GEOPHYSICAL RESPONSE OF HYDROTHERMAL ROCKS ASSOCIATED WITH COPPER-GOLD MINERALIZATION IN THE NEOPROTEROZOIC MARA ROSA MAGMATIC ARC, CENTRAL BRAZIL

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ABSTRACT

Gold and gold-copper deposits of the Mara Rosa Magmatic Arc, Central Brazil, occur in four main associations: Au-Ag-Ba; Cu-Au; Au only and Au-Cu-Bi. Mining companies have been investigating the region since the beginning of the 1970's. Between 1970 and the present, investment in exploration was discontinued several times. New regional airborne geophysics have been undertaken to assist in geological mapping and indicates the presence of many distinct geotectonic environments, such as oceanic arc, back arc basin, and accreted terrains. These environments are favourable to gold and copper-gold deposit formation because of their depth, magmatic association and structural framework. The airborne geophysical results are compared with the distribution of known hydrothermal host rocks and outcrops where Au, Au-Ag-Ba and Cu mineralization occurs. Analysis of the data indicates high positive correlation between magnetic and gamma ray anomalies. Our study is focused on characterizing the geophysical properties of the hydrothermal rocks and associated mineralization that can host gold and copper. New spots, as two new geological targets for copper minerals have been identified in the Mara Rosa Magmatic arc. The new copper-gold targets have clear physical property contrasts with their host rocks and therefore lend themselves to detection and mapping by airborne geophysical methods.

INTRODUCTION

This study applies a simple predictive methodology that has established the airborne geophysical characteristics of host rocks of Cu-Au mineralization. The airborne geophysical signatures of known deposits are compared with analogous ones and available geological data. Goals of this study are to (1) provide useful mineral information for other studies by determining the signature of host rock within the magnetic and gamma-ray data and (2) locate target areas for field verification of potentially unmapped or shallowly buried Cu-Au host rocks. The airborne geophysical datasets provide the necessary input for a regional analysis.

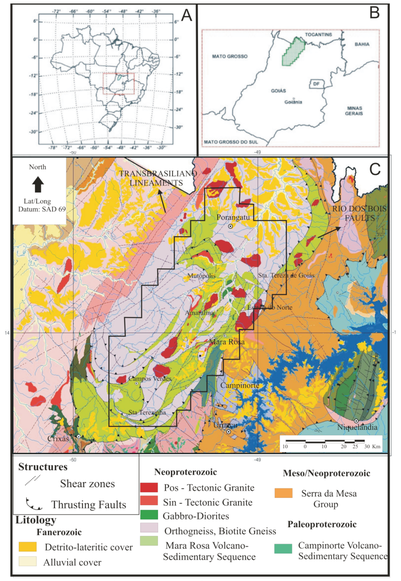


Figure 1: Geological map of Mara Rosa Magmatic arc with the airborne geophysical coverage (black polygon). The figure 1.A shows the position of the studied area in Brazil and in B a detail position of the airborne survey in the state of Góias.

GEOLOGICAL SETTING

The Tocantins Structural Province corresponds to a large Neoproterozoic (Brasiliano/Pan-Africano) orogenic zone developed between two major continental blocks: The Amazon Craton in the west and the São Francisco Craton in the east. The eastern part of the Province is occupied by the Brasilia Belt, which includes mainly a thick metasedimentary sequence and a large area where juvenile Neoproterozoic arc rocks are exposed (The Goiás Magmatic Arc). In the northern part of the Goiás Magmatic Arc, the main tectonic features are: (i) large-scale high-angle thrust to reverse shear zones (Rio dos Bois Fault) developed during the Brasiliano orogeny, separating the Neoproterozoic sequence from the Archaean granite-greenstone terrains of the Crixás-Hidrolina area in the south and from the Mesoproterozoic Serra da Mesa metasedimentary sequence in the east (Figure 1); and (ii) extensive NNE-trending, vertical dextral strike-slipe shear zones constituting the so-called Transbrasiliano lineaments

MINERALIZATION

The Mara Rosa arc contains important Au (Posse, Zacarias, Mundinho) and Cu-Au (Chapada) deposits (Figure 2). Mining companies have been investigating the region since the beginning of the 1970's. During the period between 1970 and the present, investment in exploration was discontinued several times due to gold price fluctuations in the international market. Gold and gold-copper deposits of the Mara Rosa Arc occur in four main associations: *i)* Au-Ag-Ba (e.g. Zacarias Deposit), which is interpreted as a stratiform volcanogenic-type deposit (Poll, 1994); *ii)* Cu-Au (e.g. Chapada Deposit), which has been interpreted either as volcanogenic (Kuyumjian, 1989), or as a porphyry-type deposit (Richardson et al., 1986); *iii)* Au-only deposit (e.g. Posse Deposit), which has been interpreted as an epigenetic disseminated deposit controlled by a mesozonal shear zone (Palermo et al., 2000); and *iv)* Au-Cu-Bi (e.g. Mundinho occurrence), which are considered as vein-type deposits controlled by magnetite-rich diorite

THE GEOPHYSICAL SIGNATURE OF THE MAIN HYDROTHERMAL HOST ROCKS

The integration of information generated by the interpretation of the magnetic and gamma-spectrometric data allowed the discrimination of several litho-structural domains and hydrothermal zones. The ability of these products to predict regions favourable for economic copper-gold mineralization was verified by comparing them with the occurrences of Cu-Au (Chapada) deposits and host rocks. The best interpretations of the Mara Rosa Magmatic arc were achieved from visual analysis of the ternary radioelement map (Figure 2) and the analytical signal amplitude map (Figure 3). These maps highlighted key host rocks in the area: epidote-rich rocks, epidosite, magnetite-pyrite-quartz-muscovite schist, massive kyanite and kyanite-bearing rocks (Figure 2). They represent narrow ridges associated with thrust faults that are responsible for regional foliation and structural framework of the area. Late deformations are represented by open folds and strike-slip faults with sinistral movement.

The best examples are related with the Picos, Morro do Caranã and Bom Jesus ridges (A, B and C in Figures 2 and 3). They have anomalous potassium signatures that represent the phyllic/argillic alteration of orthogneisses. The propylitic alteration (epidosites, quartz-epidosites) is recognizable as two cyan colored areas on the KThU image and medium (red) on the K image (Figure 4). This area was ground thruted with a geological mapping at 1:25.000. In the Bom Jesus rigde, the known mineralized zone extends for almost 1 km in a NNE direction hosted by the leucocratic orthogneiss near the contact with the amphibolites, where the late hydrothermal event produced an intense alteration with the development of muscovite, epidote, quartz, albite, sericite and carbonate (Palermo et. al. 2000).

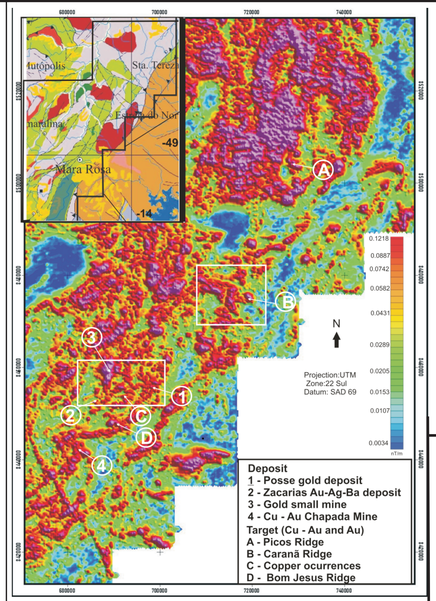


Figure 3: Analytical Signal Amplitude of Mara Rosa Magmatic Arc. The most significant hydrothermal alteration zones in this area are correlated with high analytical signal amplitudes.

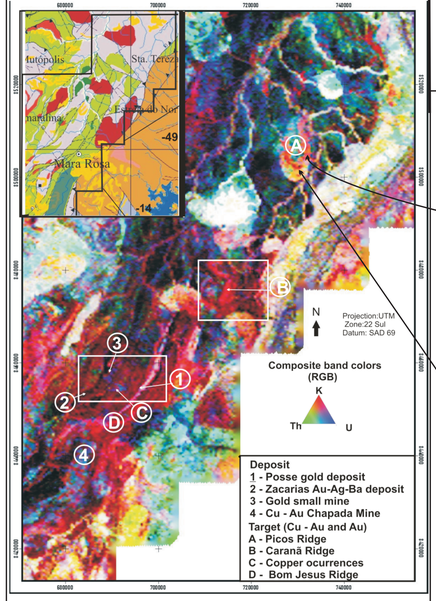


Figure 2: Gamma-ray spectrometric image RGB (KThU) of Mara Rosa Magmatic Arc illustrating the geophysical signature of the main hydrothermal alteration zones and associated mineralization. The white square polygon covers the Caranã ridge and is presented in detail in figure 4. Another one covers the new Cu-Au gold targets (Figure 5).

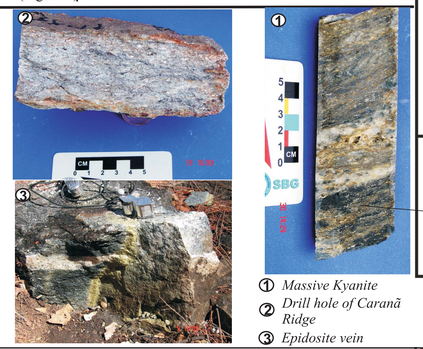
RESULTS

The Gold Mineralization

The Zacarias Au-Ag-Ba deposit is characterized by a discrete anomaly controlled by a NE trend with low amount of Th and U , intermediate values of K and high gradient in the analytical signal amplitude. Sorongo, Filó and Vendinha are small mines (*garimpos*) and are mapped in the airborne geophysical data by magenta anomalies (medium values of K and U) in RGB ternary and high amplitude in the analytical signal images corresponding with a medium grade of U and K. The anomalies have a strong NE trend enhancing the regional trend related to the gold mineralization (Figure 5).

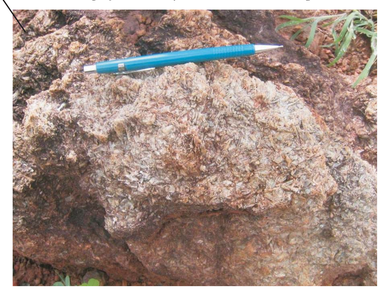
The New Copper-Gold Targets

Two new geological targets for copper-gold have been identified in the Mara Rosa Magmatic Arc. The new copper-gold targets have clear physical property contrasts with their host rocks and lend themselves to detection and mapping by airborne geophysical methods (Figure 5). Halos of potassic alteration which accompany the mineralization occur in a zone controlled by transcurrent-NS deformation, which clearly post-date the alterations which previously affected the wallrock (Figure 5)



① *Massive Kyanite*
② *Drill hole of Caranã Ridge*
③ *Epidosite vein*

Outcrop of massive kyanite in the Picos Ridge.



Detail of massive kyanite boulder in Picos Ridge

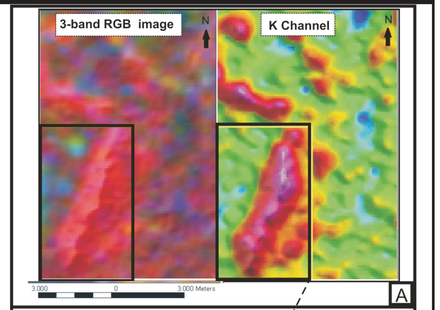


Figure 4: The RGB (KThU) and K images of the Morro do Caranã showing the high K signature that illustrate the main mineralization process in this area. This region was ground thruthed with a geological mapping in 1:25.000 scale.

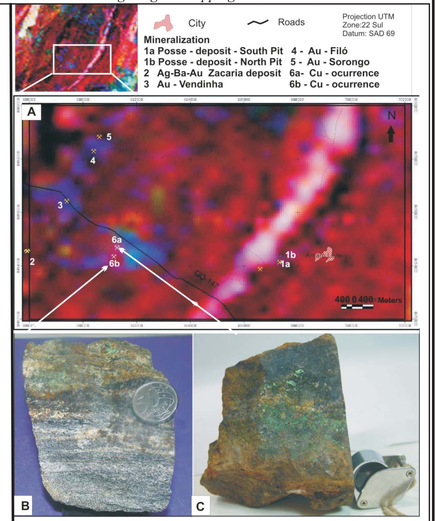


Figure 5: The geophysical signature of the Cu-Au mineralization in the RGB (KThU) image: a high uranium associated with the gold only mineralization and the another type with halos of potassic alteration that also maps two new targets (6a and 6b) Malachite (B and C) was found in the field and confirms the potential of the area.