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Case Study: Copper Mineralization in Grey Granite of Peninsular Gneissic Complex, Near Yellamanda, Chitoor, Andhra Pradesh

*Vishnu Kumar Singh**

Geological Survey of India, State Unit: Andhra Pradesh, SR, Hyderabad – 500068

Abstract

In order to reduce operational and field costs, remote sensing studies are used at the initial and general exploration stages. remote sensing methods were used to identify Anomalous regions and to show more areas with this type of the same potential. In this study. Band math function has been used in various bands of Landsat 8 operational land imager (OLI) data to access the precise distribution of points of the hydrothermally altered zone OLI data was processed and by the use of Band combination / ratio, alteration maps were prepared and with help of field data some of the hydrothermal mineralized locations were identified in the study area

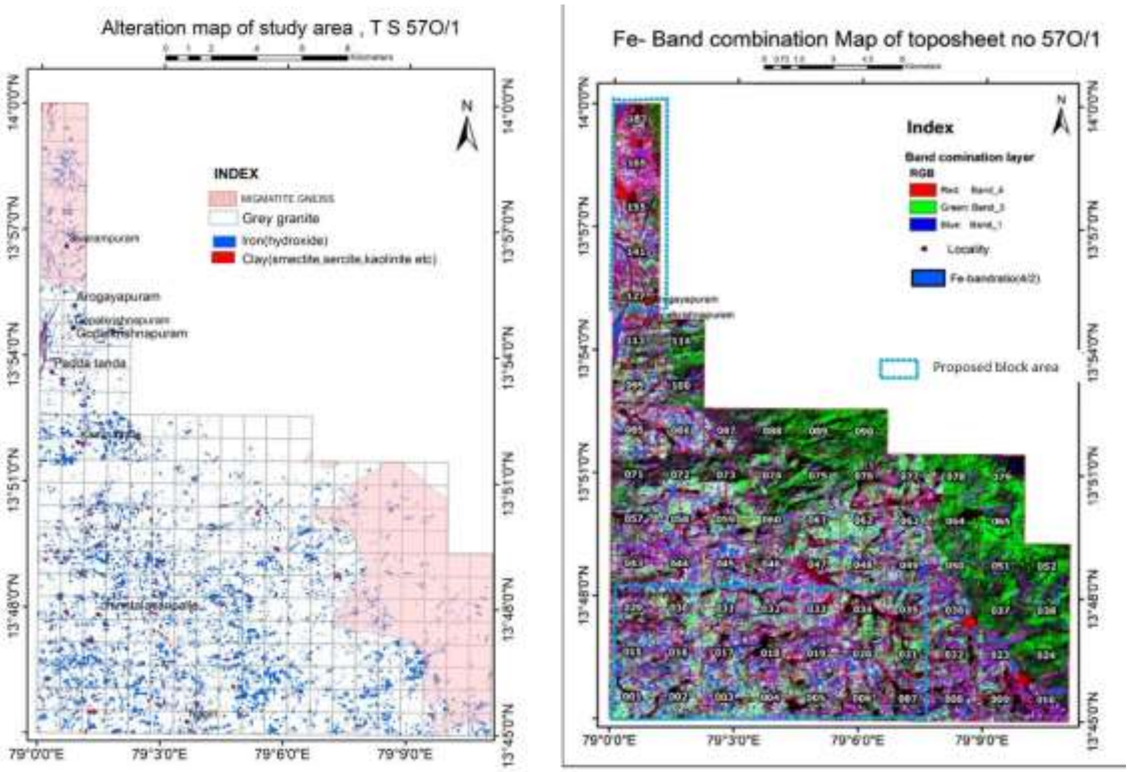
Keywords Bad Ratio, Hydrothermal alteration, Anomalous, Remote sensing

I. Introduction

Geological deposits contain different mineral and chemical compositions from surrounding rocks, and these differences are often reflected in remote sensing images in the form of spectral anomaly information. In this regard, a series of remote sensing digital image processing becomes an effective, prospective means of acquiring the geological anomaly information related closely to ore-bearing strata, mineralized alteration zones, contact metamorphic zones, and tectonic zone. Band combination and band rationing help to locate the distribution of a hydrothermally altered zone. The band math function has been used in various bands of Landsat 8 operational land imager (OLI) data to access the precise distribution of points of the hydrothermally altered zone. Physiographically, the area is a rugged terrain exhibiting a highly undulating topography marked by medium to high hill ranges with intervening plains. The main drainage pattern of the area is mainly dendritic to sub dendritic and at places radial pattern is also observed which is controlled by underlying structures and lithology of the area. Most of the streams are ephemeral in nature. The major geomorphological landforms present in the study area are pediment and Pedi plain with structural and residual hills.

II. Remote sensing Data Analysis

OLI data was processed and by the use of Band combination/ratio, alteration maps were prepared . on-ground verification Cu or other hydrothermal mineralized locations were identified in the study area.



1. A) Alteration map of the study area(with 2kmX2km grid) B) Iron/Cu map (band ratio 4/2) of Toposheet no 57O/1 prepared by OLI data (chalcopyrite contains Fe in its composition so this map is valid for Cu also and through ground check most of the location were identified for indication of Cu mineralization(with 2kmX2km grid)

Band ratio

Each object has its own spectral reflectance pattern in different wavelength portion. Spectral reflectance curve is a kind of fingerprint of the object. The objects may have high reflectance value in some spectral portion, however, it may absorb in another spectral region. According to this information, the main concept of the band ratios technique was developed. A band ratio is very simple and powerful technique in the remote sensing.

Basic idea of this technique is to emphasize or exaggerate the anomaly of the target object. Ratio is accomplished by dividing the data base DNs in one spectral band, by the data base DNs in a second spectral band for each spatially registered pixel pair. The ratio algorithm can be expressed in the form

$$BV_{i,j,r} = BV_{i,j,k}/BV_{i,j,l}$$

where $BV_{i,j,r}$ is the output ratio value for the pixel at row, i, column j; $BV_{i,j,k}$ is the brightness value at the same location in band k, and $BV_{i,j,l}$ is the brightness value in band l.

On band ratios image the extreme black-and-white tones of the gray scale represent the maximum difference in spectral reflectivity between two bands.The darkest tones are targets for which denominator of the ratio is greater than the numerator. Conversely the numerator is greater than the denominator for the lightest toneRatio techniques are usually used to enhance the spectral differences between surface materials that difficult to detect in raw images. Moreover, such techniques may suppress the effect of variable illumination resulting from

topographic variations, slope shadows, seasonal changes, and either differences in sunlight angle or intensity may also be eliminated. Information gained by ratio transforms is considered to be almost new and cannot be obtained from either of the bands independently. typical band ratios which have been used for enhancing lithological features Most effective band ratio practices used by Sabins' for geological mapping, are RGB of 4/2, 6/7 and 6/5 Sabins' band ratio is beneficial for lithological mapping and detection of hydrothermal alteration zones, Previous studies suggest that iron-rich minerals or other minerals associated with hydrothermal processes can be delineated using 4/2 of Landsat 8 OLI image(fig.1). Band ratio of Landsat 8 OLI image 6/7 is beneficial for mapping clay minerals like kaolinite, illite and montmorillonite. Ali and Pour suggest a combination of Landsat 8 OLI image 4/2, 6/7 and 5 as RGB for identification of lithology, altered rocks, and vegetation.

Kaufmann band ratio (7/5, 5/4 and 6/7) was also used for separation of vegetation from altered zones. Band ratios derived from images 4/2, 6/7, 5 and 4/2, 6/7, 10 as RGB depict reparability of rock units and alteration zones precisely. Colour variations can be seen in different band ratio results which are the primary keys to identify a hydrothermally altered zone. Several pair of bands have offered delineation of various rock-mineral types such as: (a) 4/2 – iron oxide, (b) 6/7 – hydroxyl bearing rock, (c) 7/5 – clay minerals and (d) 6/5 – ferrous mineral

Table 1:Description OLI bands Information (source :NASA website)

OLI Band Information			
Band .No	Band Name	Spectral Range (nm)	Use of data
1	New Deep Blue	433-453	Aerosol/coastal zone
2	Blue	450-515	Pigments/scatter/coastal
3	Green	525-600	Pigments/coastal
4	Red	630-680	Pigments/coastal
5	NIR	845-885	Foliage/coastal
6	SWIR 2	1560-1660	Foliage
7	SWIR 3	10.4-12.5 (TIR)	Plant heat stress, thermal mapping, soil mapping
8	PAN	500-680	Image sharpening
9	SWIR	1360-1390	Cirrus cloud detection

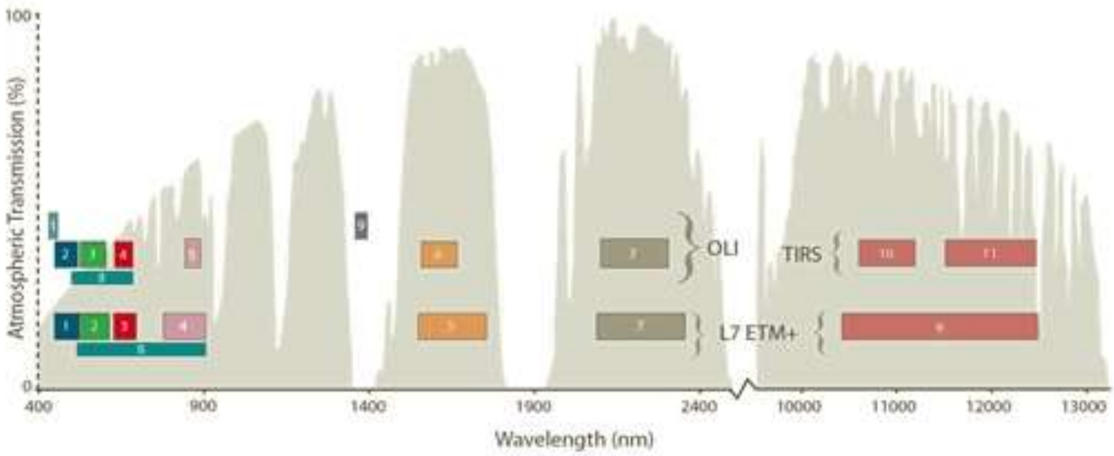


Fig3: illustration of different wavelength range for different bands of OLI Dataset (source:NASA website)

III. Geology

The area diagonally separates into two halves' and exposes two divergent group of litho units viz. Peninsular Gneissic Complex-II (PGC-II) rocks of Archaean to Palaeo- proterozoic age and Cuddapah Supergroup of rocks of Meso-proterozoic age. The Cuddapah supergroup rocks occupy the northern half and in the southern half PGC-II rocks are exposed.The PGC-II unit is composed of hybrid granite gneiss, grey biotite granite gneiss, porphyritic grey granite, quartz veins and dolerite dykes. Cuddapah Supergroup comprises the Nallamalai group of rocks consisting of Bairenkonda/Nagari and Cumbum formations. The Bairenkonda Formation is composed of quartzite and shale/phyllites and the Cumbum Formation consists of shale and quartzite units. hybrid granite gneiss is composed of small enclaves of amphibolite, quartz mica schist and banded ferruginous quartzite. This unit of rocks are exposed all along the contact with the Cuddapah supergroup of rocks between Reddivaripalle in the northwest to Turkapalle in southeast. Generally, the rock is greenish grey in colour, coarse grained and composed of biotite, plagioclase, hornblende and quartz. Under thin section the rock consists major minerals like acid plagioclase, quartz, antiperthite, greenish biotite and sphene whereas apatite, pyrite and magnetite occur as accessory minerals. Grey biotite granite gneiss which is the dominant member in the PGC-II unit is exposed in the rest of southern half of the area. The rock is medium to coarse grained, grey to whitish grey in colour and consists of quartz, k-feldspar, biotite, hornblende and plagioclase. Petrographical studies indicate that this rock consists of microcline, intermediate plagioclase and quartz as major minerals with minor amounts of hornblende, biotite, epidote, sphene, zircon, tourmaline and chlorite. Porphyritic grey granite is exposed as an intrusive in both the hybrid granite gneiss and grey biotite granite gneiss at one/two places in the area. The rock is exposed between Kottagollapalle and Dinnelapalle in the central part and around Amma Bhavi in the northern part of the area. The rock is in grey colour porphyritic and composed of hornblende, biotite, quartz and plagioclase. Quartz veins occur in the PGC-II unit of rocks with varying lengths. Generally, the veins color varies from white to light rose which is trending E-W and NE-SW directions. basic intrusive which occur in the PGC unit are represented by dolerite. These dykes are mainly medium to fine grained in nature and traverse broadly along E-W, NW-SE, N-S and NE-SW directions. The length of the dykes varies from few meters to more than 2 to 3 kilometers. The northern half of the area is occupied by the Bairenkonda/Nagari and Cumbum Formations. The Bairenkonda/ Nagari Formations consists of quartzite at the bottom and shale/phyllite at the top. At places shale is making a direct contact with the PGC unit of rocks. The Bairenkonda Formation occurs as an alternatre sequence of quartzite and shale/phyllite. The Cumbum Formation conformably overlies the Bairenkonda/ Nagari Formation and mainly consists shale horizon which is succeeded by quartzite unit.Primary bedding is noticed in the Cuddapah Supergroup of rocks. The general strike of the bedding is NW-SE with dips 10° - 35° towards northeast.

Crudely developed foliation is noticed at some places in the PGC rocks. The general trend of the foliation is N-S and dips 50°-60° towards east. Joints have developed predominantly in the area along N-S, E-W, NNW-SSE and NNE-SSW directions with vertical to sub-vertical dips on either direction. However, E-W trending joints are more profuse in nature. NE-SW trending faults are recorded in the PGC unit of rocks of the area. Few faults are extended from few meters to few kilometers. A NE-SW trending fault is noticed in PGC unit between Dasaragudem to Venkataramana colony. Few NE-W and NW-SE trending faults are noticed which are cutting both the PGC and Cuddapah Supergroup of rocks.

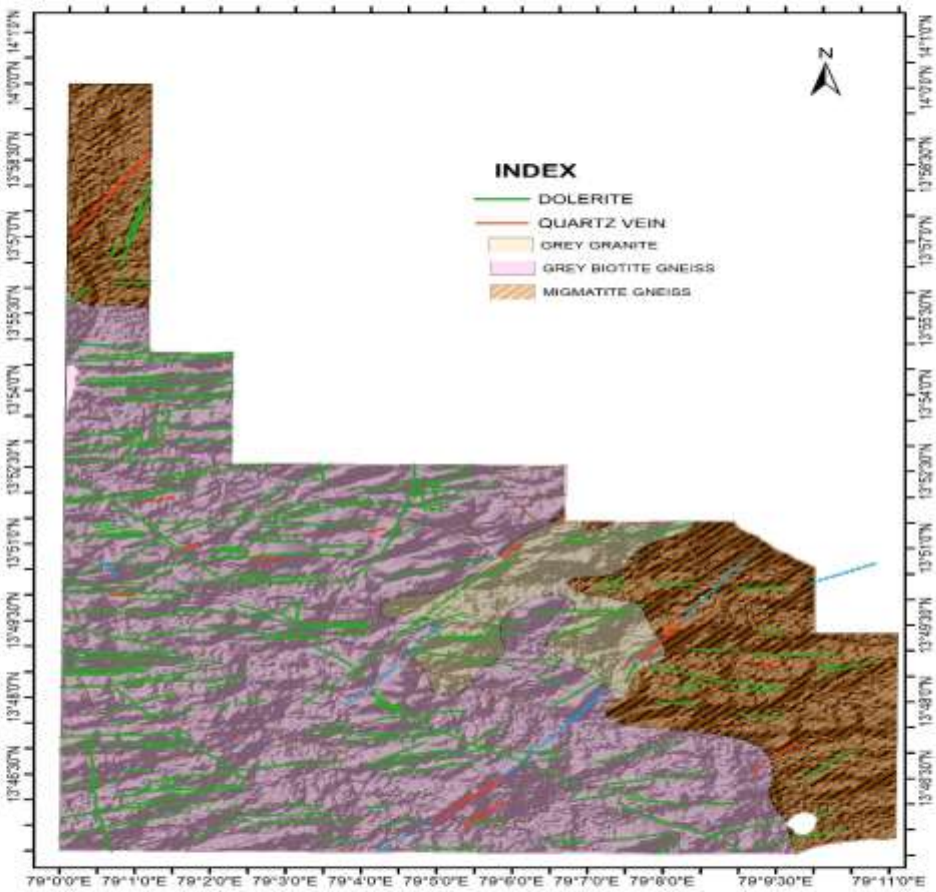


Fig:4 Geological map of Study Area (source :geological survey of India, modified by VK singh FS 21-22)

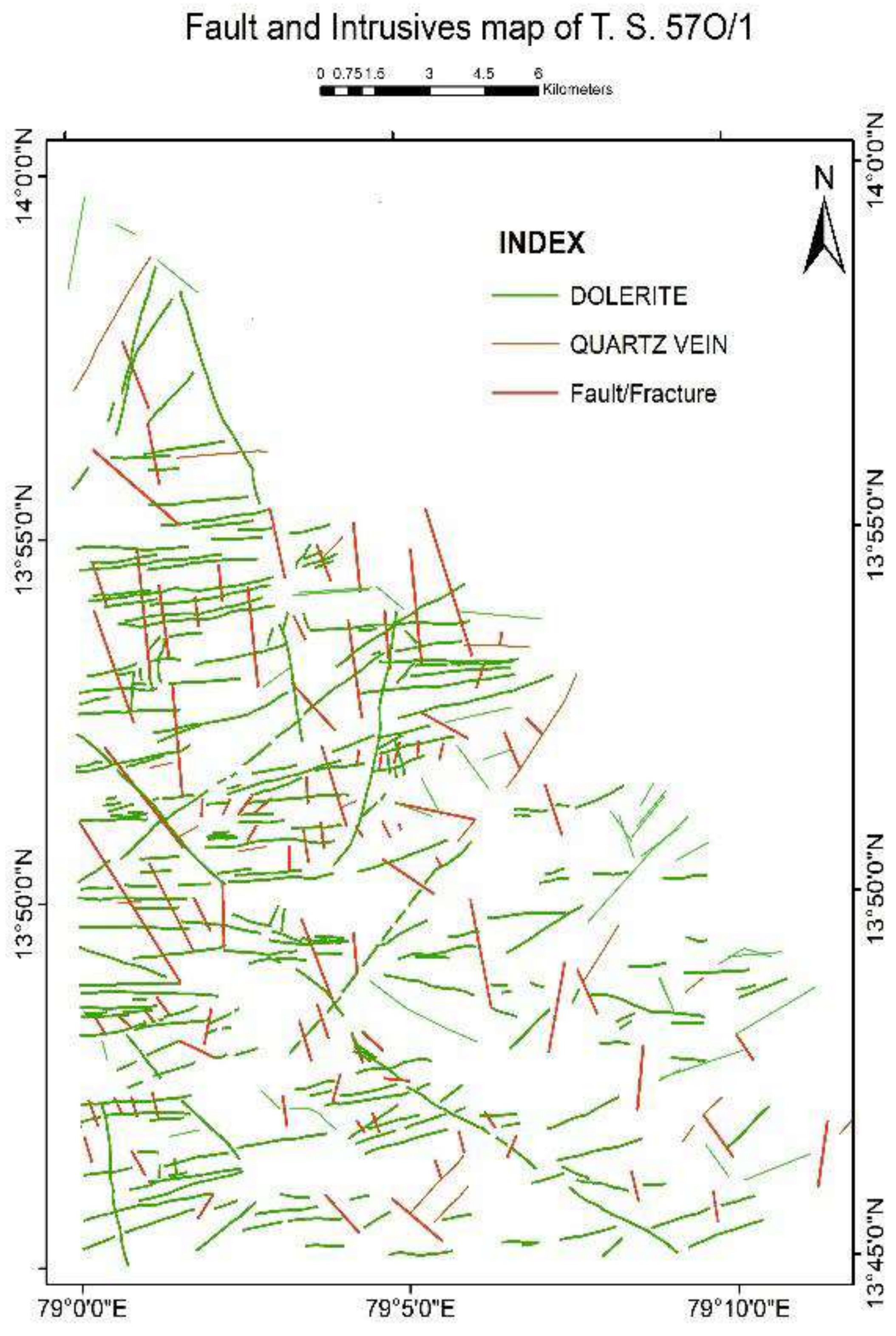


Fig:5 Fault &Intrusive body map of the study area (made on GIS Environment with the help of field Data)

IV. Copper mineralization in the Study Area

Fig 6A: chrysocolla alteration stains over the Granitic rock, south of yellamanda B. Malachite stain over the granite body along with late phase intrusive near sivarampuram.

The regional Schistosity and Gneissosity trend N-S to NNW-SSE. The chronological order of fracture trends from older to younger generations may be written as E-W, N-S, NW-SE, and NE-SW. This basement complex in the south of the Cuddapah basin is one of the important target zones for fracture-controlled uranium mineralization. Several sympathetic NE-SW to NNE-SSW trending youngest fracture zones is located in the area. older dykes, fractured reefs, and other granitic hillocks are displaced and/or omitted by the NE-SW trending fracture zone along which mineralization exhibits continuity irrespective of lithology. Therefore, NE-SW reactivated fracture must have played a role in the transportation path and precipitation of uranium and other sulfide minerals such, as Cu, Au etc) from a hydrothermal fluid.

Cu in the study area present in form of veisn, stringent ,lenses and disseminated over the rock body .copper minerals like Chalcopyrite , malachite,bornite ,azurite and chrysocolla were common phases which were identified in the study area.

Conclusion

Band combination, band ratioing are conventional methods used for explicit mineral identification in large scale. Field surveying methods for mineral outcrop mapping are difficult and time consuming. Different band combination and ratio images represent various colours of rock minerals and are key to mineral identification. the method uses radiance data of satellite image which is biased by atmospheric attenuation such as gases, dust particles, haze, etc. and hence can reduce overall accuracy. But here by the combination of field Data and remote sensing study we are able to decipher the mineral potential of the Area

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