Airborne Magnetic Data as a Support to Structural Framework Interpretation in Paracatu Region, MG, Brazil – Preliminary Analyses

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Abstract

This study discusses the use of geophysical data for geological mapping support. The main aim of this work was the airborne magnetic data process of the area and the characterization of the structural framework to aid the geological mapping, contributing to the advance in the method and characterization of prospective targets with strongly structural controls.

Introduction

Airborne geophysical data are an important tool for the geologic features interpretation, whereas it can indicate structures, geologic contacts and ore minerals. The use of geophysical data for geological mapping supports the area visualization and possibilities a better geological interpretation.

Lineaments, faults and shear zones can accumulate fluids bearing magnetic minerals, being the variations observed in airborne magnetic data usually used to discriminate and to delimit structures.

Faults and shear zone systems can accumulate hydrothermal fluids bearing ore metals or control these fluids distribution, being the structural features identification from magnetic data an important tool to understand the ore control and to support the metal prospection of an area.

The study area is located about 8km to the east of the Paracatu city, situated in the NW state of Minas Gerais and included in the Vazante-Paracatu region (Fig. 1). This region represents the most important Zn district known in Brazil and includes the Vazante hypogene non-sulfide Zn deposits composed mainly of willemite ($Zn2SiO4$) and sphalerite-rich and being carbonate-hosted Zn–(Pb) (Monteiro et al., 2003; Monteiro et al., 2006).

The area includes the Zn Ambrosia deposit, which ore is controlled by high-angle fault N30W/80SW and the style of mineralization is epigenetic. Zn mineralization is hosted by brecciated dolomite, of the Morro Calcário Formation (Upper Pamplona Member) - Vazante Group (Dardenne, 2000).

The main aim of this work was the process of the airborne magnetic data and the characterization of the structural framework to aid the geological mapping, contributing to the characterization of prospective targets with structural controls in Paracatu region.

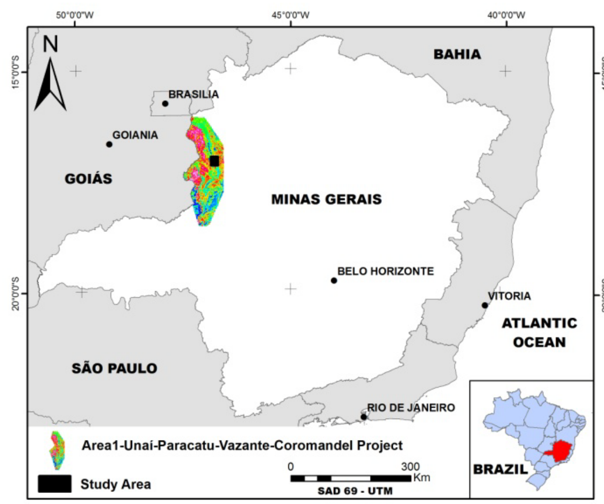

Fig. 1: Study area and geophysical project location.

Geological Setting

Paracatu region is located in the eastern part of the Brasília Fold Belt (BFB) (Almeida, 1967), that is included in the east portion of Tocantins Province. The BFB represents an unstable crustal block, whose final structural differentiation is a result of the closure of a wide oceanic basin during the Neoproterozoic Brasiliano Orogeny (Dardenne, 2000; Pimentel et al., 2001).

The study area encloses passive margin sediments, in a fold belt and thrust structure (Fuck, 1994; Fuck, *et al*., 1994). The metasedimentary cover is represented by Vazante Group, which comprises a marine detrital-carbonatic sequence made mainly of quartzite, slate, conglomerate, metasiltstone and dolomite with abundant stromatolitic structures (Dardenne, 2000). This group is exposed as a NS narrow and continuous belt, presenting fault contacts with the Canastra Group to the west and with the Bambuí Group to the east.

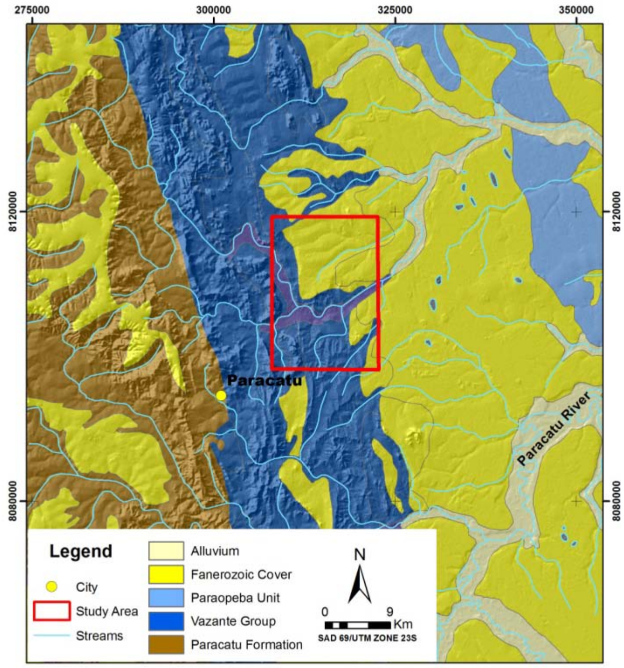

Fig. 2: Study area geological map upon SRTM image -
(modified from Bizzi et al., 2001)

Method

The airborne magnetic geophysical data used are included in the Area1-Unaí-Paracatu-Vazante-Coromandel Project of the Minas Gerais Airborne Geophysical Survey Program and were provided by the Mine and Energy Secretary of Minas Gerais State (SEME). This survey was flown in 2000 and involves gamma-ray and magnetic measures acquired using 250m spaced flight lines N30E oriented with N60W tie lines, 2,5km spaced. The nominal flight altitude was fixed in 100m and controlled by radar altimeter.

The process of the airborne geophysical data was made with the software OASIS *Montaj* 7.0, GEOSOFT^{TM}. The methodology used involved a sequential process of corrections, editing, interpolation and micro-leveling routine of the database (Fig. 3). Initially it was extracted the magnetic study area measures from the Area1 Project. The methodology begins with an overview to analyze the raw data and the flight lines distribution in addiction of the presence of inconsistent values. In this step was not found significant problems in the database. Magnetic data were then interpolated with a 62,5m cells grid, attending the suggested by Gunn (1998). The magnetic data was interpolated with bi-directional method, suggested to this kind of data (IAEA, 2003).

The levelling of the data was made by the company which acquired the geophysical data. After this, some residual errors can still be present in the airborne geophysical data and can be removed by micro-levelling (Luyendyk, 1997). Thus, Minty (1991) suggested a technique for the removal of these residual levelling errors. It consists in the application of filters to detect the residual errors and then it is subtracted from the original data. In this study the micro-levelling (Minty, 1991) was carried with the algorithm developed by Blum (1999). After micro-levelling was applied, it was created the geophysical digital images following the flow chart of figure 3. These images were enhanced by linear and non-linear filtering algorithms and displayed as pseudo-colors.

The data were organized in the Geographic Information System (SIG) to treat the georeferenced information. It was used ArcView^{TM} 9.2 for data analysis.

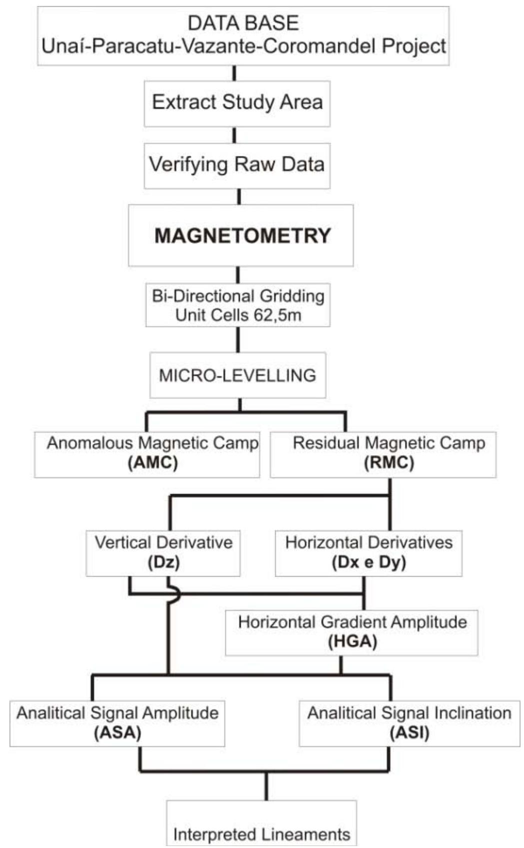

Fig.3: Flow chart showing data processing procedure.

Results

The Residual Magnetic Camp image is showed in the figure 4. It is observed a moderate magnetic relief and wide variation in the magnetic amplitude.

Figure 5 illustrate the ASA image, which define the magnetic source position that contributes to the delimitation of different magnetic sources. It is observed two principal magnetic domains. One comprises the higher magnetic amplitude, while the other comprises moderates to low amplitudes.

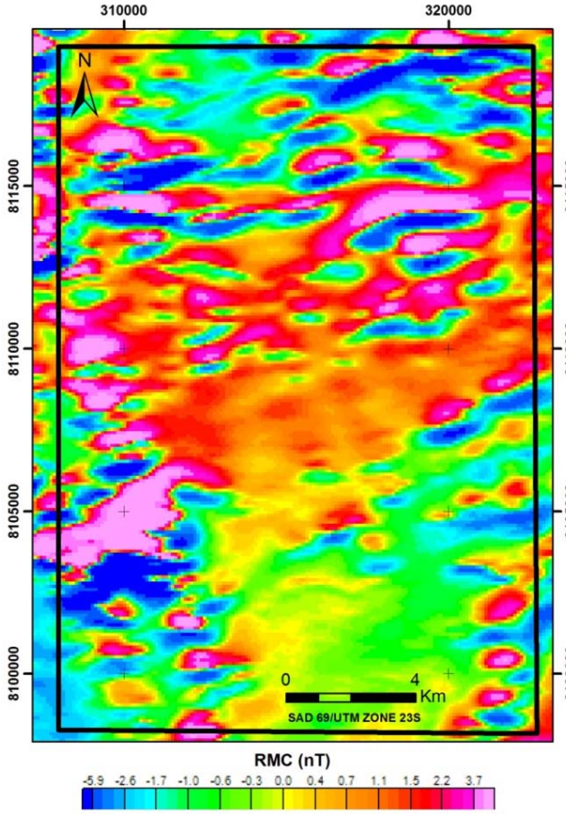

Fig.4: Residual Magnetic Camp of the study area.

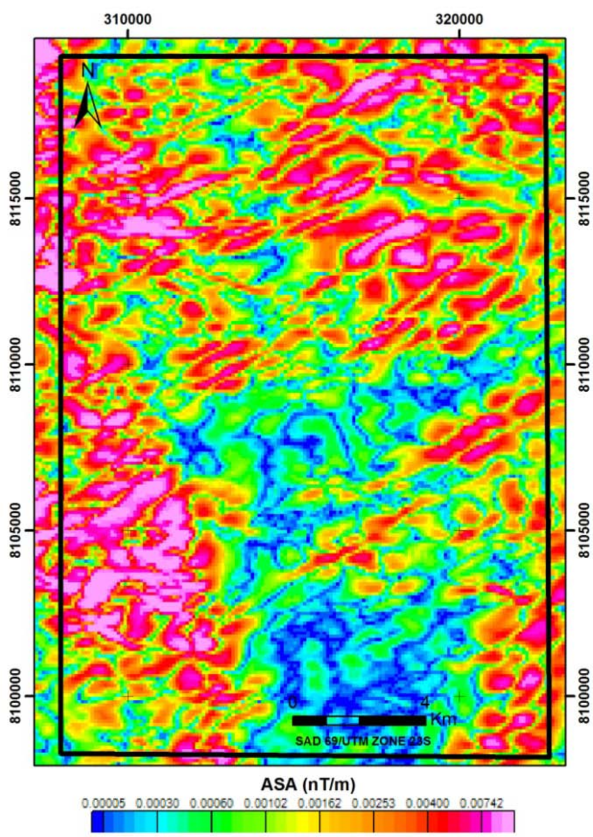

Fig.5: Analytical Signal Amplitude of the study area.

The magnetic images resulted from the data processing gave the support to the interpretation of the magnetic lineaments. All the magnetic images generated was used for the structural interpretation, but the principal image utilized was the ASI, which enhance the structures and permits the depth estimation of the magnetic source dip and the magnetic susceptibility local contrast.

The magnetic lineaments interpreted are illustrated in figure 6 and its rose diagram is in figure 7. It is observed that the most frequency direction is ESE-WNW but the most enhanced lineaments in the study area have the NE-SW direction.

The lineaments were also interpreted from the SRTM (Shuttle Radar Topographic Mission) image (Fig. 8). This figure illustrated that the majority of the lineaments have the NE-SW direction, followed by NS structure direction (Fig. 9). Although, the most important structure is NE-SW which agree with the magnetic lineaments interpreted from magnetic images. The lineaments in the southeast portion of the area suggest the dextral transcurrent zone.

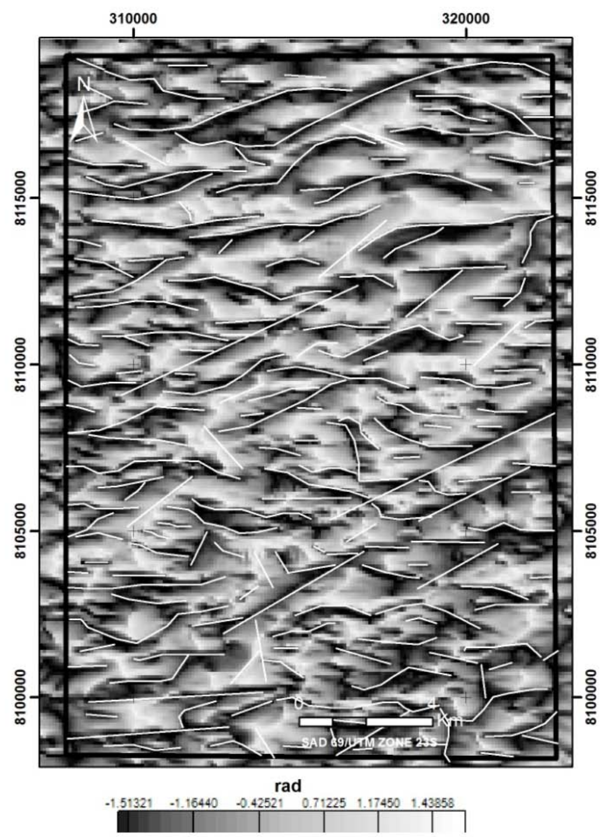

Fig.6: Interpreted magnetic lineaments upon the Analytical Signal Inclination image of the study area.

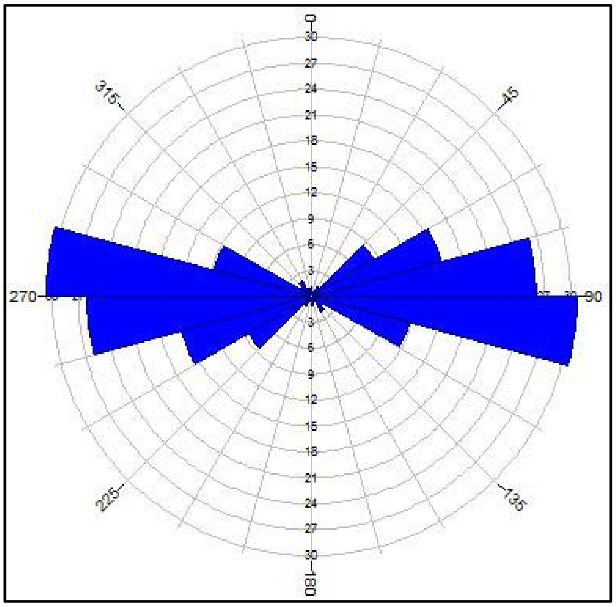

Fig.7: Rose diagrams of magnetic lineaments.

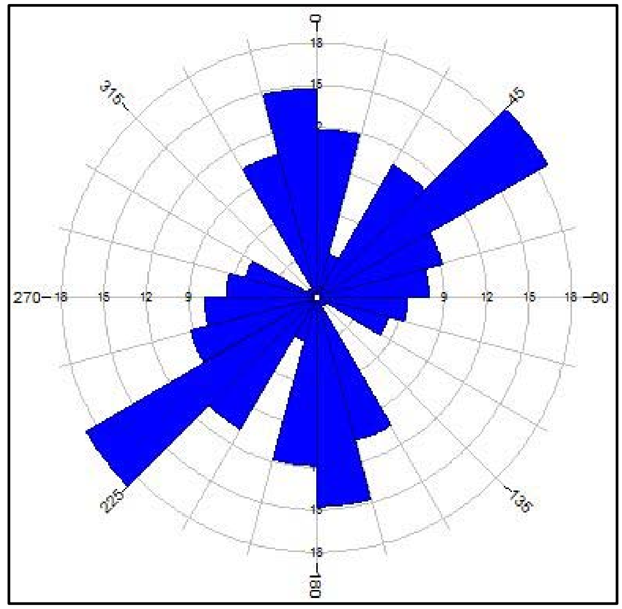

Fig.9: Rose diagrams of SRTM lineaments.

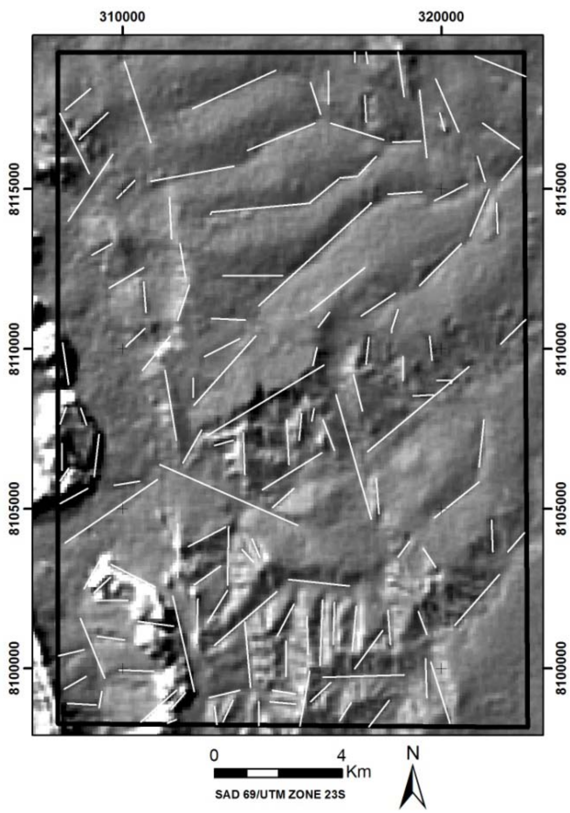

Fig.8: Lineaments interpreted from SRTM image.

Final Consideration

Airborne magnetic data utilized in this study allowed the identification of regional structural frames. Studies of this nature are critical in regions with strong chemical weathering, as in the case of carbonate rocks Vazante Group, dense vegetation and/or difficulty of accesses.

It should be emphasized that this work is preliminary. Others magnetic products and gamma spectrometry data will be added to the data here present to evaluate the structural interpretation. Green field will also be done and the structural analysis will be checked.

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References

Almeida, FFM (1967) Origem e evolução da plataforma brasileira. Boletim Departamento Nacional da Produção Mineral 243: 36 pp.

Bizzi, L. A.; Schobbenhaus, C. Gonçalves, J.H.; Baars, F.J.; Delgado, I.M.; Abram, M.B.; Leão Neto, R.; Matos, G.M.M.; Santos, J.O.S. 2001. Geologia, Tectônica e Recursos Minerais do Brasil: Sistemade Informações Geográficas – SIG e Mapas na Escala 1:2.500.000. Brasília: CPRM, 2001.

Blum, M. L. B., 1999. Processamento e interpretação de dados de geofísica aérea no Brasil Central e sua aplicação à geologia regional e à prospecção mineral. Tese de Doutorado. Instituto de Geociências da Universidade de Brasília, 229p.

Dardenne, MA (2000) The Brasília fold belt. In: Cordani, UG, Milani, EJ, Thomaz-Filho, A, Campos, DA (eds.). Tectonic Evolution of South America. 31st International Geological Congress, Rio de Janeiro, pp. 231-263.

Fuck, R. A., 1994. A Faixa Brasília e a compartimentação tectônica na Província Tocantins. *In*: Simpósio de Geologia do Centro-Oeste, IV, Atas... Brasília, p. 184-187.

Fuck, R. A., Pimentel, M. M., D'el-Rey Silva, L. J. H., 1994. Compartimentação tectônica na porção oriental da Província Tocantins. *In*: Congresso Brasileiro de Geologia, 38, Balneário Camboriú. Atas... p. 215-216.

Gunn, P.J., 1998. Interpretation of Airborne Magnetic and Radiometric Surveys. AGSO, 150p.

IAEA, International Atomic Energy Agency, 2003. Guidelines for radioelement using gamma ray spectrometry data. Viena, 173p.

Luyendyk, A. P. J., 1997. Processing of airborne magnetic data. AGSO *Journal of Australian Geology & Geophysics*, **17**(2): 31-38.

Minty, B. R. S., 1991. Simple Micro-Levelling for Aeromagnetic Data. *Exploration Geophysics*, **22**:591-592.

Monteiro LVS, Bettencourt JS, Bello RMS, Juliani C, Oliveira TF(2003) Fluid inclusions and stable isotopic constraints on the genesis of the non-sulfide and sulfide zinc deposits in the Vazante–Paracatu Belt, Brazil. In: Cailteux, J.L.H. (Organizer), Proterozoic Sediment-hosted Base Metal Deposits of Western Gondwana, UNESCO/IUGS, pp. 163–167.

Monteiro LVS, Bettencourt JS, Juliani C, Oliveira TF (2006). Geology, petrography, and mineral chemistry of the Vazante non-sulfide and Ambrósia and Fagundes sulfide-rich carbonate-hosted Zn (Pb) deposits, Minas Gerais, Brazil: Ore Geology Reviews 28: 201-234.

Pimentel MM, Dardenne MA, Fuck RA et al (2001) Nd isotopes and provenance of detrital sediments of the Neoproterozoic Brasília Belt, Central Brazil: Journal of South American Earth Sciences 14:571-585.