Geotechnologies for Geological Mapping at the State of Tocantins/Brazil

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Abstract. The study area is surrounding by a enourmos number of gold pannings in the State of Tocantins/Brazil. From this proposal, we present the analysis of the geological mapping with the use of geotechnologies to better know the area. A study and characterization of the area was made, to understand the correlation between the geological features and geophysics, and consequently, the possibility of gold and iron ore occurrence. In addition, it was possible to obtain information on the area using Also Palsar images to better understand the geomorphology and to aid during the field campaign for the geological mapping. The importance of an analysis of the elements that belong in the area of study and how they behave, in order to better know and understand the area and the correlation between field campaign and geotechnologies.

Keywords: Geotechnologies · Geophysics · Geological mapping

1 Introduction

The use of geotechnologies in mining is increasingly developed and with increasingly applications in the process of obtaining mineral occurrences. In turn, the use of geophysical data that calibrate the data obtained in field mapping enables interesting interpretations. Therefore, in a regional character study, in the region of the municipality of Natividade/TO, Brazil, it is possible to observe that the gamma spectrometry data are correlated with the data of traditional geological mapping. From the point of using the geophysical method for the production of local geological materials without the need to perform a systematic mapping, that is, enabling a mapping of targets. From this, it is possible to identify the main contacts that may have mineral occurrences and, with

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this, the financial cost of a field work is extremely low. The local geomorphology, which is directly linked to geological features, are present as conditioning factors in the soil formation, consequently inthe distribution of soils and associated ores.

The work was subdivided into two stages. In the first stage, the field was defined and in the second stage corresponds to the obtaining of aerogeophysical data of gamma spectrometry, extracted from the aerogeophysical survey carried out by the Brazilian Geological Service. Then, these data underwent a processing through geoprocessing techniques aimed at the elaboration of spatialization maps of them.

The aerogeophysical data were interpolated using the minimum curvature method for gamma spectrometry data (K, eU and eTh). Finally, a digital terrain model (DEM) was elaborated, through data extracted from Alos Palsar images,to obtain relief features of interest to the work.

2 Characteristics of the Study Area

The study area is located in the northern region of Brazil, in a place with the presence of depression and local mountains (Fig. 1 & 2). The Upper Tocantins Depression is present in the northern part of the area with soft relief. In turn, the Serra de Natividade, the main geomorphological structure of the area, covers much of it, with high variation of altimetric dimension and slope of the terrain. This geomorphological feature, in its eastern part, is the main area of studies in the area for basic mineral research. This is said, it is possible to observe by the slope of the terrain, the possibility of sediments from the mountain range being driven, by gravity and other methods of detritic flows, to other areas of the area. Therefore, it is possible that the mineral occurrences are of alluvial and coluvionar origin.

The slope of the study area is possible to observe that there are two main saws in the area. One located to the north and the other across the western edge, this area of the eastern part is composed of a gold ore host rock that is leached into the study area by the drains due to the high gradient of the terrain.

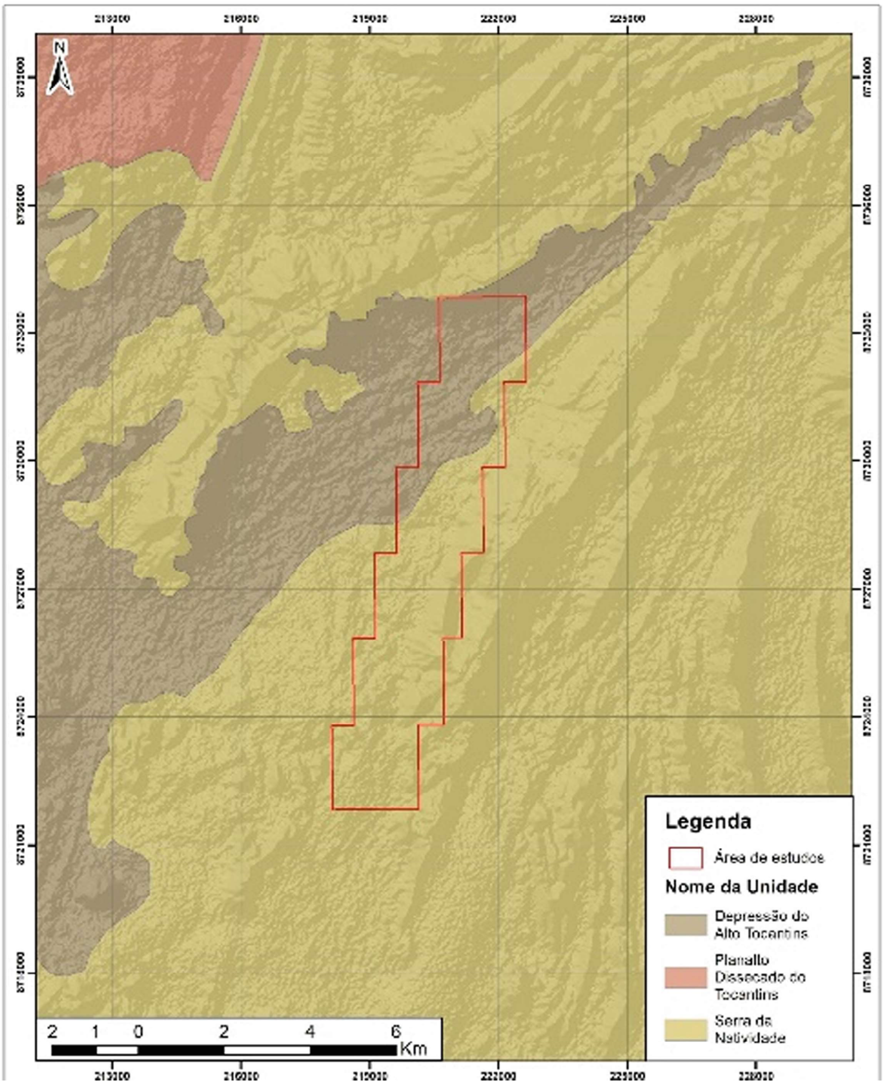

Fig. 1. Geomorphological map. Source: The authors

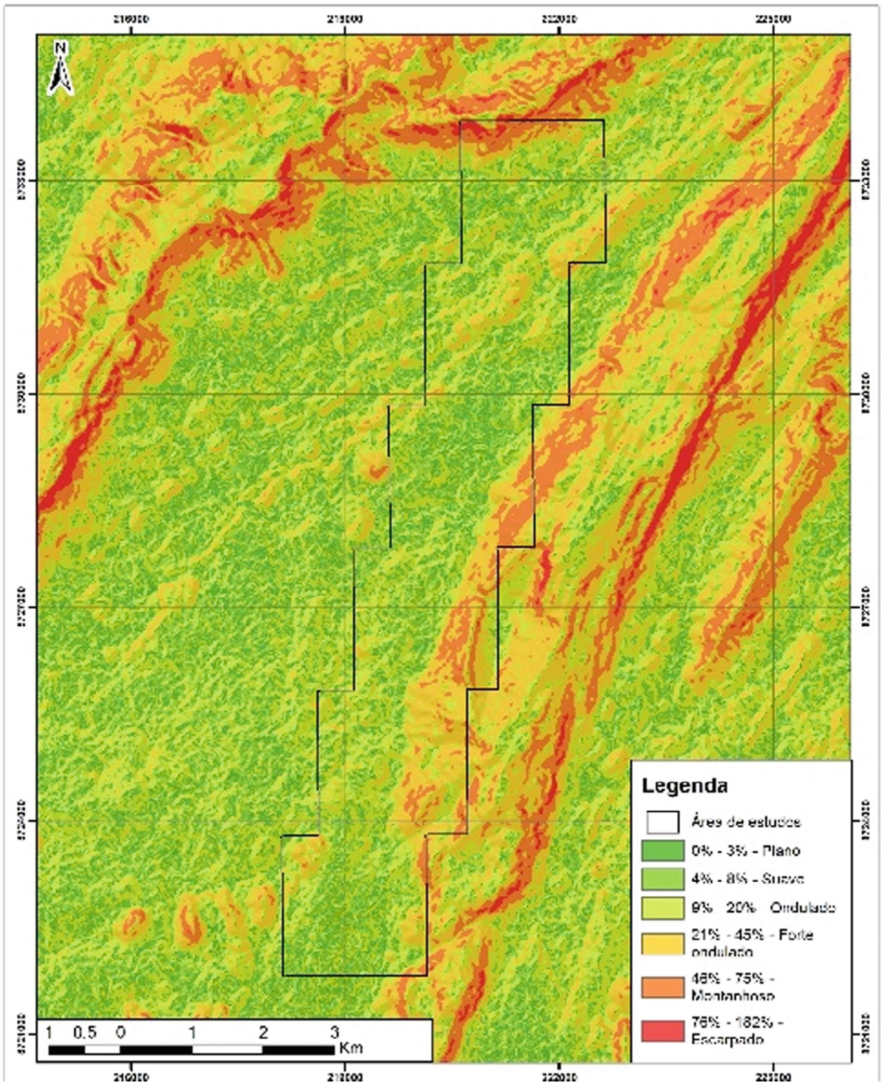

Fig. 2. Slope map. Source: The authors

3 Local Geology

The geological context of the study area is fully inserted within the rocks described in local geology as the Nativity Group. It is considered as the northern extension of the Araí Group (Dardenne, 1999) [1] and the latter, divided into the rift and post-rift phases, called Arraias and Trairas formations, respectively. The correlation with the Araí Group and consequently with the Serra da Mesa Group and Espinhaço Supergroup, inserts the Nativity Group in the processes of rifting of The Sterian Tafrogenesis between 1.8 and 1.6 Ga.

The rocks of the Nativity Group are in disagreement over the basement of granite-gnassic rocks (Almas-Cavalcante Complex and Aurumina Suite) and metavulcano-sedimentary (Riachão do Ouro and Água Suja) rocks and are covered in erosive disagreement by the Parnaíba and São Franciscan abasins.

This unit is distributed in two parts. The smaller eastern part that is not outcropin the area, located mainly north of the city of Almas, has NS structure with inflection to NNW. In images of remote sensors presents foldings clearly transposed by the extensive transcurrent shear zones.

The most expressive western portion, located in the Natividade-Pindorama region, constitutes nne steering range with inflection for NE according to regional structure and with average width of 22 km. It has bent and failed relief with regional slopes and anticline marked by the transcurrent shear zones.

In addition to the sand extension and thickness of the sedimentary package, the east and west sections show differences in relation to sedimentary facies, and in this report only the western outcrop in the area. The metamorphic degree of the sequence reached the green shale facies with formation of shales and quartzites.

From the studies carried out in regional geology, we observed that there are at least 3 geological units of the Nativity Group outcroppers within the studied area. These units were, in the field, inspected throughout the area with careful evaluations regarding their contacts, foliation, primary and secondary structures, degree of alteration, as well as sought evidence of iron ore and gold mineralization. Based on this field stage, it was possible, in addition to identifying reported geological units, subdividing them into domains and making some adjustments to their contacts in the remote sensing phase.

As a final result of this process, the 3 units of regional geology are presented here, with their nomenclature and description originally presented together with their divided domains, related to each of these units, totaling 7 local geological domains with specific characteristics (Fig. 3).

Being the domain located in the mountains to the east the most relevant, since it is place of mineralization of gold and iron.

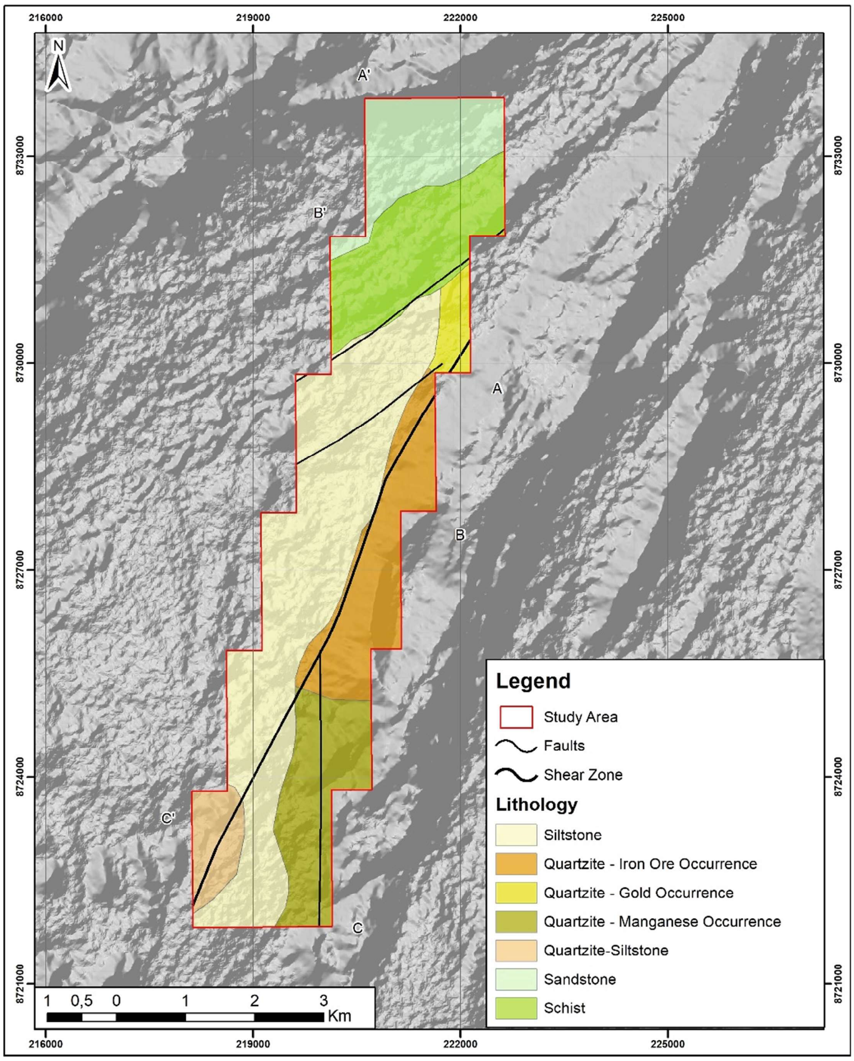

Fig. 3. Geological map. Source: The authors

The central lithology of the NNE/SSW mountain range, present in the study area, has brown soil with the presence of fine sand and drainages along the domain.

In the drains it was possible to locate quartzites, washed quartz pebbles and remnants of mining.

At some points at the foot of the mountain range, ferrous quartzites were observed, with blocks and pebbles of rock with visible presence of iron (Fig. 4 and 5), coming from the same mountain range and with research interest of the source area.

Fig. 4. Iron ore with 56% of Fe (iron). Source: The authors

The northern part of the lithology of the mountain range present in the study area has predominantly quartzite rock, with quartz granules and pebbles. It was possible to observe in drains the presence of washed quartz gravels, in addition to typical excavations of north-south direction mining. Such evidence is close to the eastern edge of the area and in some cases a few tens of meters outside the polygonal area of the study.

In some parts of the drainages located within the area in this domain it was possible to identify gold spots in concentrate, confirming some existence of gold ore that should be investigated further.

Fig. 5. Gold spots. Source: The authors

4 Geophysical Studies - Gamma Spectometry - Secondary Data

The gamma spectrometric method detects the natural emission of gamma rays (γ) from surface rocks. This method is widely used in geological mappings due to the different radioactive signatures emitted by the different types of rocks and their minerals (Dentith and Mudge, 2014) [2].

Gamma radiation emission occurs during the process of nuclear disintegration or radioactive decay of an unstable atom whose goal is to achieve a more stable energy state. When two atoms have the same number of protons and different number of neutrons they are called isotopes. Isotopes have the same chemical characteristics, but the differences between their physical properties generate stable or instable isotopes (IAEA, 2003) [3].

In gamma spectrometric surveys the main elements used as a source of gamma radiation are potassium (40K), uranium (238U and 235U) and thorium (232Th). During their decay, these radioisotopes emit high-intensity gamma radiation, which allows the detection of the same.

By geophysical studies, the flight line Dianópolis (Empresas Nucleares Brasileiras S.A - NUCLEBRÁS, 1975) [4], with flight spacing of 2,000 m and interpolated in 500 m, it is possible to observe, in the geological contacts peaks of the U/Th ratio according to Fig. 6.

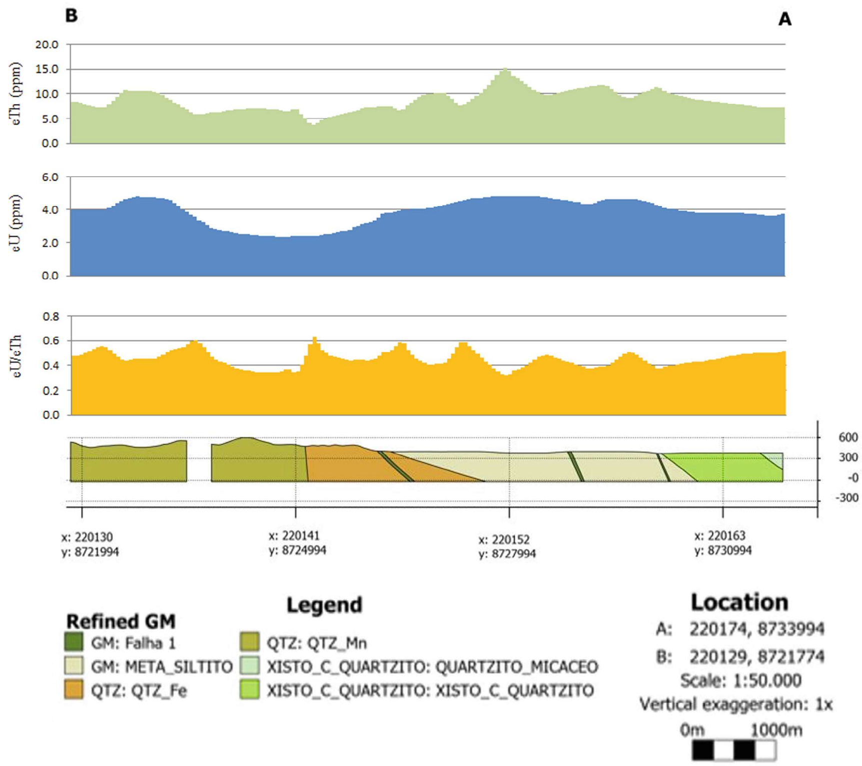

Fig. 6. The U/Tr relation with the geological contacts from the field campain. Source: The authors

This relationship demonstrates that the lithological contacts found in the area are correlated with geophysical data. In turn, the Thorium element is an excellent correlated of ultamafics rocks or even for the presence of environment with hydrothermalism. Therefore, it is possible to observe that there is a high concentration of thorium in the eastern edge and center-north part of the area, close to the occurrences of iron ore, thus validating data obtained in the field and laboratory. In turn, the accumulation of these radioelements caused by secondary variations may indicate the location of gold occurrences (Pires, 1995) [5]. Products that highlight uranium enrichment in the Northeast Region, with the corresponding values to the prospectors.

It is known that uranium anomalies present their genesis associated with shear zones and hydrothermal phenomena. In the mining region, the thorium has one of the lowest values. This high correlation between products derived from gamma spectrometric data and chemical analysis of field samples shows the potential of gamma spectrometry as a tool to indicate areas affected by hydrothermal action.

Finally, the geophysical data corroborate the various analyses performed in this paper.

5 Conclusion

The generation of the map of gamma spectrometric domains made it possible to evaluate the variation of the data obtained in field work. Within these geological units, there were variations in the contents of K, eU and eTh as a function of their correlation with geology.

Currently, with those techniques it is possible to characterize geological areas for mapping without the need of a long field campaign once it is possible to know here exactly to go from this geotechnology. The data already have a good spatial resolution, which means the possibility of studying the area by the use of digital material. Also, the Geophysical is a public data, from this, it let all the possibility to work with.

Finally, we note the demand for attention to the use of digital data to better understand de geological context and to aid to create a geological map close to reality.

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