Figueira Branca Intrusive Suite (Brazil): A Geophysical Perspective of a Layered Mafic Intrusion in the SW Amazon Craton

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3 authors:


Vinicius Louro
University of São Paulo


Marta Mantovani
University of São Paulo


Vanessa Biondo Ribeiro
The Commonwealth Scientific and Industrial Research Organisation

Figueira Branca Intrusive Suite (Brazil): A geophysical perspective of a layered mafic intrusion in the SW Amazon Craton

Vinicius H. A. Louro, Marta S. M. Mantovani, Vanessa B. Ribeiro

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Introduction

The Jauru Terrane is a Paleoproterozoic structure in the SW of the Amazon Craton. The Alto Jauru Group (1.76 -1.72 Ga), in the Jauru Terrane, hosts the Figueira Branca Intrusive Suite (FBS) in west Mato Grosso, Brazil (Fig. 01).

The FBS is a 1426 Ma layered mafic intrusion understood as an anorogenic suite. Its Nd-Sr affinity and similar age with the adjacent Santa Helena Orogeny granitic rocks, along a complex tectonic evolution, shows that the origin and evolution of the FBS still remains to be defined.

In parallel, the FBS presents occurrences of Cu, Cr, Co and Ni in concentrations typically associated with basic-ultrabasic rocks. Au occurrences are also found in the region.

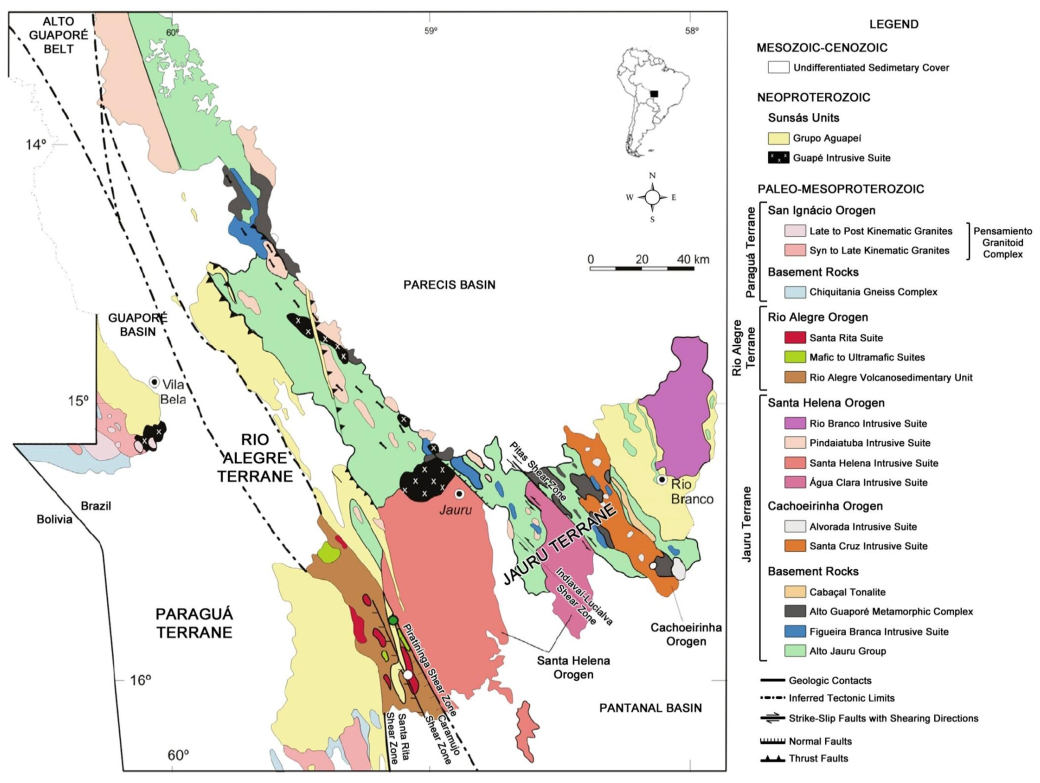
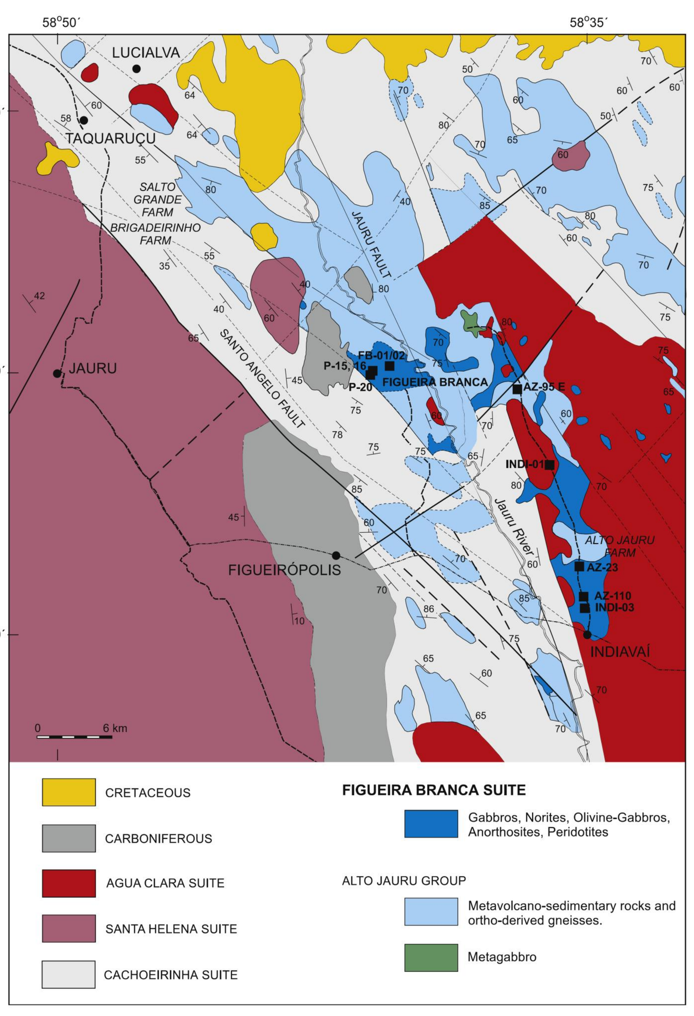


Fig. 01 – Regional geology of the SW Amazon Craton (extracted from Bettencourt et al., 2010).

Geophysical methods were applied to characterize the FBS. Gamma-spectrometry, gravity and magnetic data were gathered and joint-interpreted to delimit the intrusive bodies of the FBS – indirectly assessing potential targets for mineral exploration, to estimate the regional features of the Jauru Terrane and to evaluate the FBS role in the evolution of the SW Amazon Craton.

Geology



The Alto Jauru Group is mainly composed by meta-volcano-sedimentary rocks, ortho-gnaisses and metagabbros. The FBS is surrounded by two sinistral shear zones: Indiavaí-Luciava and Pitas (Fig. 01).

Geological studies differ on what they recognize as the extension of the FBS. Teixeira et al. (2011) present the FBS with 3 main intrusive structures (Fig. 02).

The FBS is a layered mafic-ultramafic complex constituted by a deeper zone of dunites, succeeded by piroxenites, gabbro-norites, anorthosites, and olivine-gabbros in its upper portion.

Teixeira et al. (2011) indicate through Nd-Sr data that the FBS is product of a depleted magma, linking its intrusion with a predominantly exrensional regime.

The same authors established an age of 1426 ± 8 Ma (U-Pb, SHRIMP). This age indicates that the FBS is coeval with the granitic Água Clara (1428 ± 3 Ma) intrusive suite from the Santa Helena Orogeny.

Fig. 02 – Geology of FBS area (extracted from Teixeira et al., 2011).

Geophysical Data

Potential field methods and radiometry were used to analyze the FBS. The gamma-spectrometric data showed low counts of the three elements in the FBS area (Fig. 3-A). This behavior is mostly masked by the overall low counts from the Alto Jauru Group.

The magnetic data revealed three anomalies correlated with the limits indicated by Teixeira et al. (2011) (Fig. 3-B). The anomalies were named from south to north as Indiavaí, Azteca and Figueira Branca. The magnetic anomalies are reverse to the field in the south hemisphere (Table 01) suggesting the presence of remanent magnetization. This feature was proven true by D'Agrella-Filho et al. (2012), that measured the average remanent magnetization for samples collected in the north of Indiavaí body (Table 01).

A fourth anomaly is seen to the north of the other FBS anomalies, with the same features, except for its higher amplitude, and was named as Jauru. This magnetic anomaly does not present radiometric contrast with the host rock, however in the region of the anomaly, it was possible to find outcrops very rich in magnetite.

The 195 gravity stations installed in the FBS region permitted to identify four anomalies (Fig. 3-C). The Figueira Branca magnetic anomaly did not show a counterpart in the gravity data. However, to the east, a gravity anomaly is seen in an area of several small magnetic anomalies are present, but without an expressive amplitude as the FBS anomalies.

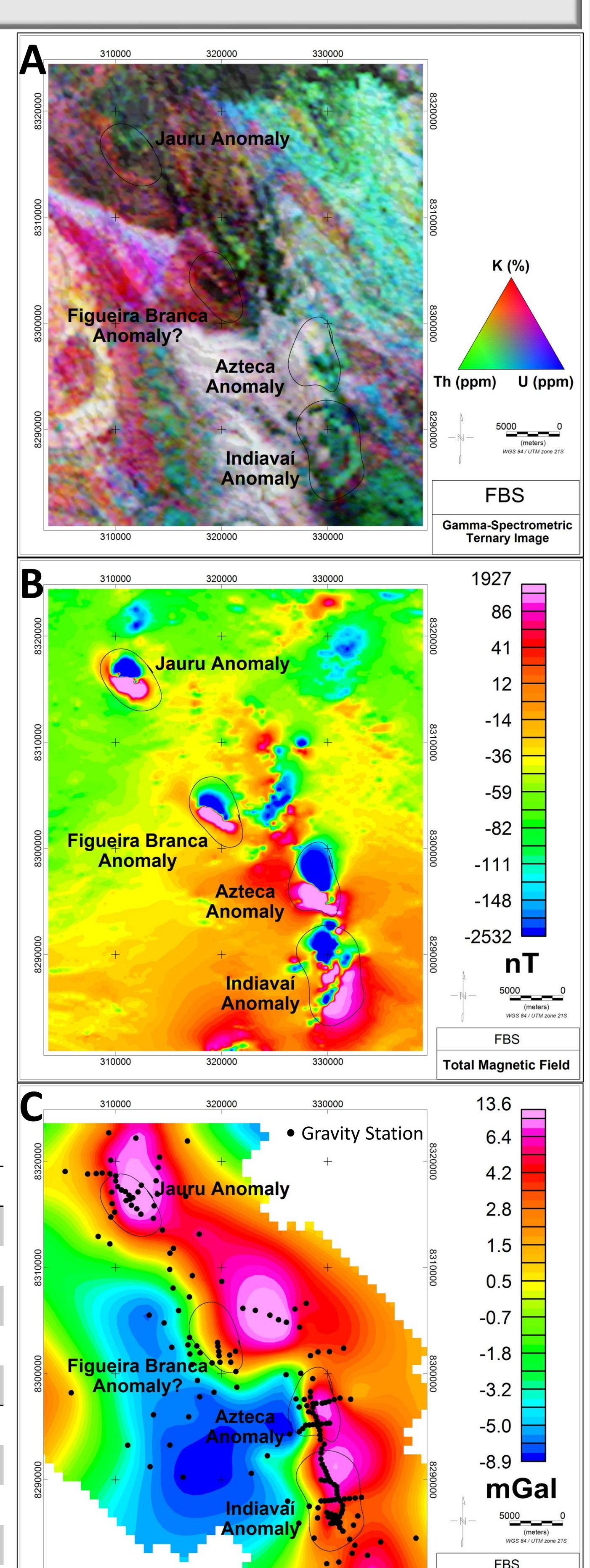


Fig. 03 – FBS geophysical data: (A) gamma-spectrometric ternary image, (B) total magnetic field and (C) Bouguer anomaly.

Table 01 - FBS and Alto Jauru group magnetic and density features

Target	Physical Property	Value
FBS	Induced Magnetization	Incl.: -11.6° / Decl. 347.5° / Intensity: 2.44 A/m
	Remanent Magnetization	Incl.: 50.9° / Decl. 209.8° / Intensity: 3.64 A/m
	Total Magnetization	Incl.: 53.4° / Decl. 281.9° / Intensity: 2.92 A/m
	Magnetic Susceptibility	0.129
	Density	2.81 ± 0.03 g/cm³
Alto Jauru Group	Induced Magnetization	Incl.: -11.6° / Decl. 347.5° / Intensity: 0.33 A/m
	Remanent Magnetization	Incl.: -1.6° / Decl. 269.1° / Intensity: 0.05 A/m
	Total Magnetization	Incl.: -8.0° / Decl. 357.9° / Intensity: 0.35 A/m
	Magnetic Susceptibility	0.02
	Density	2.68 ± 0.02 g/cm³

Geophysical Modelling

The potential field models of the FBS take into account:

a) The gravity and magnetic fields;
b) The known geology and radiometric aspects in surface;
c) Paleomagnetic analyses of 22 sites indicating the magnetic properties and average remanent magnetization of the FBS and its host rock in the Indiavaí anomaly area;
d) The extrapolation of the remanent magnetization found in Indiavaí anomaly to the other anomalies through the Reduction to the Pole technique over the magnetic data (Fig. 04). The resultinggrid has shown that the same direction of total magnetization (Induced + Remanent Magnetization) successfully reduced the four anomalies, what means that they present very similar magnetizations;
e) Density measures of samples from 18 sites in the Indiavaí and Azteca areas.

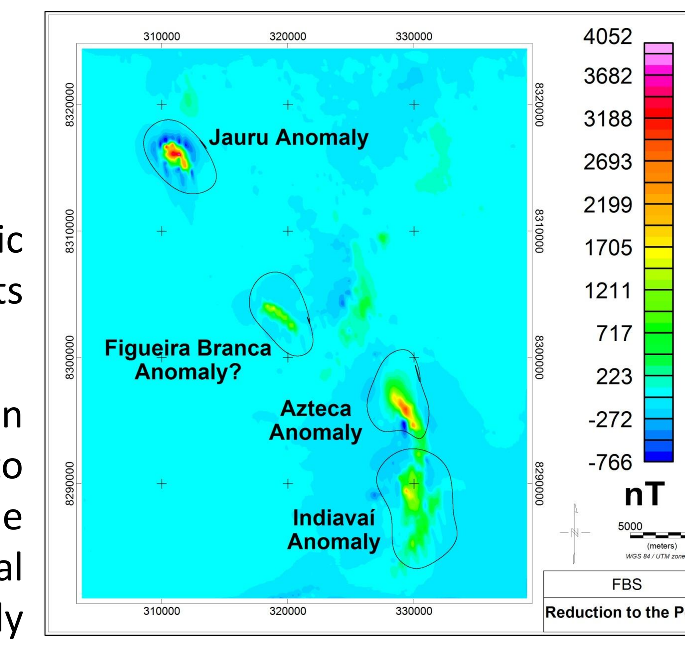


Fig. 04 – FBS Reduction to the Pole.

The Curie isotherm was estimated through spectral analysis (Okubo et al., 1985; Tanaka et al., 1999) to evaluate the relation between the coeval and adjacent, FBS anorogenic complex (Teixeira et al., 2011), and the Água Clara orogenic granites.

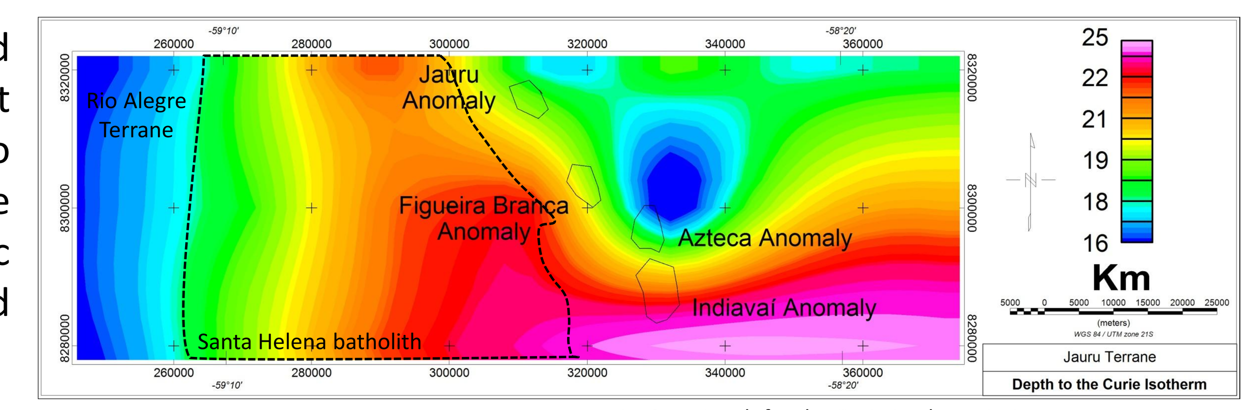


Fig. 05 – Depth for the Curie isotherm in Jauru Terrane area.

Its results also guided to maximum depth to the geophysical model. The FBS region presented the base of the magnetic anomalies at approximately 16 km (Fig. 05), thinner than the area of Santa Helena orogeny to the west.

The magnetic and gravity models showed contrasts of susceptibilities ranging from 0.10 to 0.19 and densities from 0.13 to 0.27 g/cm³ (Fig. 06) . The models presented an overall depth extent of 3.5 km, coherent with the Curie surface estimative. Qualitatively, their shapes are similar to sill-shaped intrusions. The volumes also have a differences of no more than 10%.

The Figueira Branca was not represented in the gravity model. The Jauru anomaly showed significantly higher susceptibility and density. This behavior may indicate an independence of the Jauru anomaly in relation with the FBS. Hand samples had shown that the Jauru rocks have larger minerals than the other anomalies, and a higher concentration of magnetite

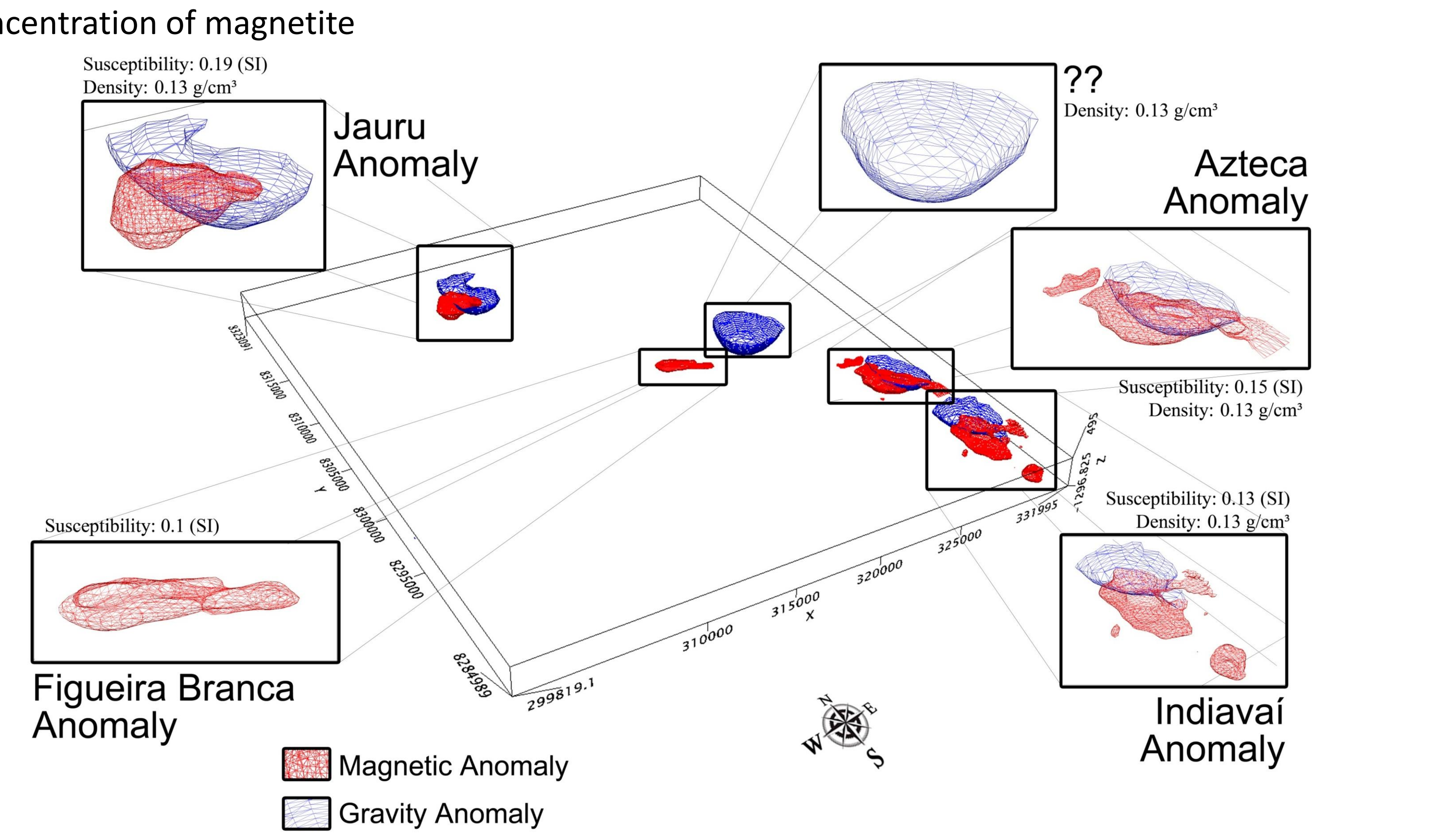


Fig. 06 – FBS magnetic and gravity inverted models.

Conclusions

The data presented in this study showed the geophysical signatures of the FBS, in the Jauru Terrane. The radiometric data evidenced outcrops of the FBS complex, but was not able to add significant information over the an hydrothermal event linked with the Cu, Cr, Co and Ni occurrences. It was possible to observe hydrothermalized rocks inside the area of the anomalies.

Magnetic and gravity data revealed anomalies related with the recognized intrusions. The Figueira Branca anomaly does not present a gravity anomaly. This behavior maybe linked with a local increase in the host-rock density or, even the absence of gravity stations in the north portion of the intrusion, where it was recently covered by a lake due the construction of a dam. The inverted models indicate outcrops over the center of the anomalies, what make the zones in the limits of the bodies the best prospects exploration of shallow hydrothermal structures probably associated with the Cu, Cr, Co and Ni occurrences.

The Curie isotherm, inferred through the magnetic data indicated an increase of the temperature of the crust and/or a thinner crust. This pattern can be linked with the extensive regime of FBS area proposed by Teixeira et al. (2011). This result weakens the possibility of a bimodal magma as the source of the FBS and points to a more complex scenario of crustal extension in a region of compressive regime, which remains to be studied.

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vilouro@usp.br, msmmanto@usp.br, vanessa.ribeiro@usp.br

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