GEOPHYSICAL SIGNATURES OF LODE Au-QUARTZ VEIN TYPE DEPOSITS RELATED TO LAVRAS DO SUL INTRUSIVE COMPLEX (RS, Brazil)

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Abstract

The Lavras do Sul Intrusive Complex (CILS, RS, Brazil) is a shoshonite- to alkaline type intrusion and shows a large number of lode Au-quartz vein deposits related to expressive hydrothermal alteration zones. Two distinctive hydrothermal zones type were recognized in the CILS: i) Aurora type hydrothermal zones and ii) Valdo Teixeira type hydrothermal zone. The main composition of these hydrothermal zones differs in that they present amphibole and sericite, respectively. The two types of hydrothermal alteration zones show contrasting geophysical signature for gamma-ray spectrometry and magnetometry: i) Aurora type hydrothermal zone shows lower gamma-ray emission (CT, K, U, Th), and higher magnetic intensity than country non-hydrothermally altered granite; while ii) Valdo Teixeira one shows higher gamma-ray emission (CT, K, U, Th), and lower magnetic intensity than country non-hydrothermally altered granite.

__Key words__: geophysical signatures, hydrothermal alteration, Au-quartz veins, granitic intrusion

Introduction

The Lavras do Sul Intrusive Complex (**CILS**) is a multiphase intrusion located in the western part of the Sul-riograndense Shield (Figure 01). It was characterized, in its actual configuration, by Gastal (1997). The CILS is composed by a range of rock types: from monzodiorite and quartz-monzodiorites, through granodiorite and monzogranites, to sieno and k-feldspar granites; these rock types are arranged in a zoned structure, but mafic rocks are placed in the NNE and northern part of the CILS (Figure 01). The CILS is intruded into a volcano-sedimentary sequence (Hilário Formation.) and into granite-gneisses (Cambaí Complex). These rock types are well-defined through regional aerogamaspectrometric data processing (Gastal *et al*., 1999).

The CILS shows a large number of lode Au-quartz vein deposits related to expressive hydrothermal alteration zones (e.g.: Goñi, 1961; Mexias *et al*., 1990a, 1990b). The ore composition shows some variation according the radially disposed fracture set that control lode veins (Andrade & Strieder, 1997). General characteristics of the CILS (shoshonite to alkaline granitic intrusion) and the mineralization (ore composition, hydrothermal alteration, etc…) permitted to assign these ore occurrences as related to Climax type intrusions (Andrade *et al*. 1998). But, it is to be realized that CILS has not any more its root, eroded by subsequent processes.

Airborne gamma-ray spectrometric data processing for hydrothermal zones related to granitic intrusions (Dickson & Scoot 1997) did not applied in a good way in the lode quartz veins related to CILS, as one can expect. Fieldwork data processing, on other hand, pointed out some significant hydrothermal differences according the fracture zone structures and highlighted geophysical implications for ore exploration. Then, the aim of this paper is to present contrasting geophysical signature for lode Au-quartz vein deposits related to CILS.

Hydrothermal alteration zone types in the CILS

Fieldwork and petrography revealed two basic types of hydrothermal zones and quartz veins controlled by fracture zones around the CILS:

1) Aurora type hydrothermal zones: hydrothermal minerals of this zone are mainly amphibole (hornblende !?), calcite, quartz and chalcedony, pyrite, calcopyrite, magnetite, galena and rare sphalerite;

2) Valdo Teixeira type hydrothermal zones: hydrothermal minerals of this zone are mainly sericite, quartz, pyrite and rare galena.

The Aurora type hydrothermal zone is variably overprinted by Valdo Teixeira type one. Some occurrences of Valdo Teixeira type hydrothermal zone show higher amounts of galena, but Cu-bearing minerals are always absent. Preliminary evaluation of these hydrothermal alteration zones show that Aurora type represent a mesothermal mineralization phase; it is overprinted by Valdo Teixeira type, that represents decreasing temperature and changing fluid composition mineralization phase (epithermal one).

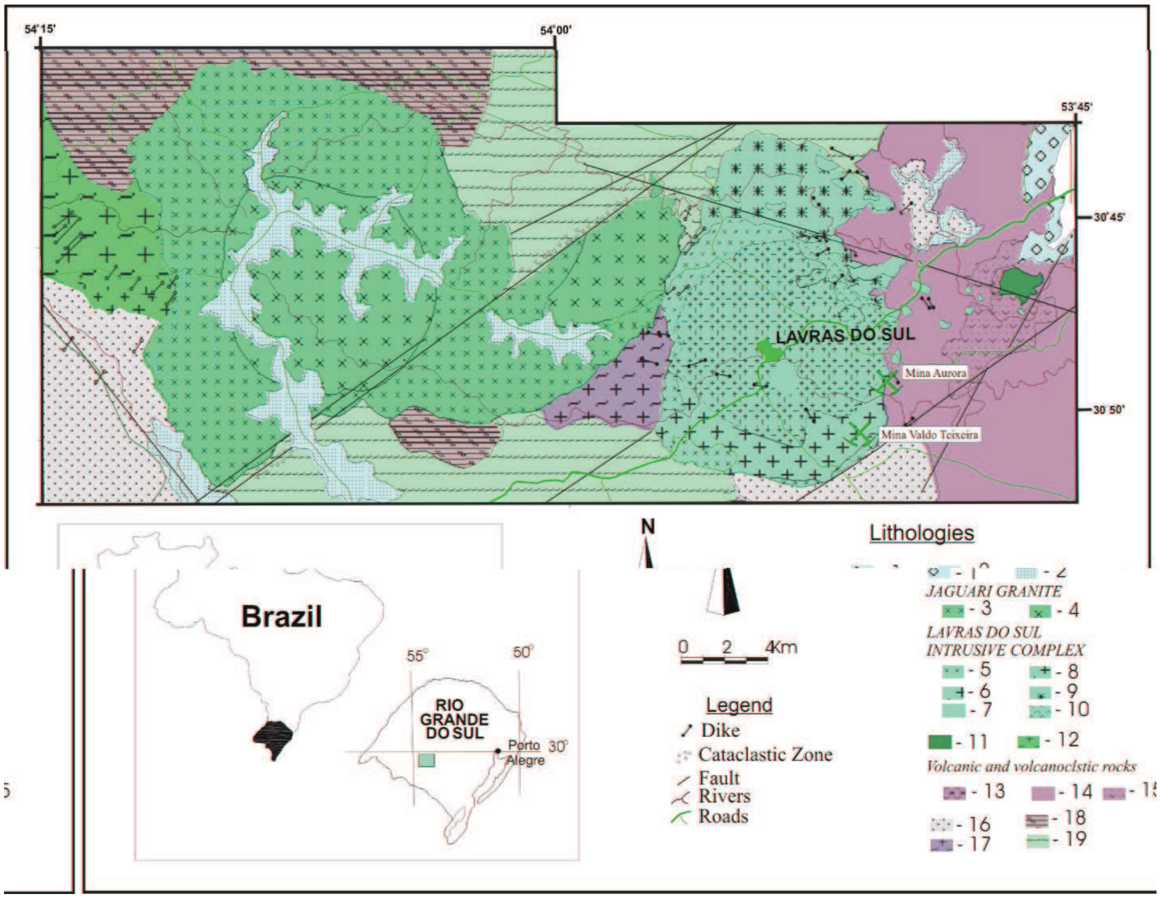

Figure 01 – Geological map of the CILS and Jaguari Granite (Gastal, 1997). Legend: 1) Santa Bárbara Fm.; 2) Cenozoic and Gondwanic sedimentary cover; 3) Sienogranite; 4) Monzogranite; 5) Pertita granite; 6) Sienogranite; 7) Porphyric quartz monzonite; 8) Granodiorite to monzogranite; 9) Quartz monzonite and monzonite; 10) Arroio do Jaques ortopirox. bearing monzodiorite; 11) Estrela granite; 12) Santa Rita monzogranite; 13) Latitic flows and breccias; 14) Andesitic flows and pyroclastic rocks; 15) epiclastic rocks; 16) Neoproterozoic cover (Maricá Fm. and Ibaré phylites); 17) Fazenda do Posto granodiorite; 18) Metamorphosed and deformed volcano-sedimentary sequences and mafic-ultramafic complexes; 19) Granite-gneissic complexes (Ortometamorphic Imbicui Suite).

Geophysical signature of the hydrothermal zones

The compositional features of the both type of hydrothermal zones point for distinctive geophysical signature, depending on selected method. Then, taking into account composition of the hydrothermal zones and the basic principles of some geophysical methods it was possible to select the best developed two types of lode Au-quartz veins (Aurora and Valdo Teixeira) and also the geophysical methods to reveal such distinctive pattern.

The selected geophysical methods were: gamma-ray spectrometry and magnetometry. The geophysical field survey was conducted in three stages and used a sampling 150 x 25 m grid. The equipments include a GRS-500/Scintrex spectrometer (differential gamma ray) with energy windows between 0.40-2.79 MeV and a GS-512 gamma ray spectrometer (Scintrex/Geofyzika), with 512 operation channel in range of 0.1 to 3 MeV, which was calibrated at *Instituto de Radioproteção e Dosimetria, Comissão Nacional de Energia Nuclear (IRD-CNEN)*. For this paper, just the GS-512 measurements are presented. The magnetometer/gradiometer (GSM-19 Overhauser Terraplus) measured total magnetic field and vertical gradient at the same stations. The measurement stations were determined with a DGPS (Garmin 100 SRV-II).

The Aurora type hydrothermal zone showed lower radiometric emission than the country granite for each of gamma channel (CT, K, Th, U), as can be seen in Figure 02. The magnetic intensity of the Aurora type hydrothermal zone, however, is higher than the country CILS granite. These signatures show that mineralization processes carried out the radioactive elements (mainly K), while enabled the crystallization of amphibole, magnetite, pyrite, calcopyrite and galena.

The Valdo Teixeira type hydrothermal zone, on the other hand, showed inverse geophysical signatures in respect to Aurora one (Figure 03). The gamma-ray emission in the Valdo Teixeira type hydrothermal zone is higher than in the country monzo to sienogranite; total magnetic field in this hydrothermal zone is lower than the country granite. These geophysical signatures are the result of a mineralization process that concentrated K in sericite and breakdown the magnetite into pyrite.

Conclusions

The lode Au-quartz veins deposits associated with CILS (Lavras do Sul, RS, Brazil) show two different hydrothermal zones: Aurora type and Valdo Teixeira type. They represent a multistage mineralization process, from high temperature (mesothermal Aurora type) to lower temperature (epithermal Valdo Teixeira type) conditions. The two types of hydrothermal alteration zones show contrasting geophysical signature for gamaspectrometry gamma-ray spectrometry and magnetometry. Aurora type hydrothermal zone shows lower radiometric emissions and higher magnetic intensity related to the country granite, while Valdo Teixeira one shows higher radiometric emission and lower magnetic intensity than the country granite.

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GEOPHYSICAL SIGNATURE

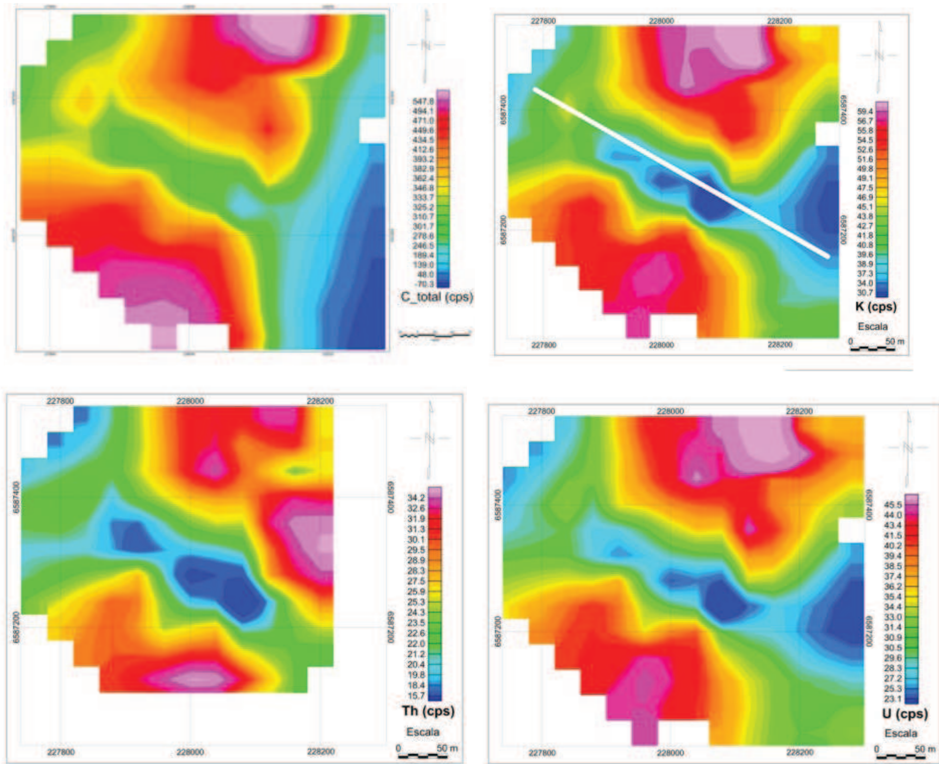

Figure 02 – Gammaspectrometric maps for Aurora type hydrothermal zone (CILS, Lavras do Sul, RS).

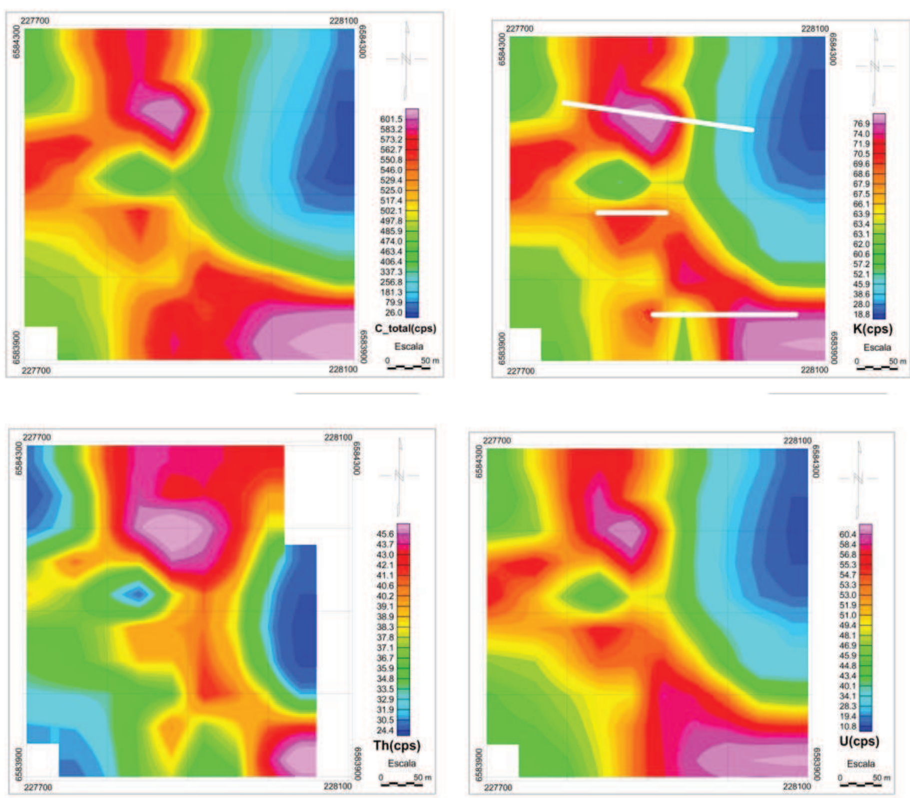

Figure 03 – Gamaspectrometric maps for Valdo Teixeira type hydrothermal zone (CILS, Lavras do Sul, RS).