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Application of Remote Sensing Techniques in Identification of Lithological Rock Units in Southern Extension of Kolar Schist Belt from Chigargunta, Chittoor District, Andhra Pradesh to Maharajagadai, Krishnagiri District, Tamil Nadu

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Abstract

Remote sensing images have been widely and successfully used for mineral exploration for decades. Multi spectral remote sensing (LANDSAT+ and ASTER) image enhancement and interpretation proved to be useful tool in identification, detection, and delineation of lithological rock units and geologic structures associated with gold deposits. Though gold cannot be identified directly from satellite images, but the tonal variation indicate matching of hydrothermal alteration zones with the locations of known base metals (Cu, Zn, and Ni), thus manifesting the signatures for gold mineralization in the area. This technique has been applied to identify the lithological rock units, structural pattern, hydrothermal alternations, geological structures associated with auriferous sulphide deposits and vegetation in the study area viz. the southern extension of Kolar Green Schist Belt (KSB) from Chigargunta, Chittoor District. Andhra Pradesh to Maharajagadai. Krishnagiri District, Tamil Nadu. The composite images are produced based on known spectral properties of the rocks and alteration minerals in relation to the selected spectral bands. The analytical expertise is used to differentiate the tonal variation and comparing with standards and interpretation has been attempted.

1.0 Introduction

Hornblende series of Kolar Schist Belt (KSB) at Kolar Gold Fields (KGF) hosted huge gold deposits mined over a century (120 years) and had produced about 800 tons of gold in a strike length of 8.0 km N-S over a width of 2-3 km[3]. From KGF on the extension of this KSB about 30 km south one more prominent gold mineralization is located at Chigargunta, Chittoor District, Andhra Pradesh surrounded by ridges of Banded Hematite Quartzite (BHQ) on the west margin and weathered Champion gneiss at the East. Further the gold mineralization is in quartz stingers associated with sulphide in sheared zone hosted by amphibolites. In Naralapalli at the tail end of the KSB sporadic gold mineralization in quartz vein hosted in amphibolite schist which is surrounded by granitic gneiss of Maharajagadai, Krishnagiri District, Tamil Nadu [1].

For decades Remote sensing images have been widely and successfully used for mineral exploration. Although gold cannot be detected directly by any remote sensing method, the presence of minerals such as iron oxides and clay minerals, whose diagnostic spectral signatures (in the visible/shortwave infrared portion of the electromagnetic spectrum) could be used as an indicators for identification of hydrothermal alteration zones, which are associated with gold occurrences.

1.2 Location

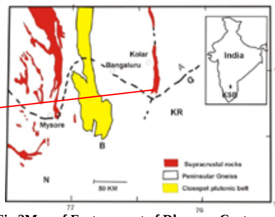

Fig.2Map of Eastern part of Dharwar Craton In India modified from Raih.et.al (1983)

Fig.1 Kolar Schist Belt-Google map

Latitude: 12039'30" – 120 47'00"
Longitude: 76008'30" – 76017'00"
The Topographic sheet at 1:25,000 that covers area in QDS 57 L/1, 57 L/2,57 L/3 57& L/6.
Kolar Shist Belt (KSB) is one of the prominent gold belts in India that belong to the eastern block of Dharwar Craton covering about 300 km2 from north Srinivaspur, Karnataka to south Chigargunta, Andhra Pradesh and the tail ends at Maharajagadai, Tamil Nadu. Kolar Schist Belt (KSB) in the extreme south splits into two bands viz. Vapanapalle band in the west and Chigargunta band to the east [1].

1.3 Physiography

Chigargunta lies prominently surrounded by granites and gneisses as north-south trending hillock which is parallel to the structural trend of the belt where the prominent peak is at 1100m above mean sea level. The drainage flows through a steep slopes in north and south mostly along the joint planes which join to the Ponnaiyar River in the south. At the southern end of the hillock a major stream flows East to West which seems to be along the fault plane cutting across the southern extension of the Kolar Schist Belt. The average rain fall is about 70-80 cm and realizes a temperature of 35^0 to 40^0 C temperatures.

2.0 Geological Setting

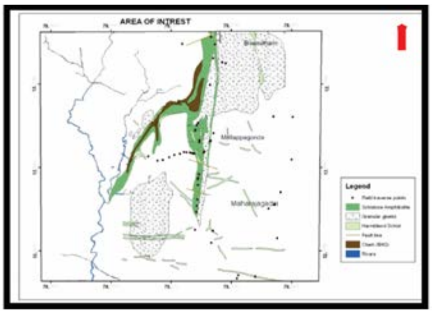

Fig.3 Geological map of Southern extension Schist belt of Dharwar Craton

The study area is located at the tail end of the Kolar Schist Belt from Chigargunta, Chittoor District, Andhra Pradesh and Maharajagadai, Krishnagiri District, Tamil Nadu. This covers a strike length of about 20 km N-S and has a width ranging from 2 km at Chigargunta and at the tail end at Narallapalli thins out to about 10m wide. The schist belt located amidst a large stretch of gneissic rocks of granodiorite to tonalitic composition of peninsular gneiss. The schist belt comprises metamorphosed basic and acid flows, pyroclastic and intrusive with banded Iron formation[2].

Interestingly the southern part of the KSB seen broken into two arms twice one near Yerrakonda dome were the main western band extending further south and splitting again into two at Vapanapalli. The band in the west is Vapanapalli band and Chigargunta band to the south. It is observed that the Vapanaplli band further broken into small synclinal tails[1].

The mafic unit occupies the western portion of the schist belt which has metamorphosed basalts with pillow structure, gabbro and pyroxinites represented by hornblende schist. The felsic units, Champion gneiss composed of quartz, feldspar and mica dominates the eastern margin of the schist belt. Pegmatites are seen both in mafic and felsic units and at certain locations which cuts across the lode system. Dolerite dyke runs N-S and also E-W.

2.1 Geology of study area

In general the rocks have undergone regional low pressure amphibolite facies of metamorphism. The different formations present in the area are characterized by the development of schistosity parallel to the axial plane of the major fold [7]. The Schistosity varies from N-S to N 20^0 E to S 20^0 W having an Easterly dip of 60^0 to 80^0. In Chigargunta a major synformal structure, overturned and plunging at 60^0 to North is seen. Number of faults are marked in the area which are identified by silicification and bracciation trending NW-SE and also E-W direction and dip vertically [2].

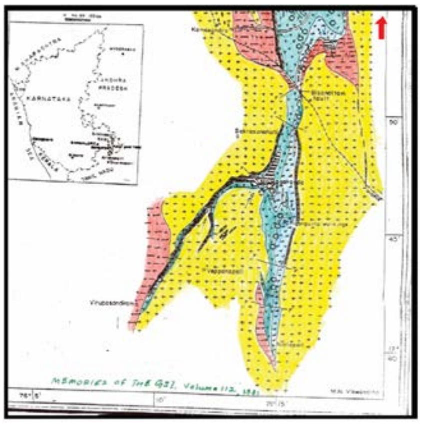

Fig. 4 Litho Units of Southern part of KSB

3.0 Remote Sensing Methodology
3.1 Landsat Images

The LANDSAT TM image with path 143 and Row 051 was acquired. The data was downloaded by taking care of the cloud position. The ETM+ images are of LANDSAT 7 that contains a total of 8 bands; 6 in the visible and Near-Infrared (VNIR), 1 in the Thermal Infrared (TIR), region of the electromagnetic spectrum, and 1 panchromatic channel (band 8), special resolution is 15m for the panchromatic band, 30m for VNIR and 60m for the TIR bands.

3.2 Remote Sensing Software

ARC GIS and ERDAS IMAGINE ver. 9.0. The digital processing of the multispectral images was carried out by using GIS and Erdas Imagine Ver 9.0 software. This includes enhancement, transformation, and classification relating to geology, hydrothermal alteration and structural portion of the study area.

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3.3 Processing Technique

Remotely sensed multispectral datasets were processed comprising LANDSAT Enhanced Thematic Mapping (ETM+) and Advanced Space borne Thermal Emission and Reflection Radiometer (ASTER) level 1 B images. Image processing methods are designed to transform multispectral image data format into an image display that either increases contrast between interesting targets and the background or yields information about the composition of certain pixels in the image. The enhancement techniques, which were applied in this study, include colour composite, band rationing, principal components analysis (PCA), and spatial filtering.

3.4 Colour Composite Images

The production of color composite images is based on known spectral properties of rocks and alteration minerals in relation to the selected spectral bands. For instance, LANDSAT TM band 7 is used primarily for mineral and rock discrimination, whereas bands 4 and 5 are primarily used for vegetation monitoring. Spectral analysis exploits spectral properties of rocks in order to interpret lithological variations in rock alterations that are expressed as variations in colour intensity values within colour composite images.

3.5 Spatial Filtering

Spatial filtering is used for extraction of features like geologic lineaments. These filters enhance visual interpretation of remotely sensed lineament maps and to get smoothness in the images.

3.0 Results and Interpretation

Remote sensing techniques for mapping lithological units are based on difference in spectral reflectance of dominant rock types in the area of investigation. Methods used include band combination, band rationing and principal component analysis. Colour composite images displayed as red, green, and blue (RGB), respectively, show rocks of similar composition in colors that tend to have same resemblance.

4.1 Mapping Lithological Units

Visual analysis of the 5-4-1 band image shows vegetation in light green, granitoids in variations of red/pink, ultra-mafic rocks in purple, quartz-chlorite schist in dark green and graphitic schist in greenish-blue color with its soils in a deep blue color. The drainage patterns are also seen clearly. The geologic features, such as the syncline structure and folds in the North West limb in the image appear clear.

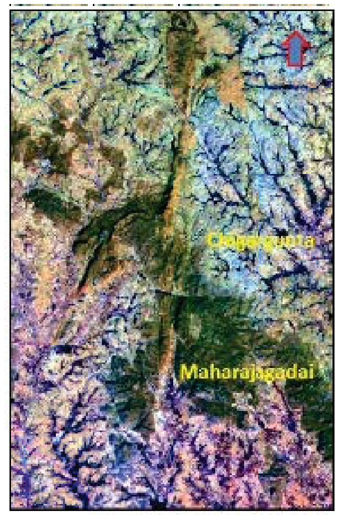

Fig. 5 Image 5-4-1 (RGB)

4.2 Mapping Vegetation

In the image given below (Fig. 6) the vegetation is identified by using LANDSAT TM band combinations 4-3-2 in RGB colors. The vegetation appear as brown to red in colour mostly along streams. Structurally a major synformation is seen at 60^0 towards North and again folds in the north western part of the belt.

Fig. 6 Image 4-3-2 (RGB)

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4.3 Mapping Hydrothermal Alterations

Generally in geological region the alteration zones are the indicator for the presence of ore body and give the nearest location for the gold deposit. Most of the alteration types associated with gold deposits is sericitization, oxidation, silicification, and carbonitization, and ammoniation [8].

The hydrothermal alterations zones are identified by using spectral angle mapper (SAM).The reflectance spectra of the image are compared with similar USGS digital spectral library (Minerals) with selected minerals plots of alteration [8].

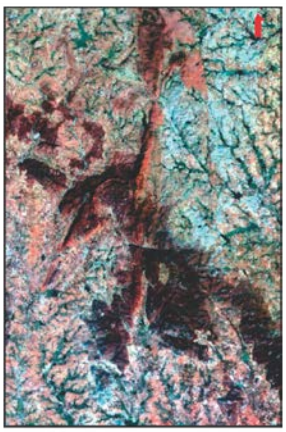

Fig. 7 Image 6-2-1 (RGB)

4.4 Structural Map of the Study Area

Satellite images processed for extracting geological features like faults, folds, and fracture zones and topographic ridges and drainage segments and lineaments. Geologic lineaments are important for mineral exploration as they are the potential locations for hosting ore bodies that are deposited by ascending hydrothermal fluids.

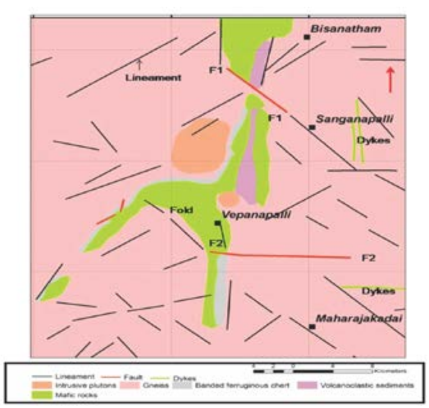

Fig. 8 Structural map of the study area

From the processed image it could be observed that two major faults trending NNW-SSE to NW-SE and E-W a cross fault were identified. Further, in the study area the KSB has been subjected to tight fold in closed synform. Three sets of lineaments in the direction of (1) NNW-SSE to NW-SE (2) NNE-SSW to NE-SW and (3) E-W, ENE-WSW were observed. Dykes tend N-S and E-W directions.

4.0 Validation of Results

The remote sensing studies validated by ground truth verification in the study area and the geological/ lithological maps available (Fig.4). The geological mapping and geochemical analysis proves the felsic and mafic minerals identified through the remote sensing techniques same. The hydrothermal alterations are found as iron oxides and calcite at the contact zone along the quartz reef in sheared area (Fig. 9 and Fig. 10).

5.1 Geochemical analysis

(I) Hornblende schist– 2km South of Naralapalli village composite sample of host rock fine grained hornblende schist collected from the study area subjected to XRD analysis. The following are the mineral composition:

Compound Name	Remarks
Hornblende	Major
Anorthite sodium	Good amounts
Quartz	Traces

(ii) Granitic Gneiss – Sanganapalli area

Composite samples of the Granitic Gneiss subjected to XRD analysis the mineral composition are as follows:

Compound Name	Remarks
Quartz	Major
Albeit	Small amounts
Muscovite	Small amounts
Clinochlore	Traces
Orthoclase	Traces likely

Report: PPOD, GSI, Bangalore

5.1 Field Photographs of Study Area

Fig. 9 Iron oxide at contacts quartz reef

Fig. 10 Smoky quartz with wall rock alteration

5.0 Conclusion

Multi spectral remote sensing (LANDSAT+ and ASTER) image enhancement and interpretation proved to be useful tool in identification, detection, and in delineation of lithological rock units, hydrothermal alterations, and geologic structures associated with auriferous sulphide deposits in the southern extension of Kolar Schist belt[4]. This Technique is considered as one of the important tools especially when there is a deep forest cover and inaccessible terrain conditions for mapping. In the above study the land sat images indicate the influence of Structural controls in gold mineralization. The morphometric analysis (drainage analysis) has also shown anomalies caused due to lineaments which are considered a place for harboring gold mineralization.

6.1 Recommendations

The northern part of the land sat image of the study area that is from Chigargunta is of great importance as just 30 km north from here lie a major gold deposit (at KGF) mined for over a century realizing about 800 tons of gold. Though extensive search on the southern extension of the schist belt were conducted on the field, yet there seems to be a scope to find signatures of gold deposit of importance by using land sat images of high resolutions as this part of the schist belt consist number of lineaments associated with structural features which are considered as the channels for gold mineralization through hydrothermal process.

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