

Remote Sensing and GIS applications in Mineral Detection and Mapping using Band Rationing Technique.

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Abstract

Image processing techniques were used for mapping structural features using a medium resolution image of Landsat ETM+. The aim of this study is to utilize remote sensed data and digital image processing techniques for preparing Band rationing map of the study part of the Kadapa district. The study area is becoming an important target for, mineral exploration and industrial investment. In this paper we firstly attempted and succeeded for Band rationing with Landsat imagery and mapped. Band rationing is the process of dividing one band by another. This process will highlight a certain feature of the surface depending on its spectra in certain bands. For clay minerals: Band 5 / Band 7 of Landsat image. For Iron oxide minerals: Band 3 / Band 1 of Landsat image. For Ferrous minerals: Band 5 / Band 4 of Landsat images were used and created individual layers. Finally, layer stacked all the three individual bands as one and got the band rationing of the study region successfully.

Key words: Landsat ETM+, Band rationing, Ferrous minerals, Remote Sensing, and GIS

1. Introduction

Mineral exploration through identification of structural guides is playing an important role in support of one of the most important economic world-wide activities, namely the mineral industry. Geologists and engineers well known that, to discover a new ore deposit is like finding a ‘needle in a haystack’. Therefore, it is not an easy task but a long process requiring the application of a wide variety of exploration techniques concerning more investment. Mineral exploration has been traditionally based on the application of a variety of prospecting methods, mainly preparation of

maps of geology, geomorphology, lineament mapping, and ground surveys, operatively integrated within exploration phases. The main criterion of the prospector is to identify anomalies, exploration of associated features with target mineral areas, gradually reducing the original extent area to a small set of anomalies (Nagarajarao et al. 1987; Chandrasekhar et al. 2009; Rajesh et al. 2004; Hung et al. 2005). This process also involves identification of structural features. Fault is an essential element in the field of structural, economic, and environmental geology. Traditional methods of mapping faults require fieldwork investigations. However, field-work is usually depending primarily on the extension and the accessibility of the area under investigation (Prasad et al. 2013, Nag et al. 2016). Topography, lithology, erosion, and other factors control fault determination in the field. Remote sensing and image processing has the advantage of providing synoptic overviews of the region, thus it may directly pinpoint the characteristics of structural, geological features extending over large areas as a fieldwork investigation. Faults are often revealed as linear or curvilinear traces on satellite images. These image lines of different contrast are commonly referred to as lineaments extend from a few metres to tens of kilometres in length. Certainly not all lineaments relate to faulting (Raju et al. 2016; Rajasekhar et al. 2017; Ramachandra et al. 2018, Pradeep Kumar et al. 2019 & 2020). They could also be attributed to lithological boundaries of structural origin. Image processing techniques like High Pass Filtering and Low Pass Filtering are often used for the lineaments of structural origin based on satellite images.

2. Study area

The study area is located in southern part of Kadapa district of Andhra Pradesh state; the surrounding locations of the district are totally sedimentary rock formation belonging to the world known Proterozoic Cuddapah basin. It is bounded by the latitudes $14^{\circ} 0' 00''$ N – $14^{\circ} 42' 00''$ N and longitudes $78^{\circ} 0' 00''$ E – $78^{\circ} 40' 00''$ E and is shown in (Fig. 1). The structural configuration has facilitated the development of extensional, “pull-apart” basin at playas and the associated faults in the basin show evidence of displacement. North-east striking faults and a few North-west striking faults are spatially associated with igneous activity as well as contact metamorphism activity in much is observed from a regional perspective. Rocks of arenaceous, argillaceous, carbonaceous along with igneous intrusion in the form of sill bodies are observed. These rocks are composed of quartzite's, shales, dolomites, with intercalations of chert, limestone, dolerites, and basalts. Stratigraphically the above formation belongs to Vempalli formation and Pulivendla formations of Cuddapah Supergroup of rocks Cuddapah basin (B. K. Nagaraja Rao et.al., 1987; Sadiya et al. 2010). Most of the rock formations are met sediments in origin. Barites mineralization is exclusively found in contact zones of dolomites with the igneous sill intrusive. The origin of the mineralization in the region is attributed to the hydrothermal solutions and contact metamorphism

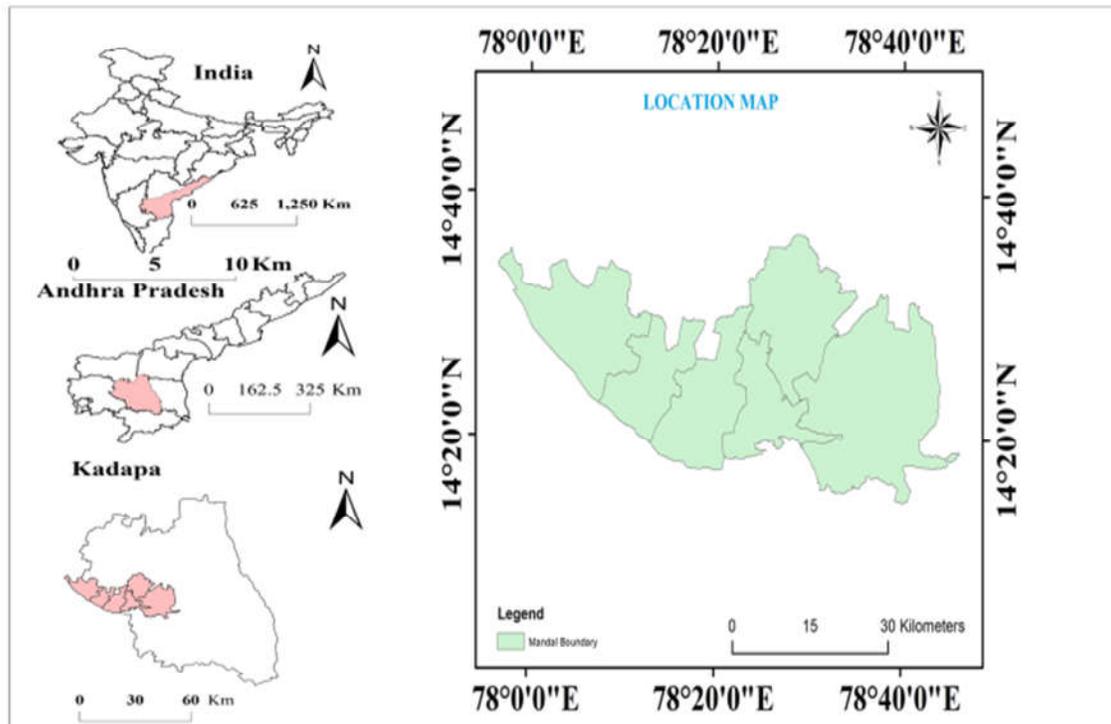


Figure 1. Location map.

3. Methodology and Data used

The main data used for the mapping of the study area's structural lineaments is LANDSAT 7 enhanced thematic mapper plus (ETM+) downloaded from global land cover. Landsat 7 ETM+ has the spatial resolution of 30 m, and an extra 15 m panchromatic (pan) band. The contemporary study includes data collection, data analysis, map preparation, report generation etc. The statistics series includes locating the mineralizing zones in the subject of the observe and accumulating the GPS point of every region for one of a kind mineral. During the data analysis was processed by way of histogram equalization and the toposheet of the georeferenced vicinity have a look at with the IRS P6 LISS III using ERDAS imagine 2014. The GPS records gathered in the course of the fieldwork have been analysed and placed in satellite imagery for pc image and mineralized places, geology, and geomorphology have been delineated the use of ArcGIS 10.4 software program. Finally, integrated mine Lineament map become prepared.

4. Result and Discussion

Remote sensing can be defined as, "the detection, identification, and analysis of objects or features through the use of imaging devices (sensors) located at positions remote from the subjects of

investigation, remotely sensed data are digital in nature and can be efficiently interpreted and analysed using various kinds of software packages (Jha *et al.*, 2007; Star *et al.*, 1997; Kurucu and Chiristina, 2007). While remote sensing can provide extensive spatial coverage at regular intervals, which is essential for GIS to be effective, GIS data layers can contribute correlative data to improve the accuracy of the remote sensing data (Star *et al.*, 1997; Jha *et al.*, 2007; Mc Harg, 1998; Bernhard Sen, 1999). Geographical information systems (GIS) are computer-based resources (Bernhard Sen, 1999) that enable several forms of data to be systematically analysed according to their shared location on the planet.

Natural resources are being more and more implemented inside the latest years due to improve in effective value of demand for minerals. The symbols of mineral indicate presence are related to structural distribution, land use, geology, topographic elevation, slopes, travelling strengths in order to expect the mineral different the backgrounds of the character and the character of the history. Integrated assessment of thematic maps using weighted guide intersection method, different based totally on GIS strategies having been determined to be appropriate for delineating mineral and groundwater potential zones.

4.1 Geology

The study area composed of a stratigraphic sequence of rocks of Papaghni group and Chitravati group of lower Cuddapah Supergroup of rocks (Table-1). The lithological the study area has a series of alternate bands of argillaceous and arenaceous rocks. Igneous activity is seen between Vempalle and Pulivendla formations and below the Tadipatri shale formation (Nagaraja Rao, et al., 1987). Geology maps were prepared based on ground water and mineral resources map (GSI) and LANDSAT imageries by using ArcGIS 10.4 Software. Various types of rock formations and geographically based imagery based on tone, texture, and drainage patterns. This map shows various features like rock formations and their stratigraphic position. This map is prepared based on geology and mineral map of Andhra Pradesh on 1: 50,000 scales prepared by the Geological Survey of India (Figure 2).

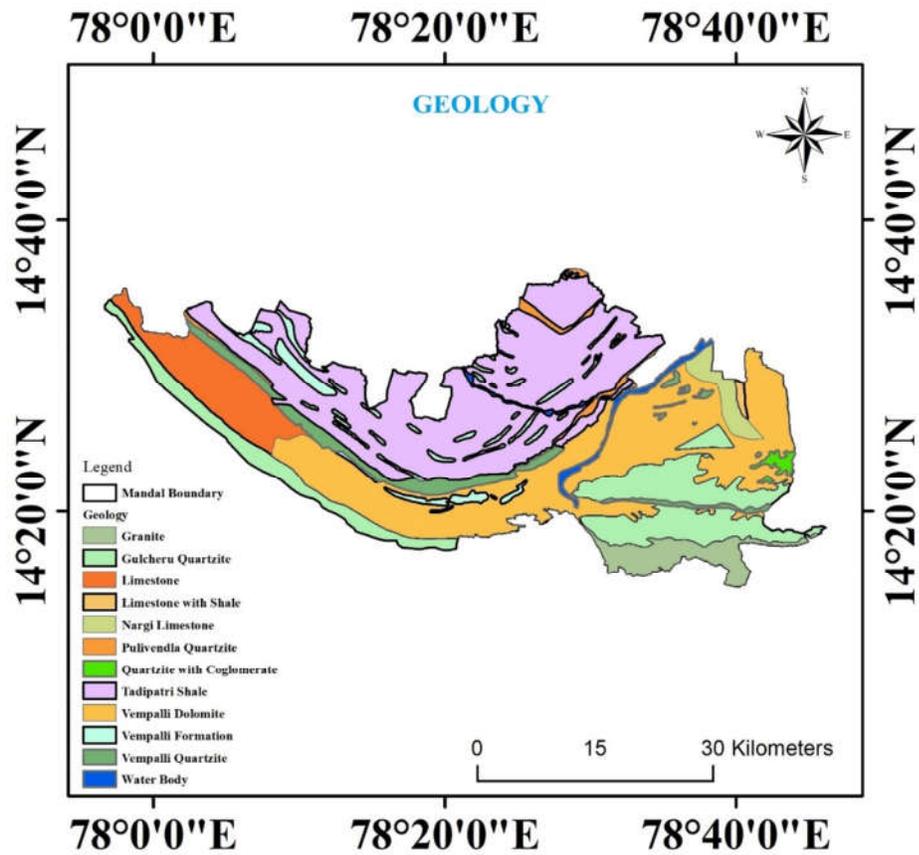


Figure 2. Geology map.

Table 1: Lithostratigraphic Succession of study area part

Group	Formation	Thickness (m)	Lithology
	Gandikota Quartzite	300	Quartzite and Shale
	Tadipatri formation	4600	Shale, Ashfall tuffs
Chitravati Group			Quartzite, Dolomite with igneous intrusives
	Pulivendla quartzite	1-75	Conglomerate, Quartzite
----- Disconformity -----			
Papaghni Group	Vempalle Formation	1900	Stromatolitic dolomite, Dolomite, Dolomite mudstone, Chert breccias

Gulcheru Quartzite	28- 210	Quartzite with basic flows and intrusives. Conglomerate and Quartzite
----- Non-conformity -----		
Archaean and Dharwar		

In above study area mostly occupied geological succession of Papaghni group and Chitravati group, main lithology being dolomite and quartzite. The river bed is flowing through quartzites of Gulcheru formation which are highly suitable for subsurface dam construction because of their porosity structural disturbances like faults, folds joints and lineaments and with inclinations varying from 5° - $>35^{\circ}$. In the present study the sand particles were classified during field investigation where river width and sand grade are suitable for subsurface dam construction within the latitude and longitudes as shown in (Fig. 1).

4.2 Geomorphology

Geomorphology of an area is a crucial element in assessing the mineral prospects due to the fact it's faraway control of the subsurface motion of mineral resources. The nature of the look at place is characterized by using dominantly with the aid of a few degree geological backgrounds the geomorphology of any region is a crucial component in indicating the mineral and is dependent on the lithography and shape of the underlying formations (Kumar et al. 2008). The substances associated with the vempalli formation. The geomorphological function in the have a look at area may be categorized into 5 devices i.e. river / waterbody, Fluvial Origin, Anthropogenic Terrain, structural Origin, Denudational Origin (Fig. 3). The geomorphology of have a look at place is a dominance of porous sedimentary rock Spatial quantity of the floor waterbodies Such as river become protecting of the observe location.

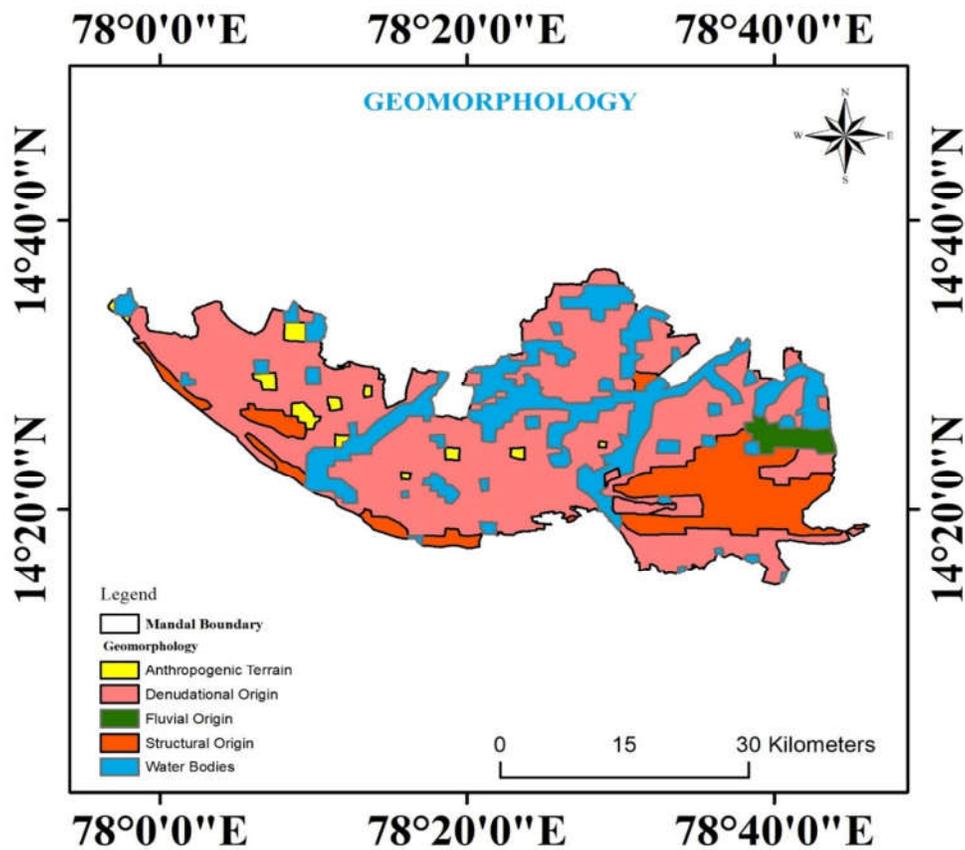


Figure 3. Geomorphological map.

4.3 Slope

Slope is individual of the significant fields which can be clarified via horizontal arrangement of the contours. In the vector form strictly spaced outlines characterize steeper slopes and thin contours. Here, the slope is steep slopes. In the raster elevation, the slope is measured by using the identity of the maximum price of alternate rate of each cellular to neigh boring cells. The slope values are considered both in percent or in both vector and raster paperwork, (Fig.4). The slope amounted from digitized contours and see heights have shown that elevation decreases from the northern component to the southern part with slope 0° to 10° in flat and mountainous regions respectively. In the close to (0-1) diploma, the floor runoff is slowed down, in which the strong slope area (10-15) degree, facilitates excessive runoff allowing less residence time for rainwater then comparatively much a lesser amount of infiltration ability.

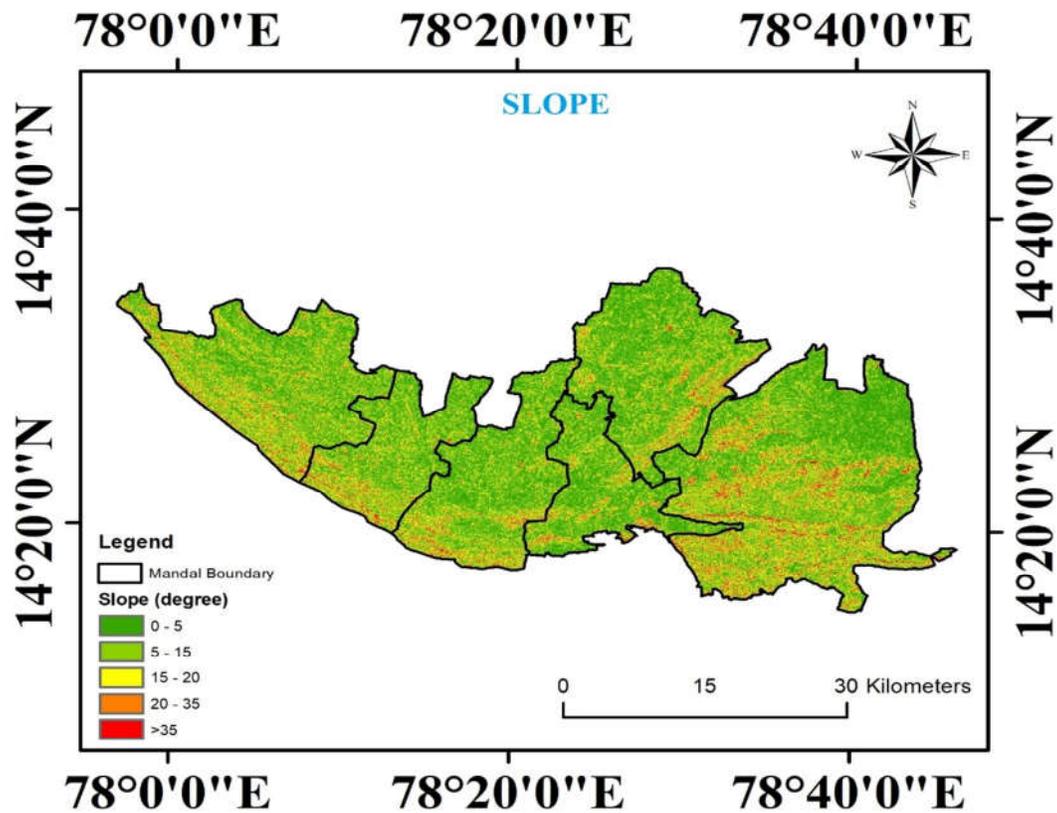


Figure 4: Slope map.

4.4 Lineament

The line of correction is an automated technique, that is primarily based on the information of the take out lineaments. An enhancement instrument is developed, which allows users to fine the lineament map (Fig. 5). There are numerous forms of strains, such as, no longer related (due to irregular reflectance on the picture), covering or too near (temporary in the watercourses or photo shadow), extraordinary lineaments (too short or too lengthy). In order to save stretch for strolling the improvement system, all lines are sorted through their coordinates. The line map, that's an end result of the vectorization software, contains traces and polyline; polylines have first to be fragmented up in lines. The resulting line map consists of handiest instantly line, with clear geometric characters.

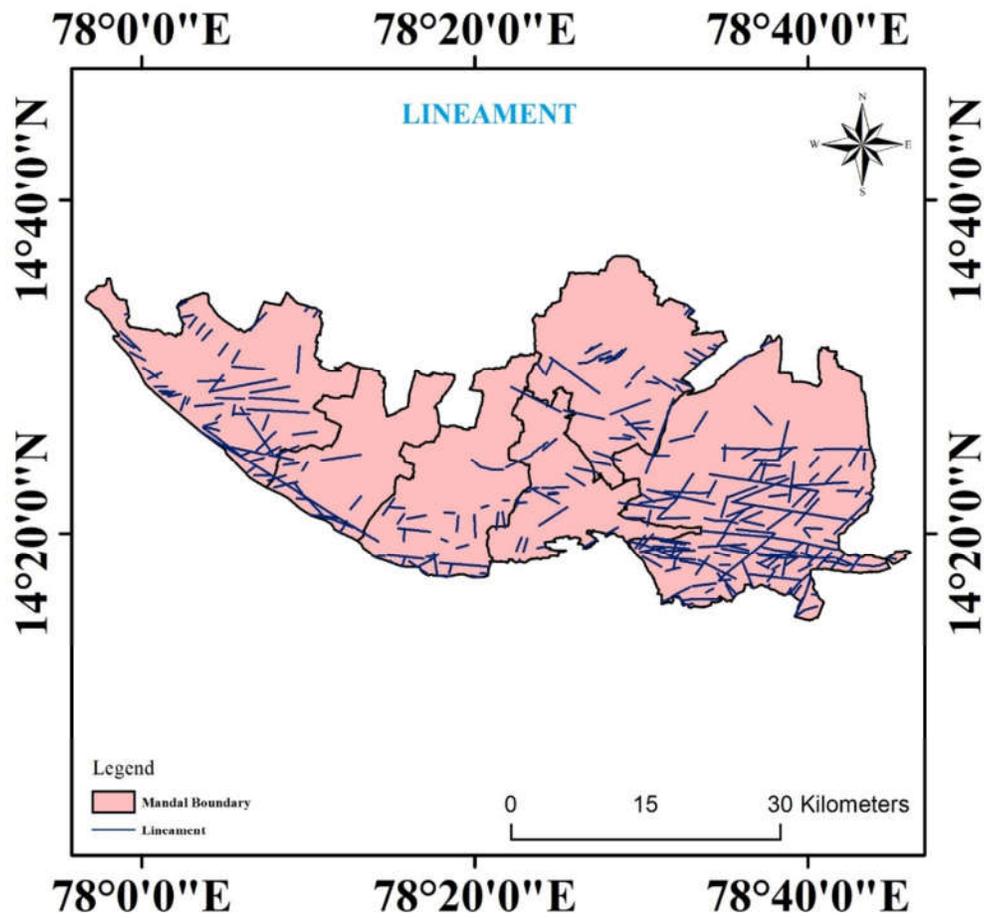


Figure 5. Lineament map.

4.5 Rose Diagram

The main way of the fault device inside the study does not resemble to the primary system within the case of the fault structure in the study. However, trying out the distribution of lineaments in a subvicinity of the lineament map could be very comparable (Fig. 6). Rose diagram from special datasets for precise look at In look at area orientation are particularly in S-W, N-E, and NNE-SSW course.

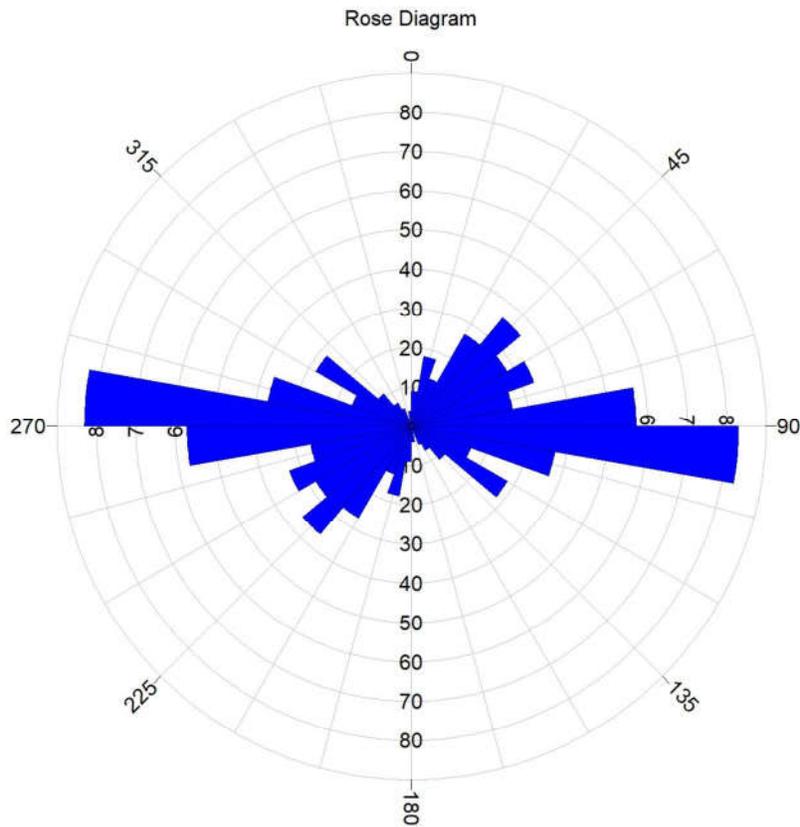


Figure 6. Rose diagram.

4.6 Lineament density

Lineament concentration may be future to the volume of the consequences of tectonic alteration, rock splitting and shearing, mineral and groundwater possibilities. Thus, the manipulate of linear density is a massive and useful method for the software of the maximum applicable facts in the subject of linear substances. Related to imprisonment inside the concentration area within the study region. Lineaments are often analysed by way of frequency histograms (Zakir et al., 1996), rose-diagrams (Karnieli et al., 1996), and lineament density maps (Zakir et al., 1999). The maximum not unusual method is to analyze the relative density of regions in line with part extent (quantity / km²), or the total duration of areas consistent with unit area (km / km²) or joining completely. However, there are hand clues. The essential hand is the variety of lineaments consistent with unit location (N - range / km²), the second predominant index is the whole lengths of lineaments in step with unit location ($\Sigma = N I L \times 1$ -km / km²), the main index is the full wide variety of intersections of region consistent with unit place (NI - variety / km²). There are two changed indexes, the fraction of the intersections (NI) versus the variety of lineaments (N) and the relation of the connections (NI) against the total duration of lineaments (L), which might be frequently used for reading fracture

regions. Specific direction. The past changed index, the standard length of lineaments (L N) is normally used while the size of take a look at is small (smaller than 1 / a hundred,000). By using this guide, we can decrease the dimensions of the lineament and the whole period of lineament. The linear density indices are considered for a positive grid cell decision, which may be positive on the basis of the geometric map and may be reclassified in the stages of values and offered as a density map (Fig.7).

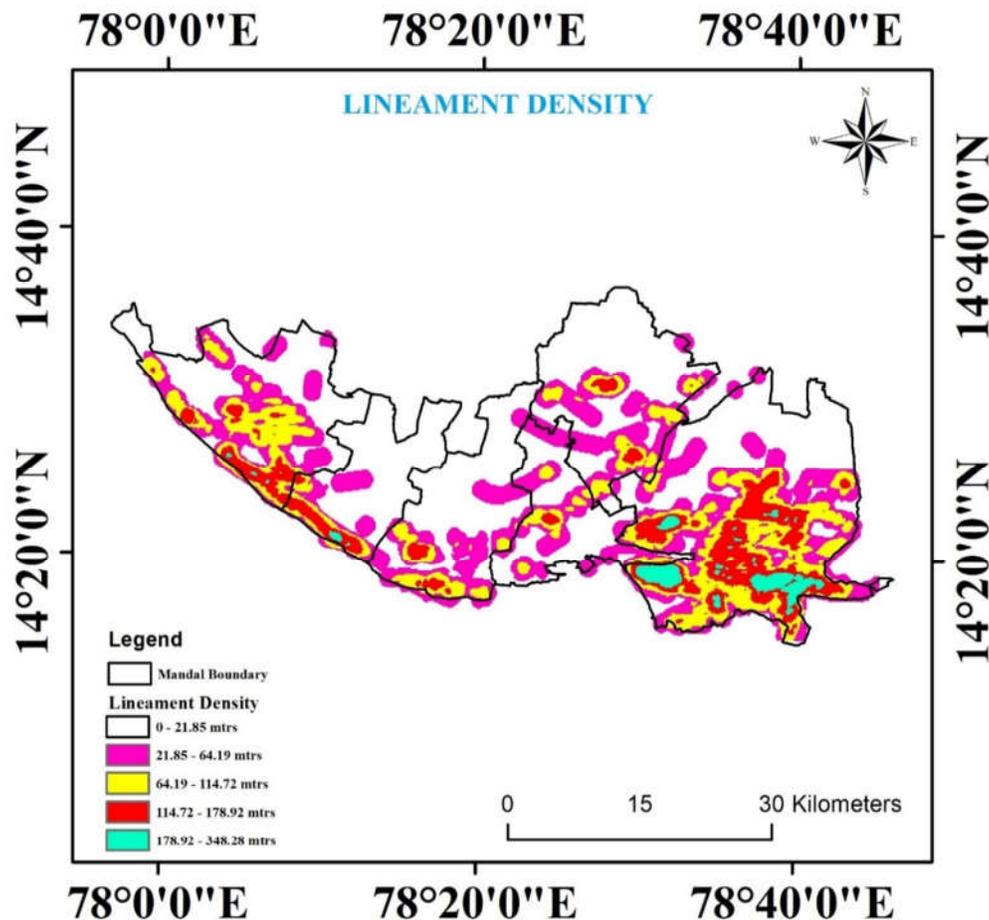


Figure 7: Lineament density

4.7 Band Combination

Image of 14 September 2008 showed comparatively larger vegetated area than that of 26 January 2017. The habitat could be lost due to habitat fragmentation, over exploitation. The changes show that though it has been declared as a nature preserve, its protection is falling behind. The map showed considerably good vegetation. It shows the kind of forest this sanctuary is. This could be a deciduous forest. Temporal changes in image of LISS 3 showed that we need immediate attention to take care of this situation of decreasing habitat exponentially. It would be suggested to check how much it

changed every year between 2009 and 2016 and guess the exponential change that is happening year (Fig. 8 and Fig. 9).

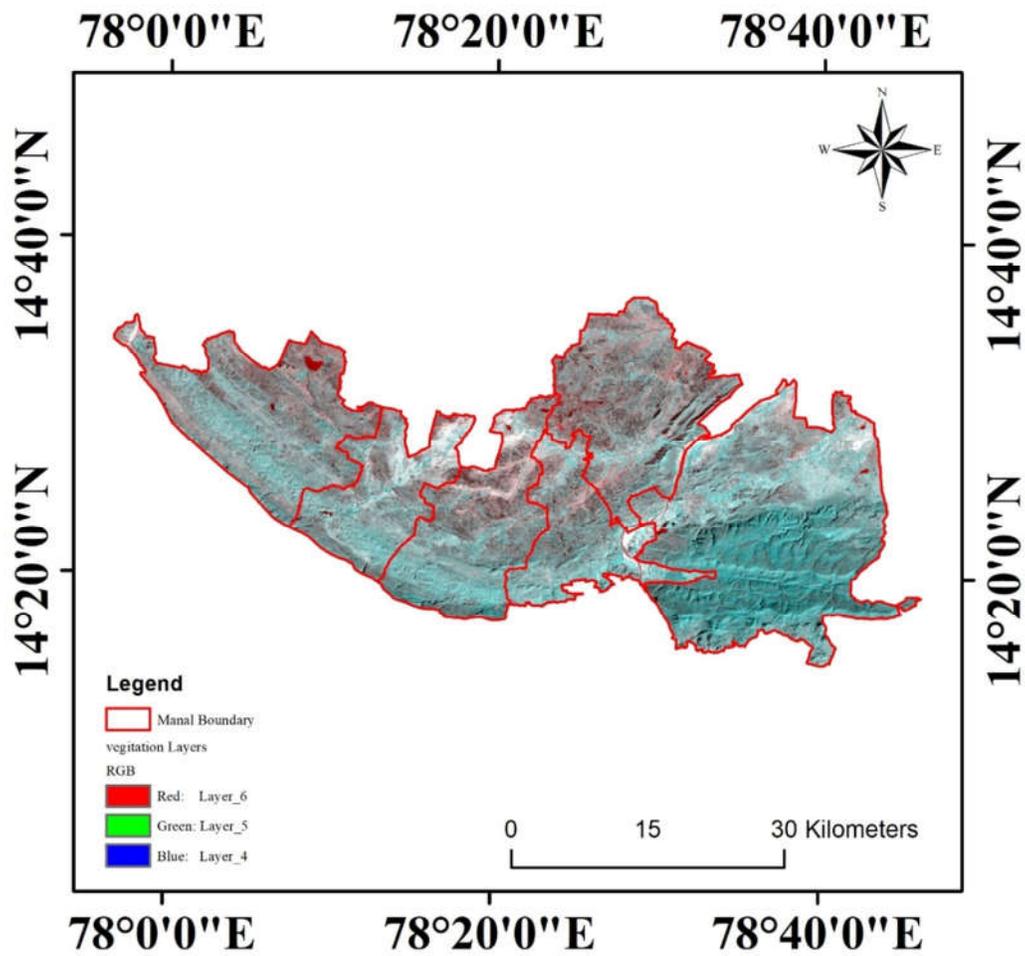


Figure 8. Band combination for Vegetation

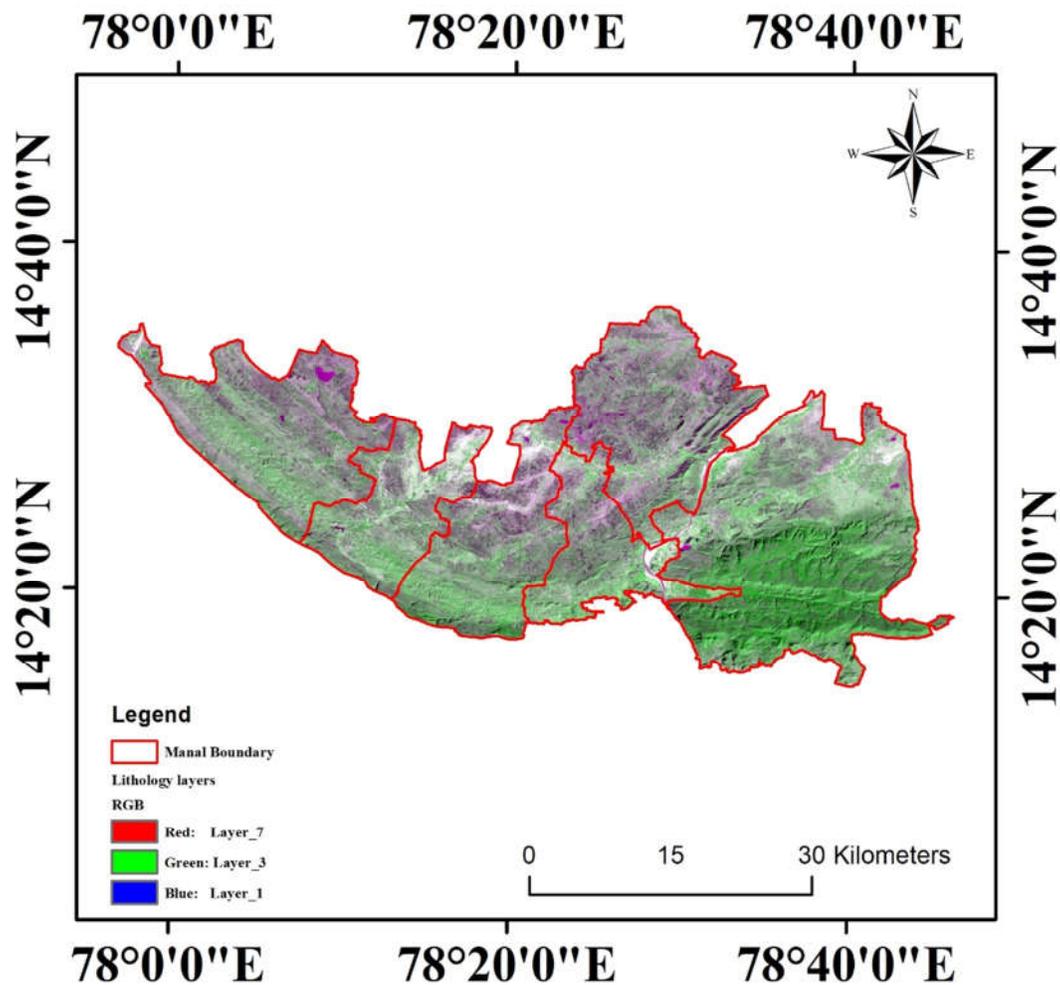


Figure 9: Band combination for lithology

4.8 Band Ratio:

Band rationing is the process of dividing one band by another. This process will highlight a certain feature of the surface depending on its spectra in certain bands. The first step is to decide which features are to be highlighted. For remote sensing geology we are often concentrated with mineral exploration. Different minerals absorb and reflect different regions of the Electromagnetic Spectrum. Using devices such as PIMA (Portable Inferred Mineral Spectrometer). We can measure the spectra of a mineral sample with the help of PIMA.

We are targeted to find Fe-rich schist, we can get that, it has a high reflectance value for band 3 of Landsat and Low reflectance for band 1. Therefore, a ratio of band 3/1 will distinguish the iron oxide minerals. In this paper we are concentrated on Clay, Iron Oxide, and Ferrous minerals present in the study region to be mapped. Band ratio as follows:

For clay minerals: Band 5 / Band 7 of Landsat image

For Iron oxide minerals: Band 3 / Band 1 of Landsat image

For Ferrous minerals: Band 5 / Band 4 of Landsat images were used and created individual layers.

Once all the three images have been processed, interpreter tool was used in ERDAS and Layer Stack operation to stack the three images in the following order

Input 1 = 5/4 Ferrous

Input 2 = 5/7 Clay

Input 3 = 3/1 iron Oxide

This will produce a three-band image in which all the ferrous minerals will appear as shades of red, the clay minerals as muddy and the iron oxide minerals as light orange, such as below figure 10.

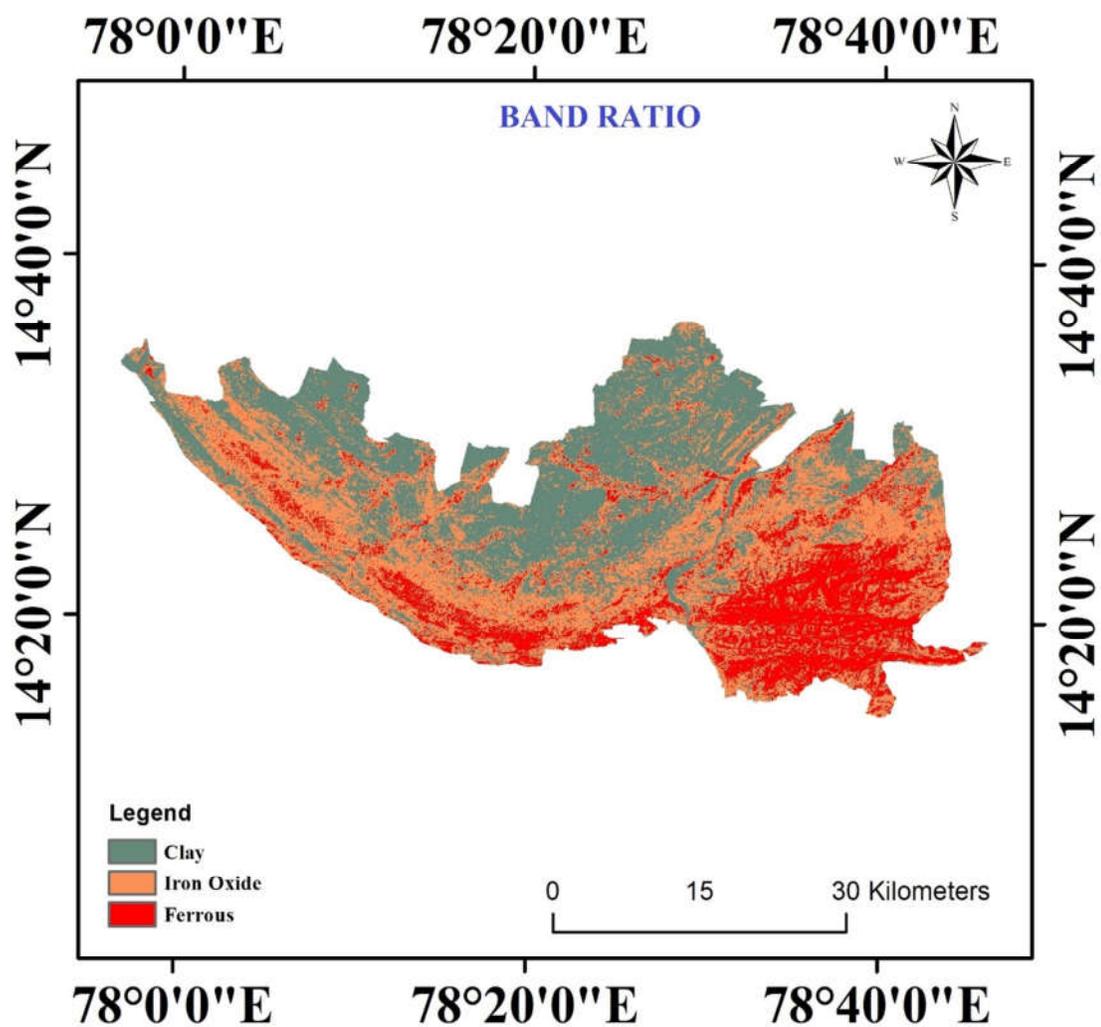


Figure 10. Band Ratio for Clay, Iron Oxide, and Ferrous in the study area.

5. Conclusion

A virtual elevation model became also analysed to enhance the translation. The effects of the analysed lineament / fractures which have area of fracture has been broken down The areas of high-grade intersections are to be had for mineral prospecting within the look at area. It became determined that most of the primary orientations in the regions included effectively The outcomes of the have a look at display that the remote sensing method is proficient of extracting lineament traits over a huge vicinity. It is the refracted recommended that the excessive degree of interference density need to be conducted of the character. Based at the Geology, Geomorphology, and Lineaments maps, we the maximum crucial source for identifying lineaments is that which is normally referred to as directly segments and steep slopes. The supplied technique makes it possible to discover the way that is associated with the study area. May be recognized and mapped on satellite imagery. Both fields and remote sensing methods need to be mixed to accurate and replace current statistics on geologic maps. The capacity is inside the water regions and minerals are happening in the final contraception. By the lineaments of the look at are they will be possible of mineral which can be suggested.

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