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MAPPING OF WOLFRAMITE REGION IN THE SIROHI DISTRICT (RAJASTHAN) IN INDIA FROM DIFFERENT DIGITALLY ENHANCED DATA PRODUCTS OF LANDSAT

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ABSTRACT

An attempt is made to map the different natural resources including the wolframite region and the landuse features (approx. 1000 sqkms) of the Sirohi district (Rajasthan, India) with Landsat data and digital enhancement techniques. The different digitally processed data products have been analysed for their information content and evaluated devising a weightage function with features identified. Band-5 data showed the granite boundary, promising zone for the wolframite occurrence.

I INTRODUCTION

Mineral exploration by the use of remote sensing techniques alone is a very difficult exercise but there are instances where Landsat data has significantly contributed in targetting mineral areas. Smith et al (1978), Farrokh (1979), Weerapan Janatarnipa et al (1982), Bhan and Hegde (1983), Rakshit and Swaminathan (1983), Swaminathan et al (1983) and Srinivasan et al (1983) have successfully used digitally processed landsat imagery in targetting some of the areas of sedimentary and hydrothermal ore deposits. It needs to verify the practical use of the Landsat imagery in the prospecting of mineral deposits of even smaller size.

The Sirohi district in the Rajasthan State of India has been of wide geological interest because of the discovery of a big Wolframite (Tungsten) deposit. The mineralised area covers only a few square kilometers. The total prospect area is about 50 sqkms. The area selected for the study covers the region of wolframite occurrence. It falls in the semiarid region of the country and is covered as a portion in the Landsat scene 160-043. Only a part of the total study area covering tungsten prospect zone has been selected for the different geological correlations as a case study (Fig.1). A single date : March 4, 1975 computer processed landsat imagery products have been used. The study is aimed to see the usefulness of the machine processed data in mineral exploration and in the mapping of other natural resources.

II METHODOLOGY

Using techniques of visual interpretation the different data products (Table-1) were interpreted on 1:250,000 scale. Relative merits and the mapping capabilities of individual data products in relation to natural resources mapping were evaluated. A parameter 'Product Weightage Function (PWF)' was devised for the relative assessment of the different data products. Thematic maps using selected data products were prepared and correlated with the geological, topographic and the natural resources maps available from conventional sources. The doubtful featurds during the photo-interpretation were field checked wherever felt necessary for their confirmed interpretation before preparation of final interpreted maps (Fig.1(a) & (b)).

III USEFULNESS OF DIFFERENT DATA PRODUCTS

To evaluate the relative merits of the data products in mapping of natural resources a parameter named as 'Product Weightage Function (PWF)' was defined as PWF = $\Sigma PGP/N$; where, PGP is the 'Product Grade Point' or the grade point

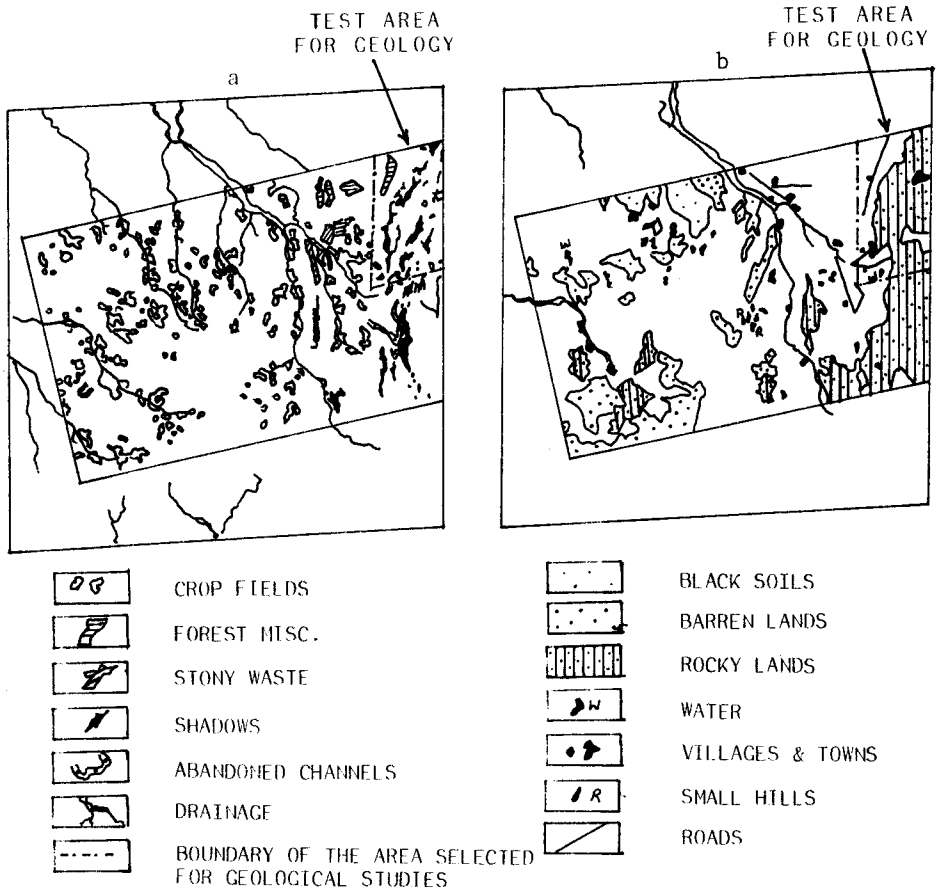

FIG.1 a & b : THEMATIC LANDUSE MAPS OF THE SIROHI DISTRICT PREPARED FROM LINEAR STRETCHED FALSE COLOUR COMPOSITE.

obtained by a product and N is the number of broad landuse features known to be existing in the study area, listed from various sources. The PGP was defined as ΣFGP, the sum of all the grade points obtained by the individual features or the 'Feature Grade Points (FGP)' on a data product. The FGP was obtained by grading the total features on each of the data products based on its clarity of appearance on a relative scale of zero to six given below :

Grade		Grade	
0	Not clear	4	Fairly clear
1	Difficult to trace	5	Clear
2	Confused traceable roughly	6	Very clear
3	Faint traceable at few places		

It has been observed that products with PWF 4.0 are good for Landuse or general purpose natural resources mapping. A FGP of five was found to be very good for the mapping of a feature on a product, though features with FGP four are also mappable. Features with FGP three are not mappable clearly. The number of features with FGP 4 and above and FGP 5 and above are also good indication of product merit. It is felt that a product with around 75% of feature detectibility with FGP of 5 will be really good for the landuse mapping, in the absence the FGP of four may be tired. The preference goes to the products with maximum PWF, FGP and percentage detectibility of feature with FGP 5 and above. The suggestion on the data products is to select minimum data

products and suitable ones to minimise the cost of the analysis. A table showing physical data merit evaluation listing features with FGP 5 and above against each product has been prepared to highlight the mapping capability of each of the data product with reference to individual Landuse features (Table-1).

The parameter PWF is useful in highlighting relative merits of the products. It also highlights the gross effect of a particular type of image processing over raw imagery data. The value of the PWF may rank from zero to six. Higher the value of PWF more is the average clarity of appearence of features in a product. The PWF has helped in the selection of a product for the general purpose natural resources mapping. The physical evaluation table (Table-1) is very useful in the selection of data products for the mapping of selected as well as over all natural resources.

IV RESULTS AND DISCUSSION

A. GEOLOGY OF THE TEST AREA AND LANDSAT ENHANCED IMAGERY

In the test region the tungsten mineralisation occurs in the metasedimentary rocks of the "Delhi supergroup". It is genetically associated with a leucogranite known as Balda granite. Balda granite is exposed on the ground. The wolfranite mineralisation occurs in quartz veins and pegmatites that occur near the contacts of granite with quartz mica schist and also within the leucogranite itself. The geological map of the study area is shown in Fig.2a. Wall Rock Alteration (WRA) of schists and granites at the contact of quartz veins and pegmatites is a common phenomenon. It is marked by dark grey colourization and hardening of schists mainly due to tourmalisation. Northeast - Southwest trending axial plain cleavage is most important planner structure present in the area followed by Northwest - Southeast trending fracture cleavage.

Out of all the data products analysed band-5 raw imagery was found most suitable for the geological correlations. A total of fourteen rock groups were identified based on tone, texture and shadow effects (Fig.2b). The results of correlation of imagery with the geologic and topographic map of the area are given in Fig-2b.

Only a weak correlation could be established between rock groups mapped on

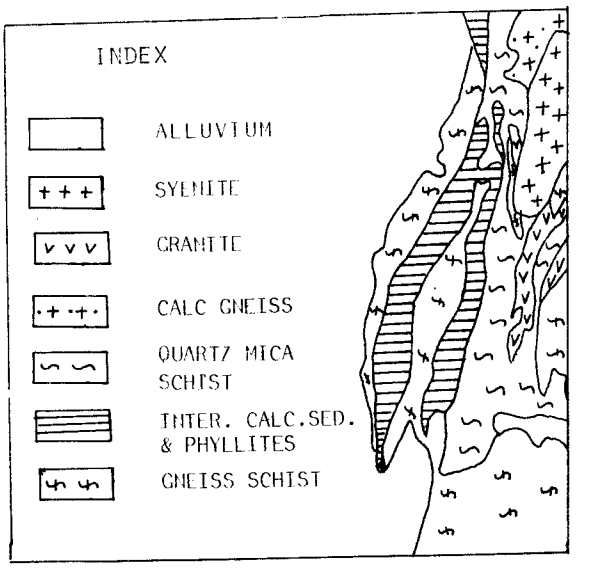

FIG.2a : GEOLOGICAL MAP OF THE WOLFRAMITE TEST AREA, WOLFRAMITE OCCURS ALONG THE CONTACT OF GRANITE WITH QUARTZ MICA SCHIST AND WITHIN THE GRANITE ITSELF.

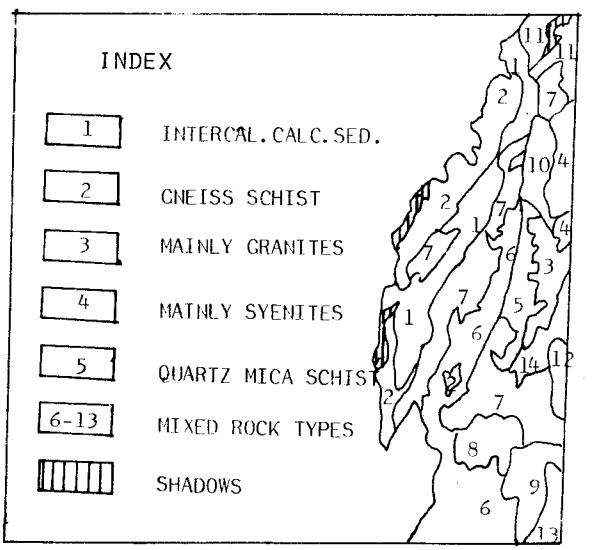

FIG.2b : ROCK GROUPS IDENTIFIED ON B/W 1:250,000 BAND-5 RAW DATA IMAGERY, A TOTAL OF 14 ROCK GROUPS WERE IDENTIFIED OUT OF WHICH ONLY FIVE CORRELATE WITH THE GEOLOGICAL MAP OF THE TEST AREA.

the imagery and the actuals. Most of the rocks present in the field do not show any characteristic tone or texture or the topography. Portions of rocks could be mapped where they form prominant topography and texture. Quartz veins and pegmatites carrying wolframite crystals could not be mapped due to resolution limits of the Landsat data. The thematic mapper data is not yet experienced within India and would show improvements. Leucogranites and its contact with the quartz mica schist could be mapped perhaps due to wall rock alteration all along granitic contacts. The major structural trends could also be mapped and they conform well with the conventional details. The rocks in the field were found physically separable but could not be mapped on imagery perhaps due to thick uniform growth of thorny desert land scrubs and trees with small leaves and absence of green biomass. Digital processing of the Landsat data did always not produce the better results, some of the feature had got enhanced while some others got masked.

B. MAPPING OF NATURAL RESOURCES AND LANDUSE FEATURES

Various data products found suitable for the mapping of different natural resources features are shown in Table-1. Analysis of the data products show that the FCCs are the most suitable products for the mapping of natural resources. They are the products with highest PWF. Among B/W data sets raw data band-5 imagery was found most superior. It may serve as a possible alternate for the landuse mapping in combination with raw data band-7 imagery, in the absence of FCC.

Forests in the Sirohi are of thorny Dry-land scrubs and trees with very small brown leaves. Their signature gets usually mixed with rocks and soils. The miscellaneous forest zones in the reserved forests could clearly be mapped on almost all the data products. Only a few of them are shown in the district forest map. Ratio of band-7 and 4 was found best for the crop fields and green biomass mapping. The irrigated lands could not be mapped due to their small size but they are clearly seen on Linear stretched product of band-7. Soils show remarkable signature differences. Fallow lands do not show characteristics signature since they occupy different types of soils. They are clearly mappable on sandy soils. Multi-season imagery will help in clear demarcation of fallow-lands. In the Sirohi metal roads are very few and narrow. Roads with different landuse on the two sides of it and those with large vacant lands on both the sides of it could only be mapped. Only large villages with large number of masonry houses with a population of 1000 or more could be mapped. Clusters of crop fields in the vast open lands of Sirohi indicate presence of villages in the neighbourhood.

Due to difficulties involved in getting the products of the digital analysis only a limited set of data products could be used. The results of the data product merit evaluation are not absolute. To arrive at the absolute results many more enhanced data products are to be included in the analysis. The analysis is to be extended to widely separated test areas of differing climate, landuse, geology and morphology.

V CONCLUSIONS

1. The PWF and physical data product merit evaluation table have shown that (i) FCC (Raw and Linear Stretched) are most suitable for the natural resources and landuse mapping; (ii) Linear stretching of imagery data is generally very useful for enhancement of features; (iii) The ratio of band-7 and 4 is only useful in the mapping of green biomass.

2. Band-5 raw data imagery was found most suitable for the rock type mapping in the test area. The boundary of the leucogranite the potential zone for the wolframite mineralisation and its contact with the quartz mica schist was mapped. The topography of the area conformed well with the actual on the satellite imagery.

3. The processed landsat imagery was found useful in the mapping of landuse features more than in geology and mineral resources.

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TABLE-1 : USEFULNESS OF DATA PRODUCTS : DATA PRODUCTS & FEATURES WITH GRADE POINT 5 & ABOVE ARE SHOWN.

	WATER			AGRICULTURE							ROCK					URBAN		OTHERS	DATA PRODUCT EVALUATION		
FEATURES / DATA PRODUCTS	Drainage	Water	Abandoned channels	Crops	Forests	Irrigated fields	Fallow lands	Open scrubs	Barren lands	Black soils	Stony waste	Rock exposures	Rock types	Topography	Rock structures	Urban lands	Roads	Shadows	No. of features mapped	% of total No. of features	PWF (rounded)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Raw data Band-4																			0	0	2.0
5	✓			✓						✓			✓		✓		✓	✓	7	39	4.5
6											✓							✓	2	11	2.5
7		✓												✓				✓	3	17	2.5
Linear Stretch Band-4	✓																		1	5	2.5
5	✓								✓	✓					✓				4	22	3.5
6									✓				✓				✓		3	17	3.5
7						✓			✓					✓	✓				4	22	3.5
FCC: Raw data	✓	✓	✓	✓			✓			✓	✓			✓	✓	✓	✓	✓	12	67	5.0
Linear Stret.	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	14	78	5.5
Ratio Band 7 & 4				✓															1	5	1.0
Band 5 & 6																			0	0	0.5
High pass enhancement Band-5	✓																	✓	2	11	3.0
6											✓							✓	2	11	2.5
Histogram Equalisation Band-5			✓																1	5	1.0
7																			0	0	1.5