

Mapping of Ultramafics and Associated Lithological Units Using Satellite Data

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Abstract

Remote Sensing Technique has opened a new era in mapping lithology. The Landsat Thematic Mapper™ data are extremely useful. The maps prepared from the conventional ground surveys are based on the field observations made along the traverse lines at regular intervals. While plotting such point information collected along the traverse line on the topographic base and ultimately preparing final maps by extrapolating the details, certain errors are unavoidable and lead to inaccuracies in maps. Since the development of remote sensing technology, the mapping procedure have undergone continuous change. Now remote sensing techniques plays an important role in mapping programmes.

Mapping ultramafic are of great economic value. The full encoded scene had been studied and Digital Image analysis had been done on the subset of the scene. TM band ratios have been utilised to form the final F.C.C. The results had demonstrated that the appropriate band ratio combination of TM bands to form the false colour composite (FCC), can significantly improve lithological discrimination.

Introduction

Mapping of lithology and alteration zones in inaccessible mountain and forest terrain has always posed a challenge. There always existed disputes on the accuracy of lithological boundaries and structural details in these maps. Vast area to be surveyed and its inaccessibility, forbids physical investigation of every outcrop. At this juncture, the potential of remote sensing is appreciable. The greatest advantage of satellite remote sensing is the synoptic view it provides, which gives a regional and integrated perspective of and interrelations between various land features. The availability of multispectral and high resolution data and the advanced capabilities of digital image processing techniques in generating enhanced and interpretable image have further enlarged the potential of remote sensing in delineating the lithological contacts and geological structure in great details and with better accuracy.

In the regions where bed rock is exposed multispectral remote sensing is useful for mapping lithology and alteration zones. Subsequent Studies, in South-West USA and elsewhere (Prost 1980, Rowan and Khle 1982, Podwyssocki et al 1983, Abrams, 1984) have confirmed that areas of hydrothermal alterations may be distinguishable

using the ratio of TM band 5 and 7. Also it is evident that the spectral characteristics of TM bands are suitable for mapping ultramafic and associated lithology.

Study Area

The Singhbhum and Chhotanagpur regions represent the part of Proterozoic-Eoproterozoic ultramafic complex, (Jain, R.S and Nautyal). Distinctive iron oxide and clay mineral alterations associated with these rocks are exposed. These have distinctive surface expressions, even though some areas are under extensive forest and soil covers.

The study attempts to identify and map ultramafic and associated lithology. The Seka and its adjacent areas are geologically a volcanic area, situated in the South East of Ranchi. The Geological processes produced large areas of hydrothermal alterations, characterised by quartz veins and amphibolites.

The study attempts to use Landsat TM data to identify map ultramafic and associated lithology.

Tectonic Setting

The transition from an essentially mantle dominated volcano-tectonic region in the Archaean to a dominant ensialic sedimentary environment place in parts of the globe in the Proterozoic. Economically important deposits in the Proterozoic fold belt of the Singhbhum Group and Chhotanagpur Gneisses are expected to be confined within the structurally favourable locations. Tamar-Porapahar Shear zone might have acted as the first-order structure, allowing the deposit occurrence.

Geology

The Tamar-Porapahar shear zone is situated within Singhbhum Group of rocks. The area constitutes quartz-mica schist, cherty quartzite and chlorite schist which are intruded by quartz veins and amphibolites. The Geological milieu is associated with sulphide-facies banded iron formations, which is subjected to high grade metamorphism and intense deformations.

Digital Image Analysis

As image processing is highly scene dependent the methodology was experimented in the study area. Landsat TM images were used to map alteration zones and associated lithology in the ultramafics complex. The Landsat TM, IRS 1C images were used to help understand their lithological and structural controls.

Land sat TM Images

We processed Land sat TM data to generate three colour composites for the Seka alteration zones.

Normal colour images using band 7 as red, 5 as green and 4 as blue. (Fig1a).

TM image 7,5,4 as RGB. (Fig1b).

TM ratio image using band ratios 5/7 as red, 4/5 as green, and 3/1 as blue. (Fig2).

Landsat TM band ratios 5/7 and 3/1 are used because clay and iron minerals have reflectance and absorption features in these bands. Landsat TM band ratios 4/5 is used because it emphasizes silicate minerals compared to FeO-rich minerals. (Abrams et al 1983).

The 7,5,4 and 7,4,2 Landsat TM/ IRS 1C images provide a synoptic overview of the study area that is useful for mapping regional morphological features such as rivers, bedrock outcrops and soils. Moreover these images are useful in identifying linear structure faults and fractures.

The image (Fig2) is used to discriminate different rock types in the study area. This image is useful in identifying alteration zones. These alteration zones are labelled 1,2,3,4,5 appear red, suggesting the domination of clay minerals.

Result and Conclusions

Landsat TM data have been used to map the lithology associated with banded iron formations because of their characteristic spectral properties. Clay minerals such as Sericite have reflectance maxima within Landsat TM band 5 (1.55-1.75 micrometer) and reflectance minima within Landsat TM band 7 (2.08 to 2.35 micrometer). (Hunt and Ashley, 1979). Iron minerals such as limonite have reflectance maximum within the TM band 3 (0.63 to 0.69 micrometer) and reflectance minima within the Landsat TM band 1 (0.45-0.52) (Hunt et al 1971). So this TM ratio image reveals Ultramafic and its associated lithology in the Tamar- Porapahar shear zone.

This study proves that ultramafic lithology associated with sulphide-facies banded iron formations can be mapped effectively.

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