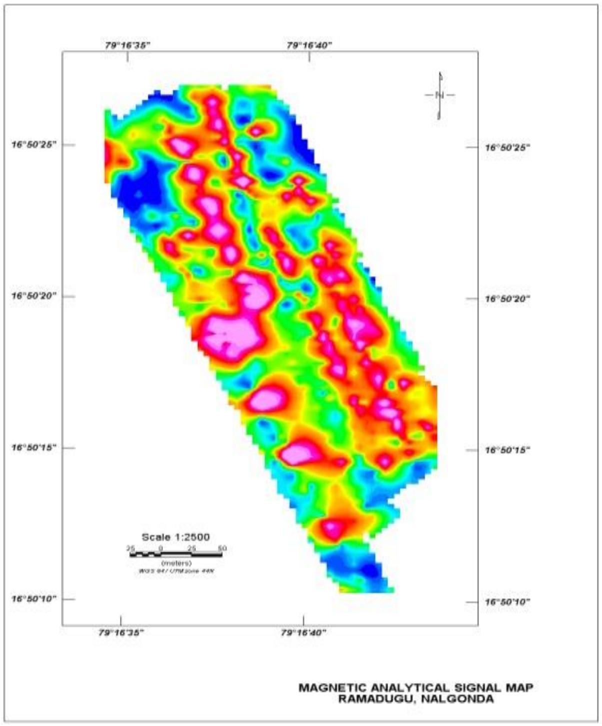


Fig. 6. Magnetic Analytical Signal Map of the study area Ramadugu

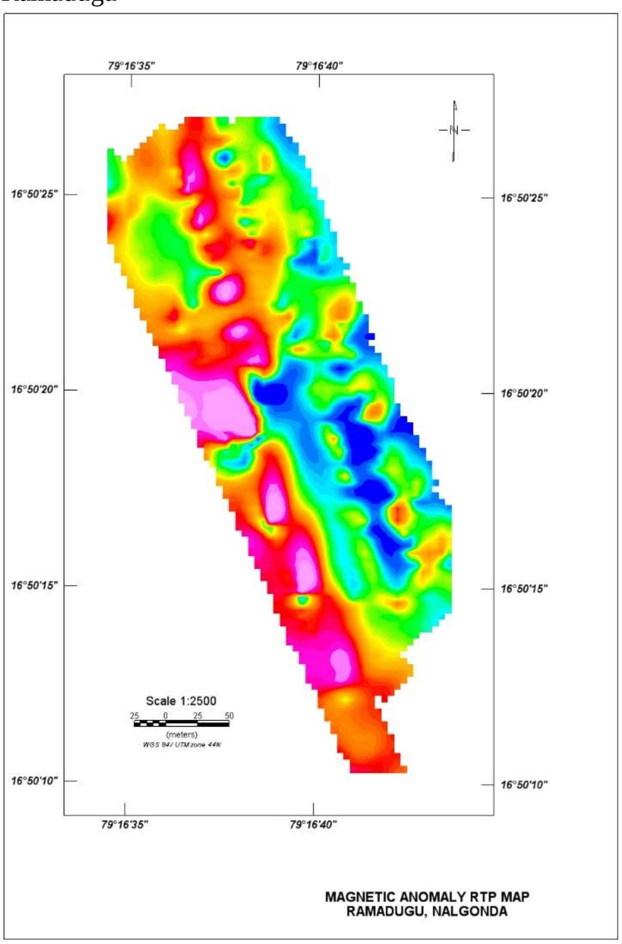


Fig.7. Magnetic Anomaly RTP Map of the study area Ramadugu

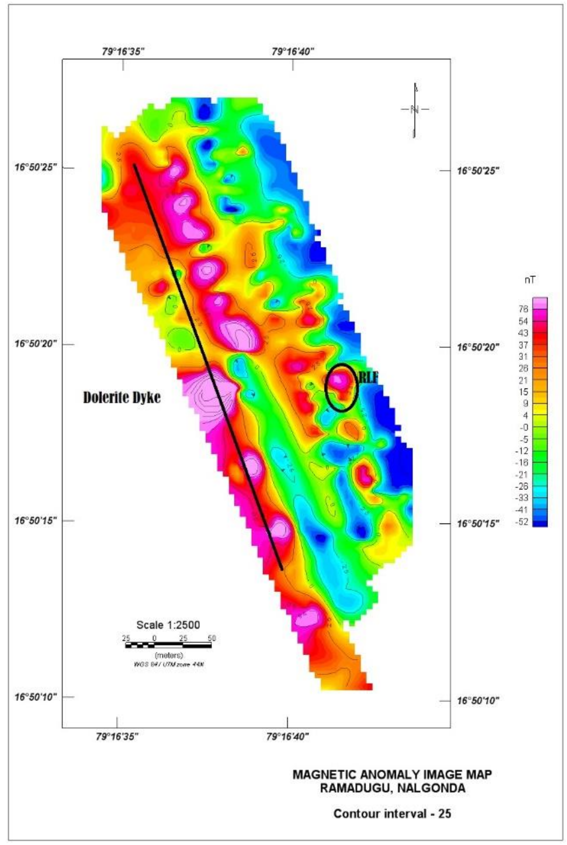


Fig. 8. Magnetic Anomaly contour Map of the study area Ramadugu, Nalgonda, India

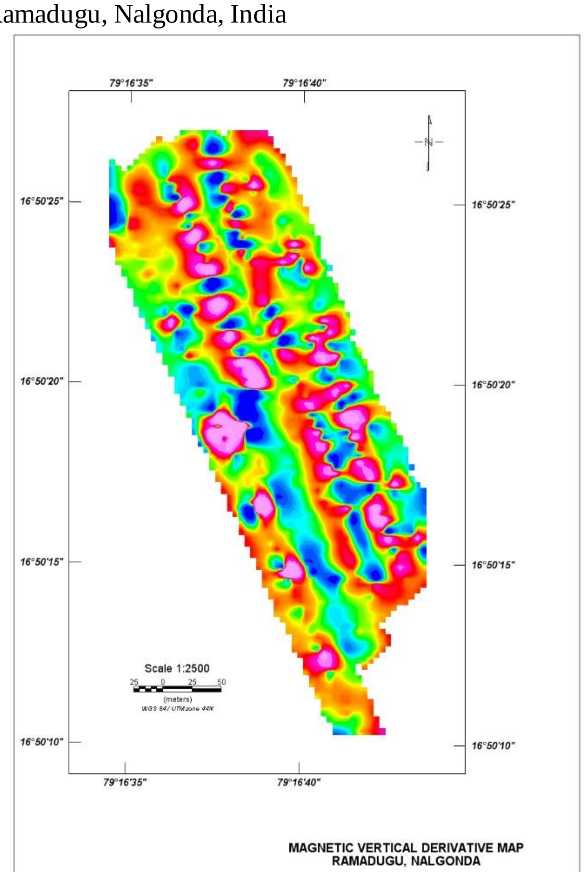


Fig. 9. Magnetic Vertical Derivative map

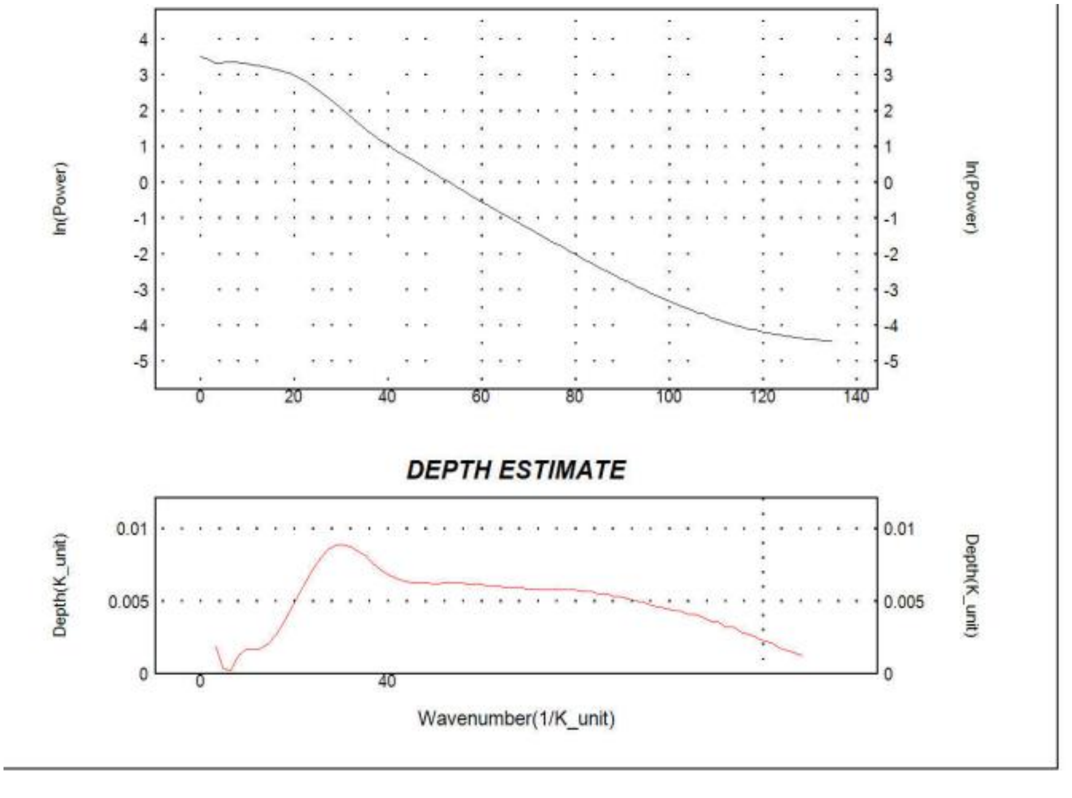


Fig. 10. Radially Avg power spectrum overall Study area zone.

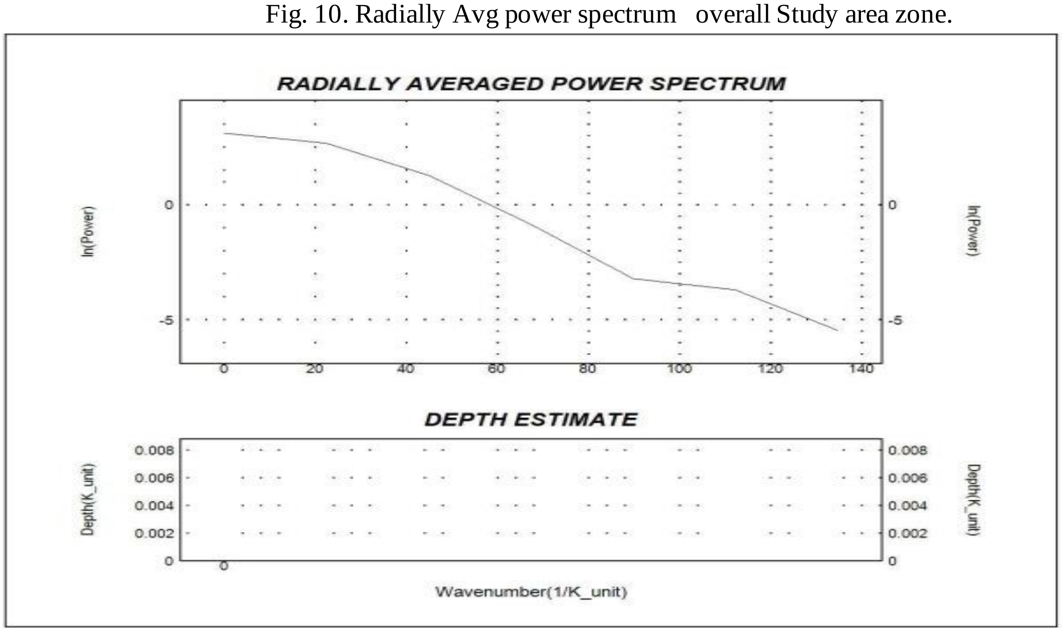


Fig. 11. Radially Avg power spectrum over Lamproite anomaly zone.

**e) Vertical Derivatives**

First Vertical Derivative maps are commonly used to enhance the shorter wavelength signal (Cordell and Grauch 1985). First Vertical Derivative responds to shallow features (Fig.8) corresponding to Lamproite and Dolerite dykes, which are linear features and are well defined in the figure.

**f) Depth estimate**

The radially averaged power spectrum (figure.9) with a depth estimate of the overall study area from the magnetic map was computed.

From radially averaged power spectrum depth estimate has been calculated. From the formula depth estimate have been calculated as **h= s /4π** Where" S "is the slope of the log energy power spectrum, **h** is the depth. (Spector, A. and Grant, F.S., 1970; Geosoft Oasis Montag software guide). From above estimate can be used as a rough guide. The depth estimates on the anomaly from the above procedures shown in figure.10. From Figs.9 and 10 Radially Average power spectrum over the anomaly zonewas obtained and the depth estimate is calculated as 10 m.

## V. Results and Analysis

Lineaments, their intersections and contacts are favorable sites for Lamproites. Remote sensing studies are mapped on the regional scale, to provide firsthand information like the structure of various tectonic belts, lineaments and fracture patterns. Remote sensing studies also helps in establishing the corridors pertaining to kimberlite / Lamproites emplacement. The Ramadugu Lamproite Field (RLF) is showing isolated anomaly in the magnetic map with co-ordinates 79.27813N, 16.83856E. In the field surface exposure of Ramadugu Lamproite is observed at the coordinates 79.27813N, 16.83856E. Magnetic method has clearly demarcated the Ramadugu Lamproite anomaly (S.H. Robinson and D.M. Barrett 1995). From Magnetic method, it was calculated that the RLF is very shallow. Lineaments interactions are observed at Ramadugu Lamproite Field. From the area Geology map and Hydro geomorphological maps, the Lineament map and Lineament interaction are observed. The structural lineaments seem to favor Lamproite emplacement through a major weak zone in the basement. Remote sensing studies are mapped on the regional scale to provide firsthand information like the structure of various tectonic belts, lineaments and fracture patterns.

## Conclusions

Major Lineaments their interactions are identified as the crustal weak zones within the craton. Lamproite emplaced along weak zones of the mantle within the crust have been identified. Remote sensing drainage and lineament maps have guided favorable zone of target of Lamproites. Lineaments are structural controls of Facture zone or weak zones of possible locations for Lamproite with in the stable Eastern Dharwar craton being the present study area. Ramadugu Lamproite body shows positive isolated magnetic anomaly. Magnetic method has successfully delineated Ramadugu Lamproite pipe.

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