Geophysical and Geological Interpretation Map of the Rio Jatapu Chart (NA.21-Y-C), southeast of Roraima State, Brazil.

Lila Costa Queiroz * (CPRM – Serviço Geológico do Brasil), Lucas B. Garcindo (CPRM – Serviço Geológico do Brasil), Tomas de M. Lisboa (CPRM – Serviço Geológico do Brasil), Vanessa Oliveira (CPRM – Serviço Geológico do Brasil), Marcelo E. de Almeida (CPRM – Serviço Geológico do Brasil), Nelson J. Reis (CPRM – Serviço Geológico do Brasil)

Abstract

This work consists of geological and airborne geophysical data integration that covers the Rio Jatapu Chart (NA.21-Y-C), located on the border region between the States of Roraima, Pará and Amazonas. The use of magnetic and gammaspectrometric data, integrated with SRTM images and geological field outcrops, revealed important information about the litho-structural units of the Southern portion of the Guyana Shield. The magnetic data provided a better definition of the pluton shapes and the results suggest that the granitoid domains (Moderna, Mapuera and Água Branca Suites) are formed by numerous small to medium-sized plutons with a low to moderate airborne magnetic response while the volcanic domain (Iricoumé Group) is characterized by moderate to high airborne magnetic response. The magnetic lineaments aided in the development of a regional structural framework with NE-SW and NW-SE lineaments related to polydeformated phases and E-W dextral shear zones as the latest stage of deformation. That lineaments showed a good correlation with field structures measurements. Airborne gamma-ray spectrometry data were useful in the mapping process in areas with less regolith cover.

Introduction

Geological provinces of the Amazon Craton are poorly studied for many reasons including the sparse population, lack of rock outcrops due to dense tropical forest coverage and difficulty to access Indian Reservations. The studied area is located in the central-south portion of Guyana Shield and its major part is covered by the *Trombetas-Mapuera* Indian Reservation. The present work includes processing and interpretation of the available airborne geophysical data from the Carajá-Jatapu (CPRM, 2007a) and Anauá (CPRM, 2007b) Projects. This study is part of the *Projeto de Integração Geofísica-Geológica do Norte da Amazônia* (North Amazonian Geophysical-Geologic Integration Project) that recently published 10 Interpretative Charts (1:250,000 scale), including the Rio Jatapu Chart (CPRM, 2015). The data analysis was done using GIS techniques, combining both geophysical and geological information. In this paper, we summarize these data and propose a new geological map based on the geophysical responses and field observations. The objective is contribute to the better understanding of the Guyana Shield south portion despite the lack of new geological data.

Geological Setting

The studied area is located in the central-southern portion of the Guyana Shield, on north Amazon Craton segment. In local context the area is in the Uatumã-Anauá Domain (Reis *et al.* 2006) (Figure 1), comprising essentially widespread felsic to intermediate Orosirian magmatism (2.03 -1.8 Ga) and supracrustals associated. Deformation occurs at greenschist to amphibolite facies conditions (Almeida & Macambira, 2007a), with NW-SE and NE-SW trends and subordinary E-W.

The basement rocks correspond to the 1,87 to 1.96 Ga Martins Pereira-Anauá metagranitic terrain (Almeida & Macambira, 2007a). Three successive magmatic events affected the Uatumã-Anauá domain, the Água Branca Suite, ~1,89 Ga I-type calc-alkaline plutonism (Almeida *et al.* 2008), the 1,88 Ga A-type volcano-plutonism represented by the Iricoumé Group and Mapuera Suite respectively (Ferron, 2006) and finally the suite Moderna felsic intra-plate magmatism with 1.81 Ga (Santos *et al.* 1997).

Statherian is marked by the Urupi Group intracontinental sedimentary cover, this sequence is cut by gabroic 1.78 Ga sills and dikes of Quarenta Ilhas formation (Veiga Jr. *et al*. 1979). Late Neoproterozoic basaltic flow represented by the Seringa Formation closes the main geological events on the area.

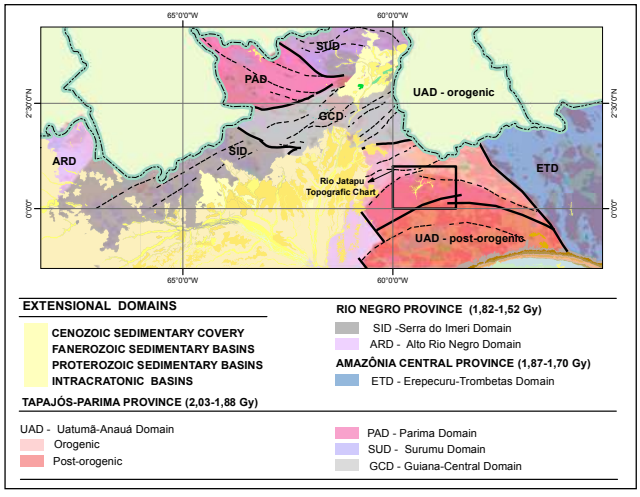

Figure 1: Geotectonic map of the Roraima State modified from Delgado et al. 2003.

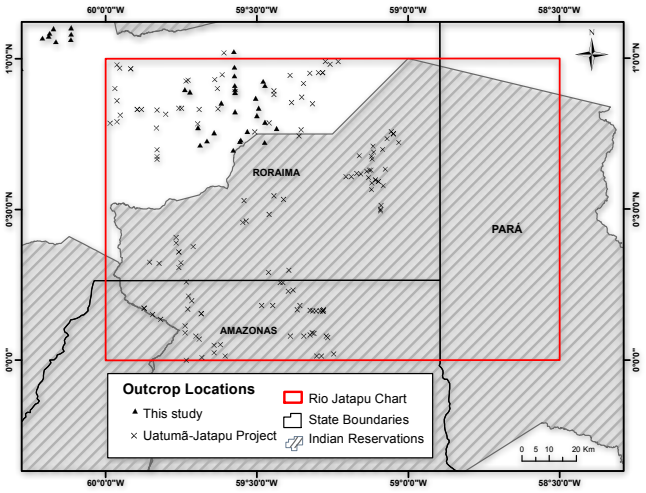

Figure 2: Outcrop and political boundaries location map.

Data

The geophysical data used in this work were the original magnetometry and gamma spectrometry aerial surveys from Caracá-Jatapu (CPRM, 2002a) and Anauá (CPRM, 2002b) Projects, performed by *LASA Prospecções S.A.* and contractors by CPRM. The airborne data were acquired using 500 m spaced flight lines (N-S direction) with orthogonal tie lines flown every 5.000 meters at 100 meters above the ground surface. We also worked with the gravimetric data from Sandwell (2014).

Cartographic data available for the area were the geological map (scale 1.2,500,000) from *Geologia, Tectônica e Recursos Minerais do Brasil* (Bizzi et al., 2003), Roraima Central map, scale 1:500,000 (CPRM, 1999) and the *Zoneamento Ecológico Econômico da Região Central do Estado de Roraima*, scale 1:100,000 (CPRM, 2002).

Geological database used for this work includes the petrographic rock descriptions and lithological data from the Uatumã-Jatapu Project (CPRM, 1984), Caracaraí Project (CPRM, 2000) and the rock types and structures mapped in field, acquired by the authors during this study. The spatial distribution of the outcrops data is shown in Figure 2.

The final map is result of an integration of all products derived from geophysical data, geological maps, rock types, structures mapped in field and digital elevation models.

Methods

This section provides an overview of the airborne geophysical data processing on the Rio Jatapu Topographic Chart, referring to the different methodologies used in this work. The geophysical data were processed and visualized using the Oasis Montaj software, version 8.3 of GEOSOFT™, licensed for CPRM Geophysics Department.

The magnetic data was expressed as the anomalous magnetic field (AMF), after applied corrections of diurnal variation, the main geomagnetic field (IGRF) and leveling errors. The gamma spectrometric data were discriminated into energy channels with reference to the total energy (total count channel, which was expressed in cps), while the potassium channels were expressed in percentage. The uranium and thorium channels were expressed as micro-equivalents. The data was interpolated in a regular grid, using the appropriate algorithms to maintain data fidelity to the original sample locations. The more efficient interpolation method for the magnetic data was the bi-directional (implemented in Oasis Montaj as bi-grid) with square cell of 250 meters. For the gamma ray spectrometric data the more efficient interpolation method is the minimum bend, with the same size of square cell.

Linear transformations were used in magnetic data treatment, mainly dealing with the amplitude of the analytic signal (ASA), which are important products to locate the spatial distribution of magnetic sources and to determinate geometrical parameters, such as the geological and structural boundaries. The derivatives of the anomalous magnetic field, mainly the first vertical (Dz), helped to determine the spatial position of these sources and were also extremely useful to characterize structural features. The horizontal derivatives allowed the mapping of lateral limits of these sources. The total horizontal gradient (THG) integrated with the ASA have good correlation with the geological data and was used to define some lithological boundaries.

The integrated interpretation of the gamma ray spectrometric and magnetic images was performed in a GIS environment, using ArcGIS 10.2, like all maps prepared for this work. Figure 3 shows the products generated for the magnetic and gamma ray spectrometric data.

Structural Framework

The Paleoproterozoic Anauá tectonic-stratigraphic domain is bordered to the north by the Itã fault or shear zone, that separates it from the Central Guyana domain. To the west, it is limited by strong magnetometric and gravimetric N-S lineaments from the Imeri domain and the basement is covered by Fanerozoic sediments. This Domain is subdivided in: Martins Pereira-Anauá terrain, that comprises metavolcanossedimentary sequences (Uai-Uai Group) associated with a TTG complex (Anauá metamorphic complex) and the Igarapé Azul-Água terrain (Almeida & Macambira, 2007b), that comprises the homonymous intrusive suites, among others, and metavolcanossedimentary sequences (Iricoumé Group and Urupi Formation) .

We have defined three magnetic lineament groups for the studied area:

(1) NE-SW lineaments associated with high-dip tectonic foliations in the same direction, down-dip lineaments and some gently dip magmatic flow foliations;

(2) NW-SE lineaments related with high-dip angle tectonic foliations (NE or SW azimuth) and some gently dip magmatic flow foliations;

(3) E-W and ENE-WSW lineaments, high angle foliations predominantly to N with low angle dip directional lineations, related with the structural pattern interference made by the Itã shear zone. The Figure 4 shows this lineaments in the central portion of the studied area.

The Itã shear zone is a ductile-brittle anastomosed system (CPRM, 2000) with sigmoidal geometry, mega-scale S-C structures associated with E-W to ENE-WSW patterns, high angle foliations and sub horizontal plunging lineations, suggesting a dextral cinematic.

On the west border of the Anauá domain, the magnetometric structural lineaments pattern combined with the gravimetric interpretation (Sandwell, 2014) suggest an import N-S sigmoidal structure. This structure is similar with a sinistral shear zone, in a ortogonal association with the Itã fault.

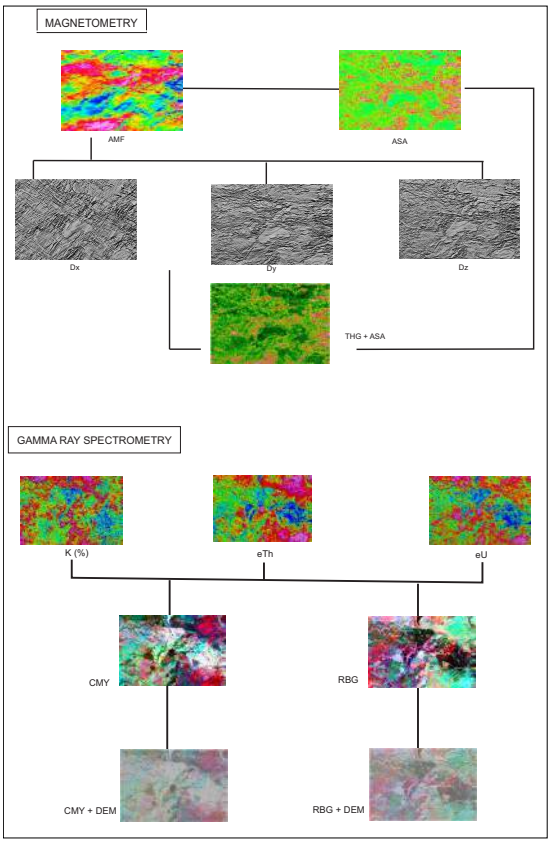

Figure 3: Flowcharts illustrating the steps of processing, analysis and interpretation of the magnetic and gamma ray spectrometric data.

Lithological Associations

In the following section we describe the lithological units portrayed by the Geophysical and Geological Interpretation Map (Fig. 5).

- *Aluvionar Deposits:* This unit occurs associated with the major rivers and displays a good response in SRTM and gamma ray ternary images (Fig. 4).
- *Lateritic Cover:* This unit is defined based on the Th high leves and SRTM topographic responses.
- *Seringa Formation:* It is characterised by an intense magnetic response and low levels of radiometric elements. The magnetic lineaments are NE-SW and NW-SE oriented. Locally this unit could be associated with high K levels.
- *Quarenta lhas:* This unit appears only on a small portion in the south of the area and was established by the geological information available.
- *Moderna Suite:* This unit was defined by the smooth magnetic texture, lack of significant magnetic lineaments and scarce geological field outcrops. Occurs in the central portion of the map as a medium sized intrusion (Fig. 4).
- *Mapuera Suite:* The granitoids of Mapuera Suit occur intruded in the Água Branca granitoids and are characterized by high eTh, eU and K levels and low to moderate magnetic responses intensity.
- *Iricoumé group :* This unit was defined based on the high intensity and variable NW-SE to NE-SW oriented magnetic fabric. The eTh, eU and K values are usually low (Fig. 4). Sometimes it is defined by a high potassium response on the ternary map.
- *Água Branca Suite:* This unit covers the major part of the studied area and is characterized by a low to moderate magnetic response and variable NW-SE to NE-SW oriented magnetic fabric. The eTh, eU and K values are usually high.
- *Urupi Formation:* This unit appears only on a small portion of the studied area and was individualized by geological data available in literature.

Discussion

The litho-structural map (Figure 5) was constructed using field observations integrated with airborne geophysical data and SRTM images. This integrated approach led to some significant contributions for the geological cartography of the area, despite the lack of new field data from the *Mapuera-Trombetas* Indian Reservation.

One of the major distinguishing parameters for lithostructural mapping is magnetic texture. The similar magnetic properties of some lithologies helped us to distinguish different textural patterns. The integration with

the geological data, allowed the association of this patterns with geological units.

The shape and magnetic texture of the granitoid domains have been studied and led to the observation that igneous domains consist of several generations of granitoid intrusions, that can be recognized by their magnetic fabrics. The Moderna suite represents the youngest generation of granites in the area and for this reason, we defined a boomerang shaped body in the center of the area as this lithology (Figure 4).

Spacial analysis of the K, eU and eTh concentrations highlights the mobility of potassium, especially in equatorial climates, such as the studied area. For this reason is difficult to define lithological limits based just on the gamma spectrometric data. In the gamma-ray spectrometry grids, detritic-lateritic covers display a bright green color, indicating the retention of Th by the Fe-rich weathering products (Martelet et al., 2006).

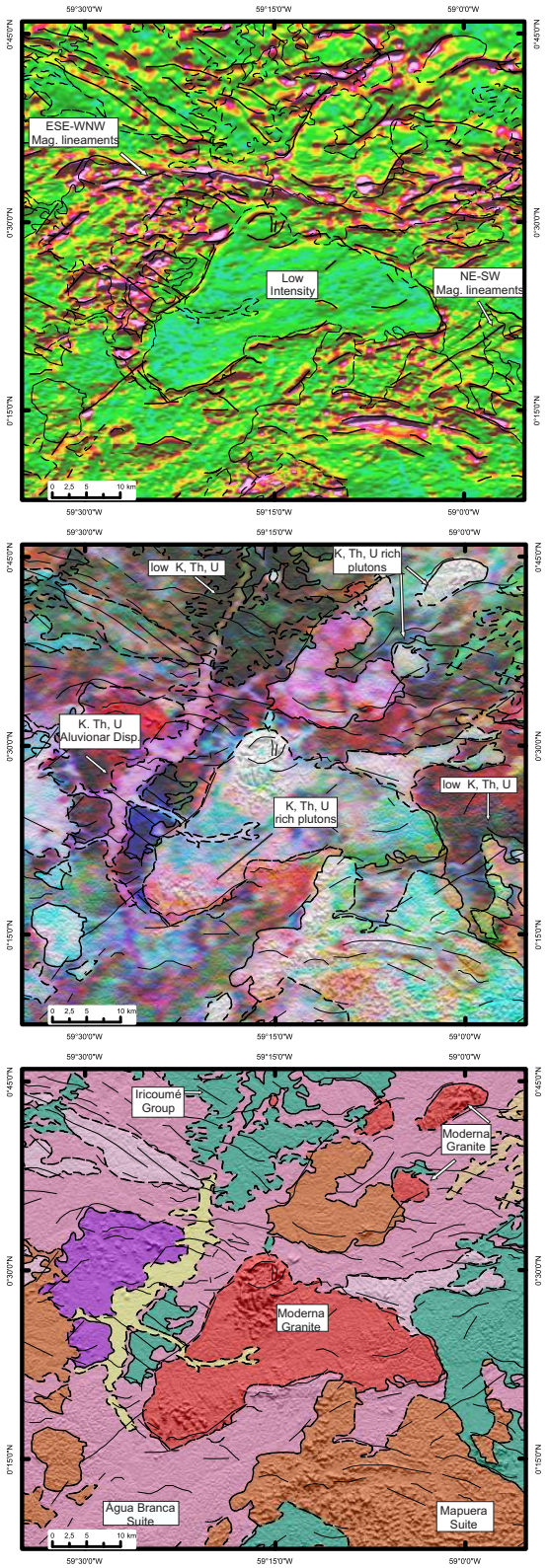

Figure 4: Detail in the central portion of the map shown in Fig. 6. Upper map: ASA overlay over first vertical derivative; Intermediate: ternary grid of the gammaspectrometric data; Lower map: geological interpretation (see Fig. 6 for legend). Abbreviations : Mag lineaments = Magnetic Lineaments and Aluvionar Disp. = Aluvionar Dispersion.

Conclusions

In this work we present a new geophysical and geological integration map of the southeastern Roraima at 1:250,000 scale (Fig. 5). The map integrates existing and new geological field data, airborne geophysical data and SRTM images in order to provide a litho-structural framework for the NA.21-Y-C Chart. Important conclusions were obtained:

1. The granitoid intrusions of the Água Branca, Mapuera and Moderna suites were individualized following magnetic and gamma spectrometric patterns combined with field data. This units exhibit low to moderate susceptibility values and the eTh, eU and K values are usually high.
2. The Moderna Granite, is characterized by a smooth magnetic texture and low intensity in the ASA map. A boomerang shaped body in the middle of the area was interpreted as this geological unit and corresponds to the more significant feature mapped (Fig. 4).
3. The Iricoumé group was defined by a moderate to high magnetic intensity and variable NW-SE to NE-SW oriented magnetic fabric. It appears at the central-west portion of the map in contact with the Água Branca granitoids.
4. Several E-W shear zones were identified using magnetic data, following the Itã Fault trend, especially at the central portion of the map, representing the youngest deformational event on the area.

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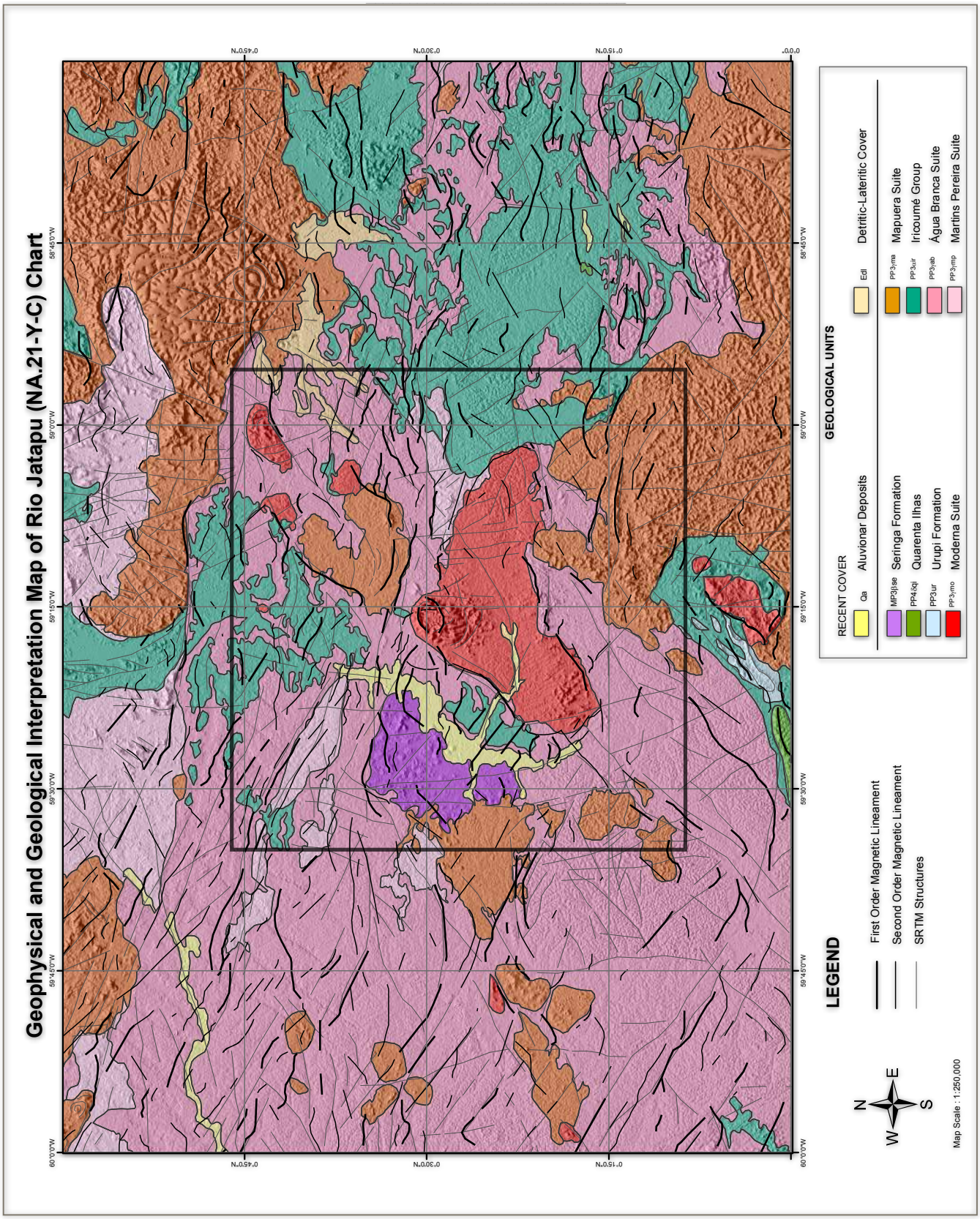

Figure 6: Geophysical and Geological Interpretation map of the Rio Jatapu (NA.21-Y-C) Chart. The rectangle in he middle of the area was detailed in Figure 5.