

IRS R2-LISS IV SATELLITE IMAGE ANALYSIS FOR MAPPING LITHOLOGICAL, GEOMORPHOLOGICAL, DRAINAGE AND STRUCTURAL FEATURES ALONG THE KALWAKURTHY – NALGONDA-HUZURNAGAR PROFILE, TELANGANA STATE, INDIA

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Abstract

The IRS-1D, LISS-IV satellite image of an area of 6744 Sq.km corresponding to the part of Mahabubnagar and Nalgonda districts of Telangana northwestern part of proterozoic Cuddapaha basin of Eastern Dharwar craton (EDC), India, was analyzed. Remote sensing data and geographic information system (GIS) were used to determine the geomorphological, geological, structural, drainage maps are prepared along with the existing maps. The zones of intersection of structural trends, resulting in circular drainage to oval shaped structural features, faults, dykes are mapped which could have acted as potential areas of minerals resources in the study region.

Keywords: Dharwar Craton, Peninsular Gneissic Complex, Lineaments, Driange, Geomorphology

1. INTRODUCTION

In this study Remote sensing, Geology and Geomorphologic techniques are applied to demarcate lithological and structural features of the Kalwakurthy - Nalgonda granulite terrain area of Mahabubnagar, Nalgonda districts of Telangana bounded by geographic coordinates of 16°40'14.325"N, 78°29'29.107"E and 17°3'2.587"N, 79°38'24.79"E in India. The study area covers an area of 6744 sq. km and is bounded on the eastern side of Mahabubnagar and major southeastern part of Nalgonda district falls in parts of the Survey of India (SOI) 1: 250,000 scale toposheets of 56L and 56P and 1:50,000 scale toposheets of 56 L6,10,14,56 P 1,2,5,6,7,8,9. The Study area covered Kalwakurthy, Devarkonda, Mallepally, Nalgonda, Miryalguda, Huzurnagar towns (Figure.1) which are well connected with state highways to major cities.

Remote sensing technology is placing a significant role in mineral, groundwater exploration that large areas of the land surface can be covered for detailed geological and geophysical studies. The availability of the Images provides a new digital geocoded mapping which can be used in this study to determine the new potential area of minerals importantly Uranium, Base metals (Lead, Zinc, and copper) and Kimberlite / Lamproite bodies.

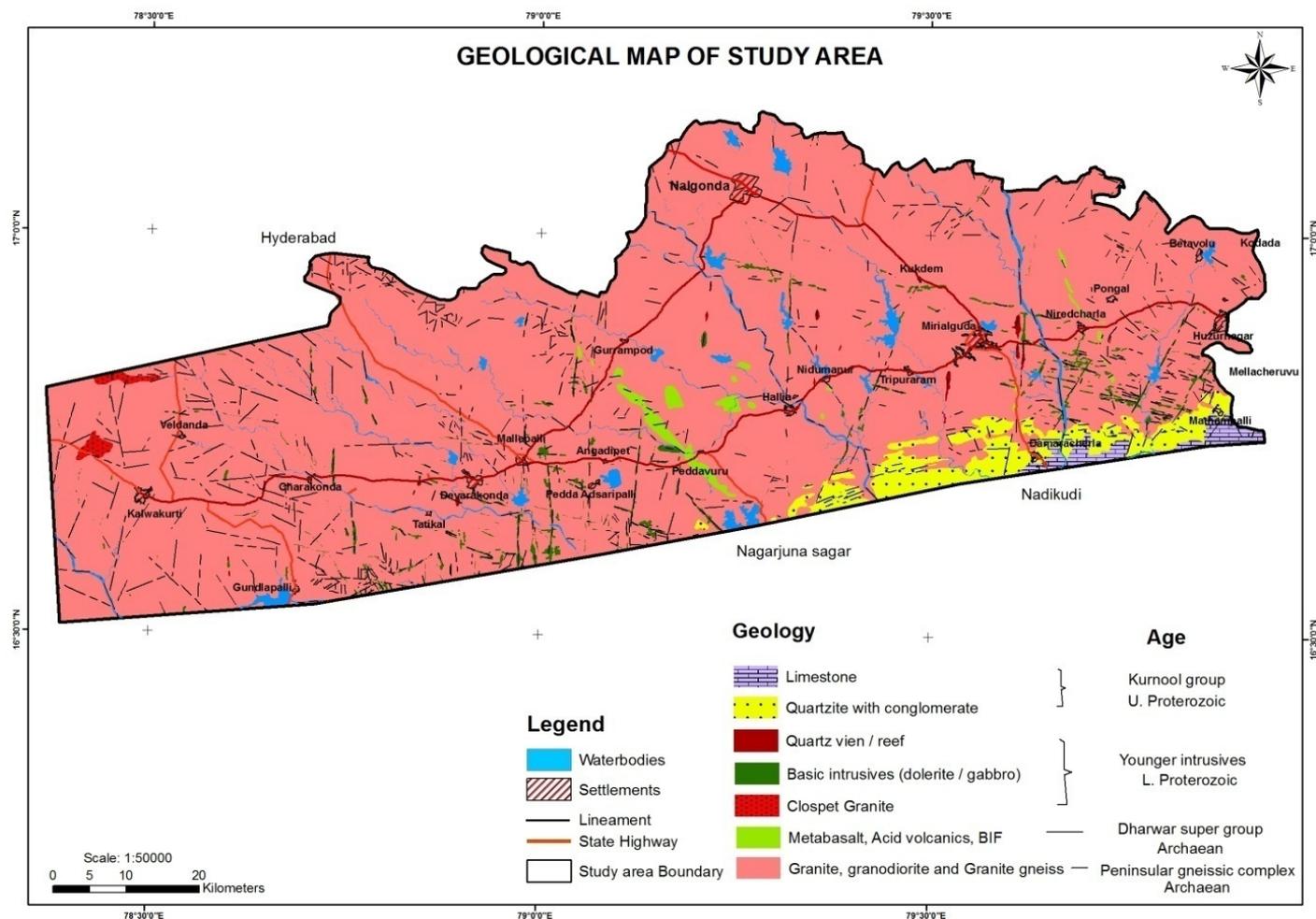


Figure 2. The geological map of the stud area (After GSI 2011).

The Dharwar super group are exposed as linear belts near Peddavura on the Hyderabad-Nagarjuna Sagar road. In the southern part of the district along the northern bank of Krishna river, the rocks of Achaean Peninsular Gneissic complex are unconformably 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, limestones (Sriramulu et al,2016) are exposed at the southeast margin of the traverse. The study area is represented by magmatic gneiss and ultramafic rocks. These are followed by metabasalts. Banded iron formation is interbedded with ultramafic flows and mafic dykes intrude the volcanic sequence.

5. IDENTIFICATION OF LITHOLOGICAL AND STRUCTURAL LINEAMENTS

Lithologic mapping is usually the first step of mineral resource mapping studies. Lithological discrimination has been done with various spectral geological techniques using IRS R2 + LISS IV (Figure 3) satellite image. Various types of FCC image were prepared using several band combinations and as many band rationing/ indexing techniques mentioned by several authors (Goetz,1975; Chavez et.al. 1982; Singer, 1980; Miller and Pearson, 1971; Price,1995, Subhash Babu et.al 2014) were used to correlate the available lithology of the study area as well as to find new litho-units of the study area. Various attempts have been made to do such lithological boundaries using spectral geological methods (is part of satellite remote sensing for geology) like band combinations, band indices/ band ratios, principle component analysis (PCA), minimum noise fraction (MNF), spectral angle mapper (SAM), curve matching etc. Based on the available geology (Peninsular Gneissic Complex – PGC rocks of Granite Gneisses, Migmatites etc. Pink and Grey Granites as well as younger dykes all possible attempts have been made to differentiate the litho-units.

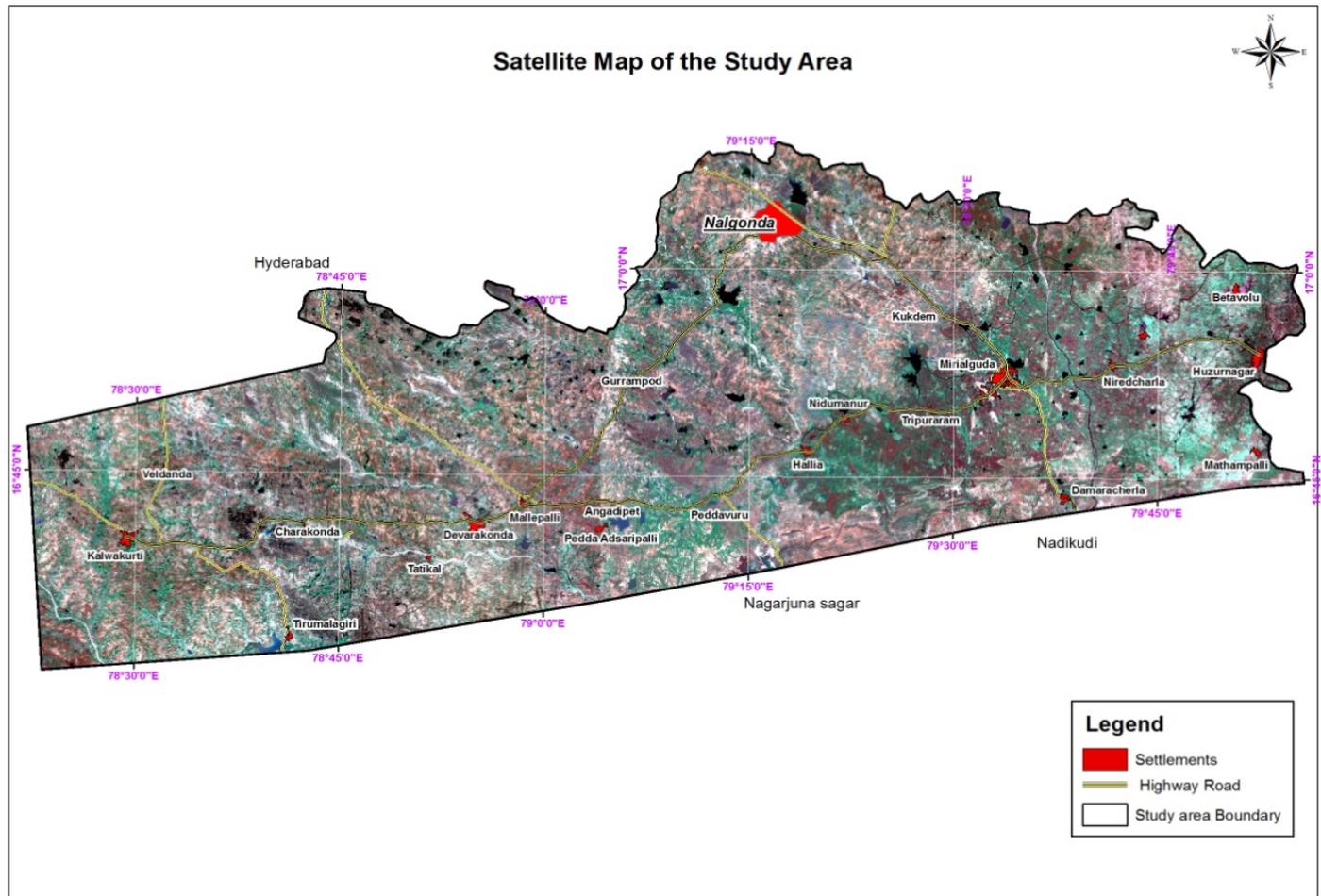


Figure 3. IRS R2 – LISS IV Satellite image of study area

The remote sensing technologies display surface lineaments like joints, fractures; faults etc. those are penetrated into deep-seated. also delineated using various spectral geological techniques, intersections of these are the main source of kimberlite emplacement, Many studies have emphasized the importance of lineament interpretations and digital lineament analysis in localizing the major mineral deposits and notes that there is a strong correlation between mineral deposits and lineaments (Kutina, 1969, Katz, 1982, Liu et al. 2000, Rein and Kaufmann, 2003). Geological structural map (Figure 4.) was prepared by digitizing lineaments, faults in ArcGIS software package from the geology map. Different structures that should be mapped have been represented on the map with appropriate line symbols.

In the present study, visually interpreted lineaments using satellite images reveal that these lineaments densities are very high at north and north-east of the study area. These lineaments of the highlands are mainly joints and fractures rather than faults. In buried pediments where granitic rocks with little soil cover and Padi plains where soil cover is much high, these lineaments are not visible much through visual interpretation.

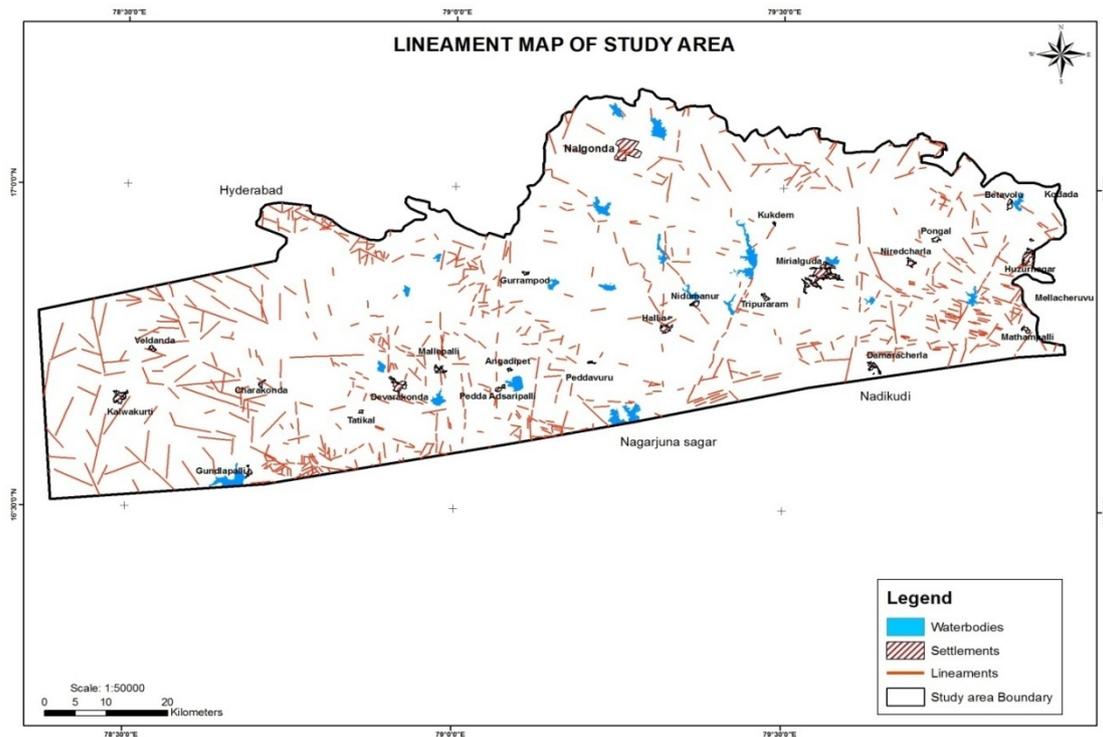


Figure 4. Lineament map of Study Area

6. IDENTIFICATION OF GEOMORPHOLOGICAL FEATURES

Geomorphology as a science developed much later than geology although several aspects of geomorphology are embedded in geological processes. Geomorphology deals with the surface features of the earth, their forms, nature, their origin, and development is termed as geomorphology (Khadri et al., 2014).

Figure 5. shown the geomorphological features of the study area. Geomorphically the study area is divided into valley fill, Pedi plain shallow, Pedi plain moderate, buried Pedi plain, pediment, pediment inselberg complex, residual hill, denudational hill, mesa/dyke ridge, inselberg and water bodies and the details of statistics is furnished in table-I.

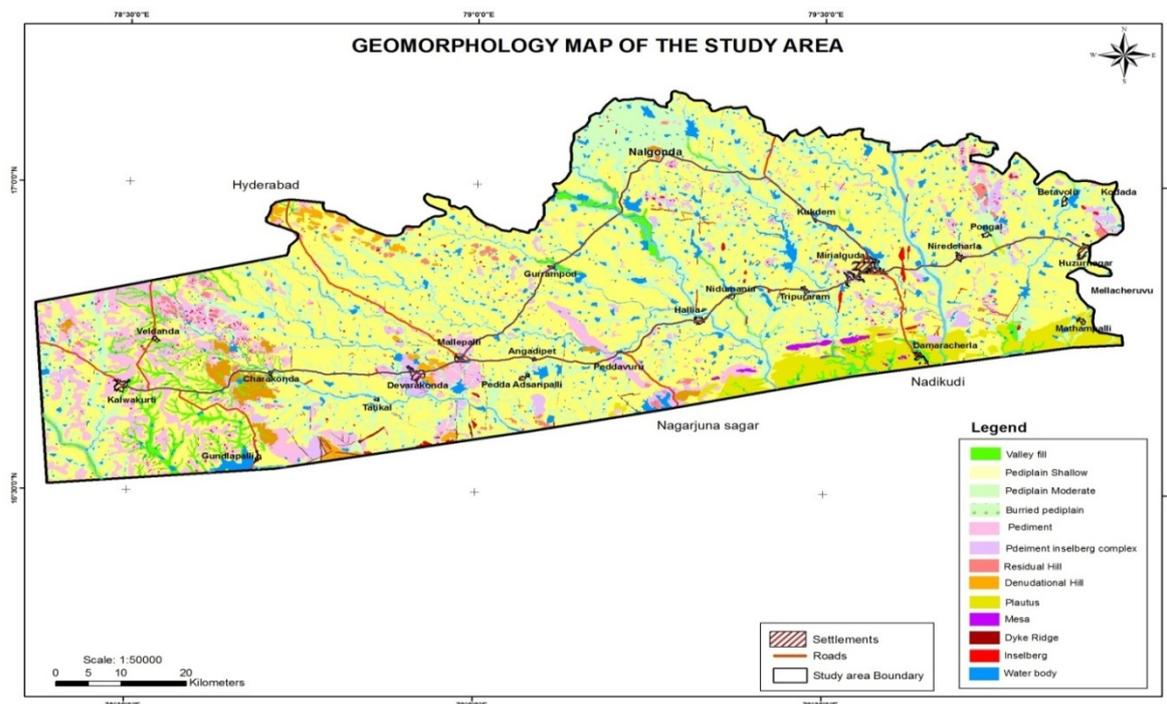


Figure 5. Geomorphology map of Study Area

From the Figure 5 can be seen that either Alluvial or Pedit plains areas are adjacent to both Krishna and Halia river plains where cultivation is going on during the rainy season. Adjacent to some of the minor streams also alluvial plains are seen in the study area. Buried piedmonts are main areas of granitic terrain with a very thin cover of soil. Highlands are mainly seen the northwest portion of the Devarkonda, Miryalguda towns. These are mainly consists of Dharwar schists which are younger than Peninsular Gneissic Complex (PGC) rocks. These highlands are shown severe joints, fractures (in turn faults) along with dykes where these are emplaced weak zones of these highlands fractures.

6.1 Valley Fills

Valley fills were found along narrow synclinal depression or along fracture valleys that trap sediments that are removed from the hill summits, slopes and as a result cobbles, pebbles, and unconsolidated sediments were deposited in the valley. In the imagery Figure 5 valley fills were identified by its dark red tone (with vegetation), light gray tone (without vegetation), shape and associated with the hill ranges are important elements to recognize these landforms in the study area covered by 205 sq.km.

6.2 Pediplain

Pedi plains are formed due to intensive weathering under semi- arid climatic conditions, representing the final stage of the cyclic erosion . These are identified in the imageries due to gray tone on the false color composite. Pedit plain has developed in the western and northeastern portions of the area under in investigation as a result of the continuous erosional process. Further, On the basis of weathering, buried Pedit plain can be further subdivided into deeply, moderately and shallow weathered pediments. It covers an area of (Table.1) Pedit plain shallow,Pedit plain moderate,buried Pedit plain an area of 3540 sq.km,1380 sq.km, and 55 sqkm respectively .The older alluvial plain, deeply buried Pedit plain and valley fill have good mineral potential in the area.

Table 1. Covered area of Geomorphological units in Study area

S. No	Geomorphological Units	Area in Sq km
1	Valley Fill	205
2	Pedit plain Shallow	3540
3	Pedit plain Moderate	1380
4	Burried pedit plain	55
5	Pediment	520
6	Pediment Inselberg Complex	234
7	Residual Hill	50
8	Denudation Hill	115
9	Plautus & mesa	235 &13
10	Inselbergs	21
11	Dyke ridge	42
12	Water Bodies	334
Total		6744

6.3 Pediment

The pediment is developed by a combination of processes including stream erosion, weathering, sheet wash, etc. Much of the area forming the pediment consist large area as a result of the continuous process of pedimentation, It is normally termed as a Pedit plain. These pediments have been divided into 3 categories based on the thickness of weathering mantle, climate etc. Pediments at a shallow depth which show medium gray tone and medium texture in the satellite FCC composite, ii. Pediments at the medium depth that show greenish red tone and irregular/regular texture in the satellite imagery and iii. Pediments at deep depth, which show dark red to dark green tone and smooth texture in the satellite data the total area covered by 520 sq.km.

6.4 Residual Hill

Residual Hills are the end products of the process of Pedit planation, which reduces the original mountain masses into a series of scattered knolls standing on the Pedit plains. Residual hills occur as small hills comprise of more resistant formations formed due to differential erosion are found in the western part of the study area. These features occur as dark greenish- brown patches with forest cover in the imagery figure. The residual hill region covered a total of 50 sq.km Sq.Km.

6.5 Denudational Hills

Denudational hills are the massive hills with resistant rock bodies that are formed due to differential erosion and weathering processes (Yokoyama et al 2002). These hills are composed of Cuddapah sediments which are fractured, jointed having no soil cover moderate to steep slope. On the satellite image, these landforms were identified by light or dark brownish with mix green colour due to thick forest cover. Denudational hills occupying western portions of the study area cover about 115sq.km in geomorphic maps.

6.6 Plautus /Mesa

Broadly, any comparatively flat area of great extent and elevation and extensive land region considerably elevated (more than 120 -516 m in altitude) above sea level and commonly limited on at least one side by and abrupt mean descent, having a flat or nearly smooth surface but often dissected by ranges of small hills and having a large part of its total area covered is 235 sq.ikm in the study regions A plateau is usually higher and has more noticeable relief than a plain (it often represents an elevated plain) and is usually higher and more extensive than a mesa and is covered by 13 sq.km.

6.7 Inselbergs/ Dykes

Many younger intrusive rocks are emplaced along the weak planes of the highlands and adjacent to highlands. These intrusive rocks are having various rock types like granites, dolerites, pegmatite's. The total area covered by inselbergs and dyke ridges is a 21 sq.km and 42.sq.km respectively.

6.8 Water Bodies

The water bodies are covered by a total 334 sq.km. In this case, water body will be identified under the wetlands category. Water bodies are however very fine textured with their tone ranging from pale to cyan to almost black depending on the depths and turbidity

7. IDENTIFICATION OF PHYSIOGRAPHY AND DRAINAGE

The terrain represents a gentle undulatory plain with few residual hills in the north and inselbergs of granitic rocks many places in a scattered manner. The highest elevation is 516 m about 3.8Km NE of Kalwakurthy town. Krishna River passes through an extreme east corner of this study region. Halia River, one of the major tributary of Krishna River is flowing in the North-South portion of the study area.

The drainage pattern and texture seen on images are good indicators of landform and bedrock type (Thornbury, 1986) and also suggest soil characteristics and site drainage conditions. Drainage in the present study area is mostly dendritic is shown in Figure.6.

The drainage density (ratio of total length of all streams of all orders in a basin to the area of a basin) and the drainage frequency (the number of streams in a drainage basin divided by the area of the basin) determine the drainage texture (Chorley, 1972, Panday, 1987). The drainage density

can be broadly divided into three major classes – coarse, medium and fine. A comparative study of the drainage of the imaged area indicates that in the reflection of their respective resistance to weathering/ erosion and patterns of porosity, the drainage ranges from finely textured in the peninsular gneissic region, to medium in the granitic areas to almost absent in the schistose regions.

The overall drainage is dendritic to sub dendritic, homogeneous nature of the area and controlled by numerous joints and fractures. The general slope of the area is observed tending towards the southeast. The Peddavagu-Haliya river is also showing the flood plains in the study area even through this stream is dry throughout the year except few days after rains.

The radial (domal) structures are reflected in the geomorphology of the region as elevated circular drainage pattern of the region from which the disposition and various geomorphological units can be identified. The major drainage of the region is provided by the river Krishna and its tributaries. The well developed weathered layer along with the final drainage density gives rise to numerous ponds in this region. Domal structures are one of the several indicators of potential kimberlite/lamproites bearing zones (Kirkley,1991). Since such structures are reflected in the geomorphology of the region as elevated circular features, topographic highs, in turn, are indicated by regions of circular or radial alignment of the drainage.

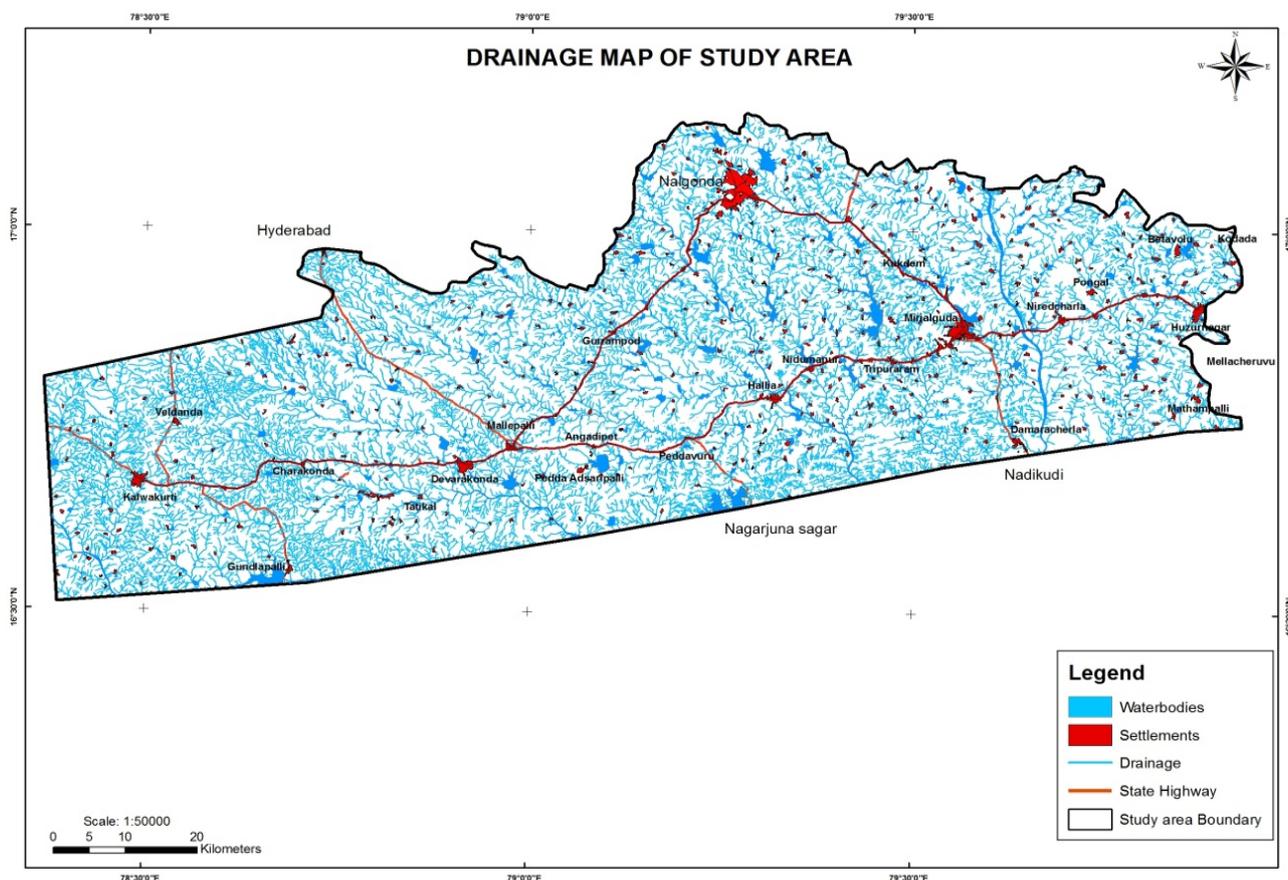


Figure 6. Drainage map of the Study Area

The southern part of the district along the northern bank of Krishna river is a plateau. The mean elevation of the terrain is 150m above msl and the general slope is towards the southeast. The general drainage pattern in the gneissic country is coarse dendritic to sub-dendritic, whereas in the limestone dominant sediments, a trellis to the radial pattern is apparently seen. The major rivers include Krishna, Dindi, Peddavagu, Musi, Aler, Haliya, Kongal and Palleru which form part of the Krishna River Basin. All the streams generally flow in the south-easterly direction and join in the Krishna River. While general slope of the area is to be to the east, and drainage density is 0.8 to 1Km/km². The drainage pattern is apparently being controlled by structure and lithology in the study area. The lithologic variation has given a rise to different drainage patterns., based upon the occurrence of circular alignment of the drainage pattern, coinciding Ramadugu lamproite clusters.

8. CONCLUSION

Multispectral Imagery of the IRS-1D and LISS-IV, high-resolution data of the Mahabubnager and Nalgonda district 4 metres was analyzed using Arc GIS and ERDAS software and prepared geological, geomorphological and structural elements/ Lineament maps and drainage maps (Figures 2,3,4,5 and 6) . Several structural features fractures and dyke NW-SE,NE-SW,N-S and E-W trends, are mapped, which are responsible for the emplacements for mineral resources in the study region. The geomorphological units such as flood plain, valley fill and deeply buried Pedic plain are prospective zones for groundwater exploration and development in the study area. Ramadugu and Ramannapet (Jaggayapet) lamproites are emplaced along NE-SW and NW-SE lineaments contact between the dyke and granite gneisses and implying the involvement of distinct deep-seated faults/fractures in controlling their emplacements.

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