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RESUMO - NOTAS / ABSTRACT - NOTES

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OBSERVAÇÕES/REMARKS

Paper accepted for presentation in the IGARSS'89, Vancouver, Canada, July 13, 1989. Paper developed in the Canada Centre for Remote Sensing supported by CNPq/INPE/DOCEGEO. [1] INPE=Instituto de Pesquisas Espaciais; [2] CCRS (Canada Centre for Remote Sensing); [3] INTERA TECHNOLOGIES LTDA.

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ABSTRACT

A Background Geobotany approach has been applied for geologic exploration in the Archean metavolcanic Pojuca Belt, Carajás Province. The test site is characterized by rugged topography; thick latosol profiles and almost absence of bedrock outcrops. The vegetation is typical of tropical rainforest. The analysis focussed on community level and has been tested through digital image processing of orbital RS (TM-LANDSAT) and DTM data. The preliminary results of the investigation have shown that 11 RS biophysical classes were detected; the majority with spatial correlations with previous geological units. In addition, elevation and slope have presented an important role in the characterization of the geobotanical background patterns.

Key words:
GEOBOTANY; TM-LANDSAT; DTM; AMAZON REGION.

1. INTRODUCTION

Satellite-based remote sensing has been used successfully in tropical semiarid environments for lithological discrimination (Paradella et al, 1987). Results in tropical rainforest regions are scarce however, relying on spatial attribute analysis or having site specific conditions where iron laterites cause changes in biomass which result in spectral contrasts (Paradella, 1986). At more temperate latitudes, a Background Geobotanical (BG) approach was developed for extracting geologic information in vegetated terrains (Bruce & Singhroy, 1984). It is based on the hypothesis that the nature and distributions of plant communities occur as a result of environmental conditions and therefore, variations in distribution from the established norm of an area may be indicative of changes in the geology (Hornsby et al, 1988).

In Brazil, recent discoveries of Cu-Pb-Zn, Ni, Cr, W and Sn have been made in the Carajás Province of the Amazon craton, in addition to the known Fe, Al, and Mn deposits in the area. The province is characterized by heterogenous topography, deep chemical weathering producing thick latosol and little outcrops. Vegetation cover consists of a complex and multi-level canopy composed of numerous species.

This paper reports on the first results of a research program which has been established to

develop remote sensing applications in this kind of environment. The following questions are to be answered: 1) to what extent is it possible to extract geological information from satellite-based remote sensing data, given the commonly held view that tropical rainforest vegetation is so complex as to appear homogeneous and featureless? 2) what are the controls on spectral patterns and of what comparative importance are geological controls among these? and 3) what is the optimum approach to extract geologic information from the most commonly and economically available data set (remote sensing and topography) in the planning and implementation of exploration activities?

1.1 - STUDY AREA DESCRIPTION

A 230 square kilometre test area was selected, centered on the Pojuca Cu-Zn deposit located in the Carajás mountain range. The oldest of these Archean rocks are a sequence of medium to high grade metamorphic rocks known as the Xingu Complex. This complex occurs in the northeast portion of the study area and has characteristic low relief. Discordant with this basement is a volcano-sedimentary sequence characterized by west-northwest trending parallel ridges. This is the Igarapé Pojuca Group consisting mainly of greenschist to amphibolite phases rocks with several Cu and Cu-Zn deposits. Above the Igarapé Pojuca Group are widespread low-grade clastic sediments of early Proterozoic age called the Rio Fresco Group, and located in the southwest of the study area. It is characterized topographically by a plateau with small intersecting hills. Tertiary laterite and Quaternary alluviums complete the geological sequence (Figure 1).

The vegetation cover is typical for tropical rainforest. Three ecological regions can be recognized: 1) Montana tropical forest associated with the highest altitudes (Rio Fresco Group); 2) Sub-Montana tropical forest with woodland/broadleaved forest (Pojuca Group and part of Xingu Complex and 3) Mixed woodland forest (Xingu Complex) (Veloso et al, 1974). A total of 552 specimens with 119 species; 89 genera and 39 families were identified from one hectare transect in this area (Silva et al, 1987).

2. METHODOLOGY

Figures 2 and 3 illustrate the methodological approach. Landsat Thematic Mapper (TM) data from May 31, 1984 and a digital elevation model (DEM) were

used in the investigation. The 512 x 512 pixel area was geometrically corrected to a UTM projection base. Elevation, slope, and aspect images were derived from the elevation model. This data set was analysed through a combination of enhancements (frequency equalization, band-ratios, principal component transformation) and unsupervised (clustering) technique. A feature selection routine called the optimum index factor (OIF) was used to aid in the selection of the best colour composite image (Chavez et al, 1982). Eight biophysical maps were interpreted and integrated into a final integration map with 11 biophysical classes. This map was compared with supporting geological information to identify geobotanical relationships.

3. RESULTS

The final integration map is shown in Figure 4. Figure 5 is the best enhancement product obtained with TM data. This was a PC transformation of the input bands 3/2, 4/1, 4/3, 3/5, 7/4, 5/4, 5-4/5+4, 5-7/5+7, 4-3/4+3. From Figure 4 the following class associations can be made: class A = laterite; B = Rio Fresco Group; C = Rio Fresco Group; D = Igarapé Pojuca Group; F = Igarapé Pojuca Group; F = Granitic areas; G = Xingu Complex, H = Quaternary sediments. There is insufficient information about the substratum to identify geologic associations with classes I and J. In the colour composite different tonal patterns are detected, of particular interest, one correlated with the Pojuca trend (area A).

Figure 6 is the result of clustering the elevation and slope data. More than half of the biophysical classes have spatial correlations with the thematic class produced from the elevation and slope data. The associations are as follows: class A with 2; B with 3; D partially with 6 and 5; G with 7; H with 8, 9 and 10; I partially with 9.

4. CONCLUSIONS

The geologic characteristics of the terrain play an important role in controlling the spatial distribution of the biophysical remote sensing classes. In addition, geology also controls in part, the main geomorphometric terrain descriptors of elevation and slope. The role of aspect, which appears much more complex, was not evaluated in this phase of the research. The detection of these geobotanical patterns will help to improve the delineation of main geological units elsewhere in the Carajás Province beyond the area of detailed mapping. This is particularly important in the case of the Pojuca Group which hosts the Cu-Zn mineralizations. Future development of this methodology is planned in order to produce an operational tool for geological exploration in tropical environments using thematic mapper and topographic data.

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Figure 1. Geology of the Pojuca area.

Figure 4. Final integration map.

Figure 2. Phases of the RS component.

Figure 5. Best enhancement product.

Figure 3. Phases of the DTM component.

Figure 6. Unsupervised classification of elevation and slope.