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New Pb-Zn-Cd (Ag) occurrence at Cabeceiras do Lajeado, Rio Grande do Sul State, Brazil

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Abstract

A new Pb-Zn-Cd (Ag) occurrence, named Cabeceiras do Lajeado, was recently discovered by CPRM-Geological Survey of Brazil in the juvenile São Gabriel terrane, Sul-Rio-Grandense Shield, following airborne magnetic and radiometric anomalies. The mineralization is composed of sphalerite, galena and pyrite as the main sulfide phases, and is hosted by hornblende gneiss with medium- to fine-grained hornblende needles, with grain size less than 5 mm. The hornblende gneiss shows mineralogical banding composed of quartz, amphibole and sulfides, and of amphibole, quartz, feldspars and/or very fine-grained cordierite. Euhedral to globular pink garnet and chloritized biotite are also present. Pb and Zn (>10,000 ppm), Se (>100 ppm) and Cd (>2,000 ppm) contents exceeded the detection limits of the ICP-MS technique, whereas Ag grades 60.5 ppm.

Keywords: lead, zinc, Sul-Rio-Grandense Shield, base metals, mineral resources.

INTRODUCTION

In this work we present the new Pb-Zn-Cd (Ag) occurrence at the Cabeceiras do Lajeado (RS) region, identified by CPRM – Geological Survey of Brazil during the execution of the Agriminerals of the Rio Grande do Sul Project, from field checking of aero-geophysical anomalies characterized by strong magnetic signature and low gamma spectrometric radiation. This occurrence has UTM coordinates 773946 S / 6618307 E, and is located in the Sul-Rio-Grandense Shield (Figure 1).

GEOLOGICAL SETTING

The Pb-Zn-Cd (Ag) occurrence area is located in the meridional portion of the Rio Grande do Sul State, in the southern segment of the Mantiqueira Province, and is inserted in the Neoproterozoic São Gabriel Terrane. This terrane consists of associated metavolcano-sedimentary and plutonic rocks with juvenile isotopic signature, considered as formed in magmatic arc setting and associated to ophiolite fragments.

LOCAL GEOLOGY

The Cabeceiras do Lajeado Pb-Zn-Cd (Ag) mineral occurrence is inserted in the Passo do Ivo Metamorphic Complex (Oliveira, 1982), integrating part of the São Gabriel Terrane, which is constituted of serpentinized ultramafic rocks, magnesian schists, amphibolites, hornblende gabbros, paragneisses, quartzites and metapelites.

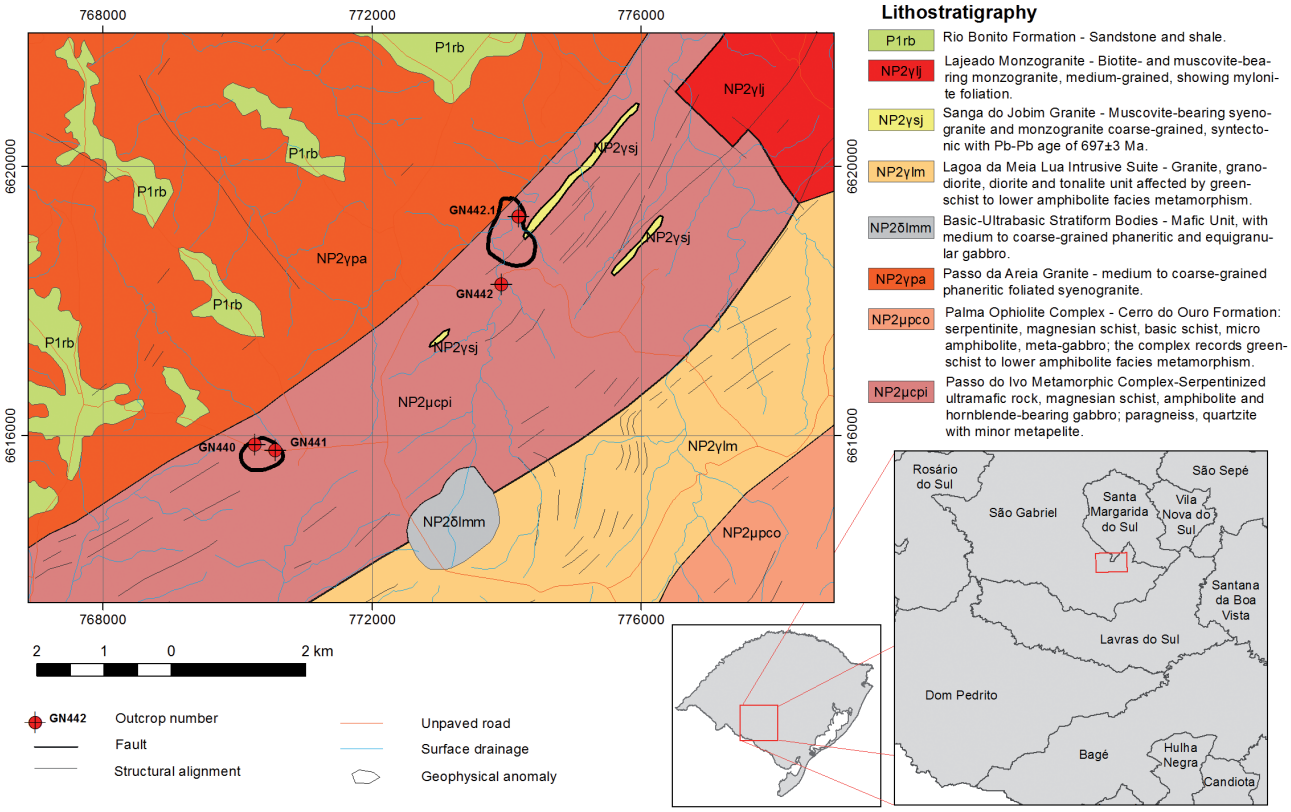

Figure 1: *Location of the geophysical anomalies and sampled points. Geology according to Laux et al. (2012).*

Two main geophysical targets were checked on middle-northeastern and southwestern portions (Figure 1) of the Lagoa da Meia Lua Sheet (SH-21-Z-B-VI). In the first target, named outcrop GN-442, a sulfidized hornblende gneiss, showing expressive Pb, Zn, Cd and Ag contents was identified. In the second geophysical target, named outcrops GN-440 and GN-441, we described phyllonite, composed of quartz and mica, and a magnetic, isotropic and medium-to coarse-grained serpentinized ultramafic rock, black in color. Syntectonic intrusions of muscovite syenogranite to monzogranite complete the rock association occurring as elongated crests striking to N70°E.

GEOPHYSICS

Geophysics has been an important tool to indicate prospective targets, playing fundamental role to develop the Agriminerals of the Rio Grande do Sul Project by CPRM – Geological Survey of Brazil (final report in elaboration). Several mineral occurrences were identified from aerogeophysical data processing, highlighting phosphate in carbonatites, iron formations and this Pb-Zn-Cd (Ag) occurrence. Other targets, yet without field evaluation, indicate high potential for new mineral discoveries.

The two targets evaluated in the field were selected by means of the correlation and integration of the first vertical derivative and analytical signal amplitude of the anomalous magnetic field with gamma spectrometric data of RGB ternary composition of K, eTh and eU, from the Rio Grande do Sul Shield Aerogeophysical Project data (CPRM, 2010).

Figure 2 corresponds to the image of the studied region analytical signal, submitted to a modification of the normal color scale to highlight the two studied anomalies. Magnetometric lineaments, interpreted from first vertical derivative of the anomalous magnetic field, were combined with the analytical signal image evidencing the relation between the magnetic anomalies and ultramafic rocks, along with the strong control on these bodies by lineaments with NE-SW and NW-SE strikes (Figure 2).

In addition to this, the depth of the anomalous sources was estimated from the semi-quantitative study using deconvolution algorithm of Euler, with structural index 2, indicating that the causative body of the southwestern anomaly is shallow, while the body that produced the middle-northeastern anomaly does not crop out, which could justify the lack of identification of outcropping magnetic rocks associated to this anomaly.

Figure 3 shows the RGB ternary composition of the K, eTh and eU elements with overlapping of the magnetometric lineaments. Two main gamma spectrometric domains occur in the area, limited exactly by the NE-SW structure that controls the ultramafic bodies. This is an important indication to define prospective targets. The domain at northwest of the lineament shows high K, eTh and eU contents, while at southeast the values are lower for these three elements.

The two targets evaluated at field show low gamma spectrometric values, reflecting the wall rocks nature. In the field, punctual measurements of rock magnetic susceptibility by kappameter, and, of radioactivity, by gamma spectrometer were also undertaken.

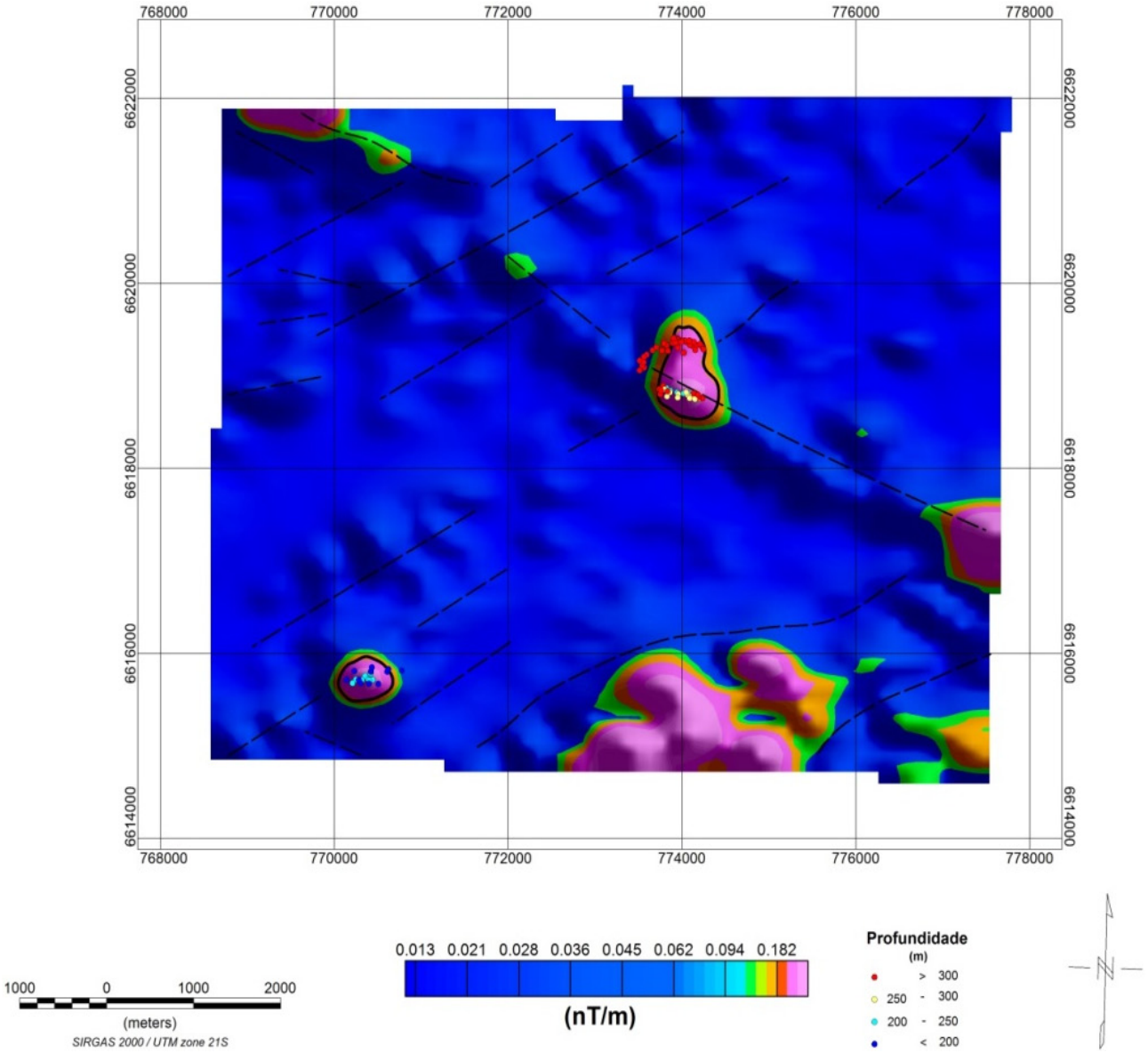

Figure 2*: Map of analytical signal amplitude with location of geophysical anomalies and described outcrops. Black dashed lines represent magnetometric lineaments interpreted from the first vertical derivative map of the anomalous magnetic field. Black circles represent two anomalies evaluated in the field, highlighting that the middle-northeastern anomaly, where the Cabeceiras do Lajeado mineralization occurs, is situated at the intersection of NE and NW magnetometric lineaments.*

OCCURRENCE DESCRIPTION

The Cabeceiras do Lajeado Pb-Zn-Cd (Ag) occurrence was described in a single outcrop, with ~20 m length and 1 m of apparent thickness, at a road cut of a secondary road (GN-442), ~1 km from the border of the main portion of the magnetic anomaly associated to the target located in the middle-northeastern portion of the area. The rock is a dense sulfide-bearing hornblende gneiss, dark grey to greenish in color, non-magnetic, with vertical foliation striking to N60°E (Figures 1, 4 and 5A).

On the magnetic anomaly itself (outcrop GN-442.1 of Figure 1), only rare small and loose blocks of phyllonite, white quartz and granitoid rock were found, which do not justify the delimited magnetic anomaly. The source of this anomaly remains unknown.

PETROGRAPHY

The host rock of the Pb-Zn-Cd (Ag) occurrence corresponds, petrographically, to banded hornblende gneiss with alternating bands of black, green and white colors (Figure 5A). The gneiss shows nematoblastic texture defined by the orientation of medium- to fine-grained (<5 mm) amphibole needles (Figure 5B). The banding is marked by alternation of quartz-rich layers with hornblende, sphalerite (15%), galena (5%) and pyrite (5%), and layers of hornblende, quartz and feldspars (?),possibly associated with very fine-grained cordierite (Figures 6 and 7). Grains of euhedral to globular, post-kinematic, pinky garnet also occur, in addition to some interstitial quartz, which is stretched in the foliation strike, and chloritized biotite.

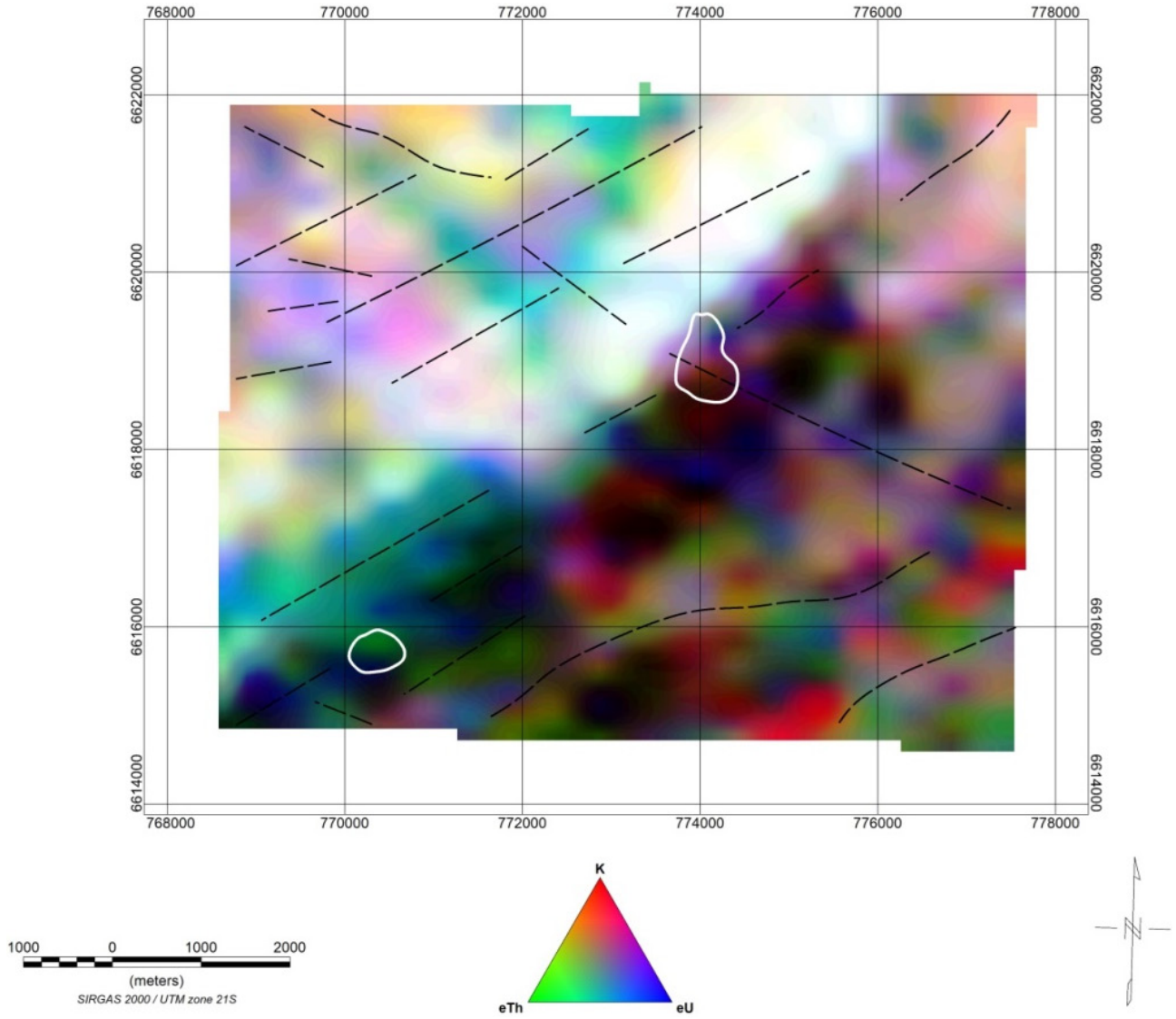

Figure 3*: RGB ternary composition image of the study region. Black dashed lines indicate magnetometric lineaments interpreted from the first vertical derivative map of the anomalous magnetic field; white circles represent the studied anomalies.*

Figure 4*: Image of the GN-442 outcrop.*

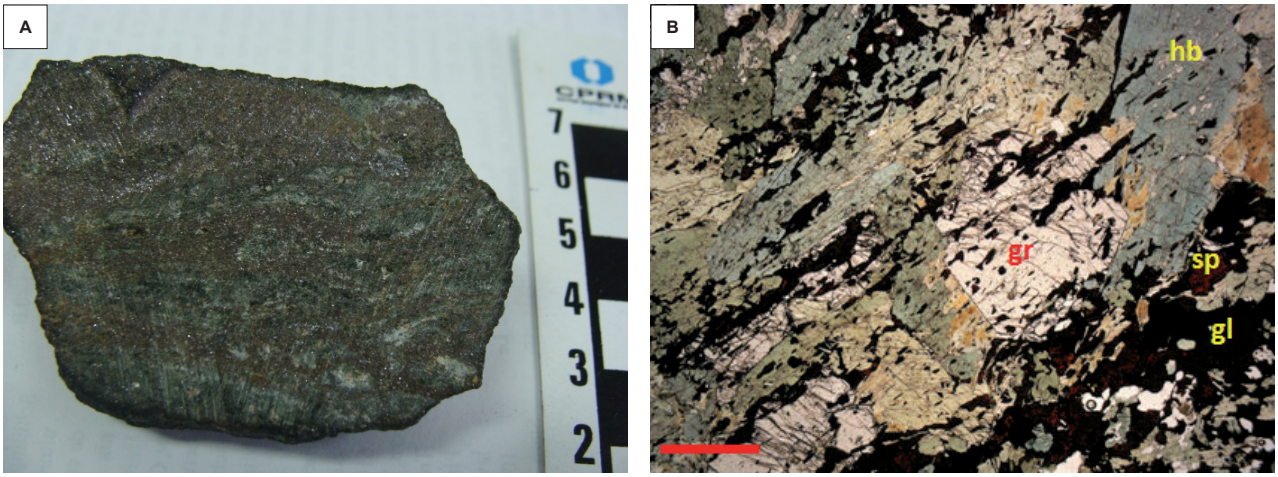

Figure 5: *A) Hornblende gneiss (GN-442) with banding marked by alternation of silicate minerals-rich layers (with predomination of quartz and hornblende) and layers richer in sulfides. B) Hornblende gneiss GN-442 photomicrograph showing nematoblastic texture, with oriented hornblende (hb), garnet (gr), galena (gl), and sphalerite (sp). Polarized light. Graphical scale = 1 mm.*

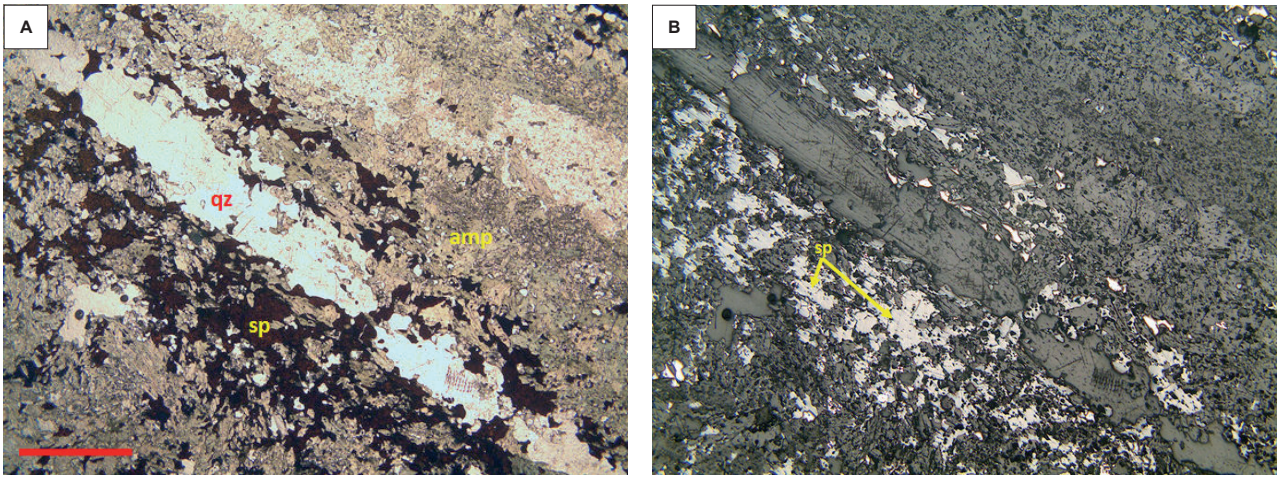

Figure 6: *A) Hornblende gneiss GN-442 with detail of the banding characterized by alternation of whitish layers with amphibole (amp) and quartz (qz), and dark, reddish sphalerite (sp)– rich layers, under plane-polarized light; graphical scale = 1 mm. B) Same field and same graphical scale of A, under reflected light, highlighting sphalerite (sp).*

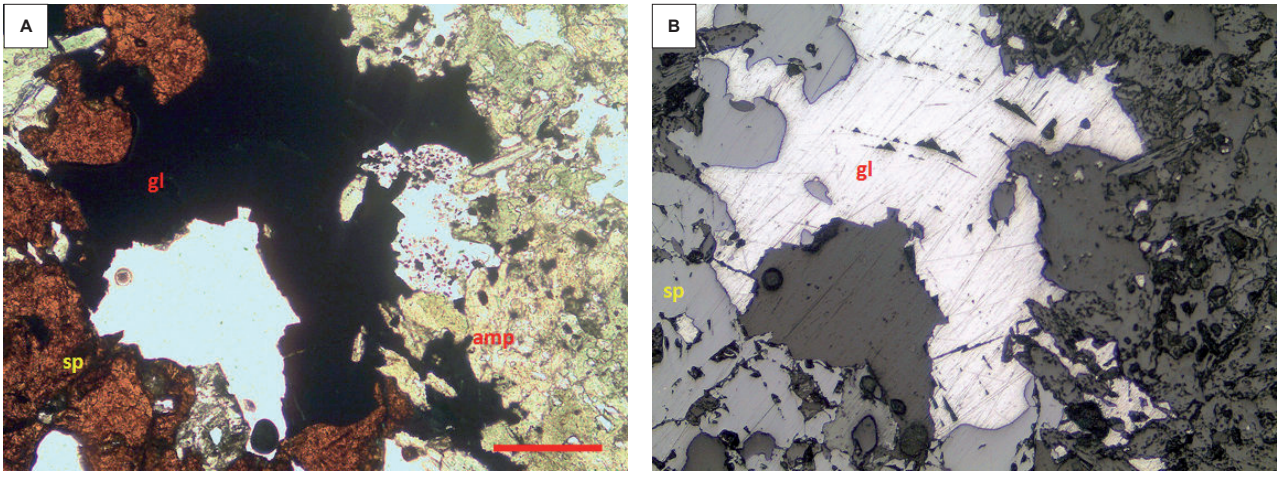

Figure 7: *A) Hornblende gneiss of the GN-442 outcrop, with detail of reddish brown sphalerite (sp) in contact with galena (gl) and amphibole (amp). Plane-polarized light; graphical scale = 0.5 mm. B) Same field and graphical scale of A, under reflected light, highlighting sphalerite (sp) and galena (gl).*

CHEMICAL ANALYSIS

The GN-442 sample was analyzed by ICP-MS for major oxides and 53 trace elements. The analysis of Pb (>1%), Zn (>1%), Se (>100 ppm) and Cd (>2000 ppm) exceeded the detection limits of the utilized method (Table 1, values in red characters). It must also be emphasized the high Ag (60.5 ppm) and Au (53.5 ppb) values.

FINAL CONSIDERATIONS

The follow up of aerogeophysical anomaly carried out by the Agrominerals of Rio Grande do Sul Project identified up to now the Três Estradas and Joca Tavares carbonatites, along with several other vestiges of prospective areas in the Sul-Rio-Grandense Shield. Among these areas, the new Pb-Zn-Cd (Ag) occurrence, named Cabeceiras do Lajeado, in the São Gabriel Terrane, was presented here.

The large-scale structural controls that allowed these recent discoveries by CPRM in the Sul-Rio-Grandense Shield are associated with aeromagnetometric and gamma spectrometric anomalies located mainly on crosscutting NE and NW lineaments.

In this same region, downstream the occurrence described here, the active stream sediment geochemical survey indicated gold anomalies from pan concentrates (Toniolo & Kirchner, 2001) and anomalous Pb, Zn and Ag contents in stream sediment samples (93 ppm Pb, 54 ppm Zn and 49 ppm Ag) in a drainage located upstream the occurrence described here (Laux et al., 2012), demonstrating the possibility of finding new prospective targets nearby.

The Pb-Zn-Cd (Ag) occurrence discovery at Cabeceiras do Lajeado (RS) opens the perspective to develop prospective works by private companies, which is an important contribution of CPRM – Geological Survey of Brazil to develop the mineral sector of Brazil. This work also shows the importance of using geophysics as a mineral prospection tool in the Sul-Rio-Grandense Shield.

Table 1*: GN-442 sample analytical results.*

Al_2O_3 %	CaO %	Cr_2O_3 %	Fe_2O_3 %	K_2O %	MgO %	MnO %	Na_2O %	P_2O_5 %	SiO_2 %	TiO_2 %	LOI %	TOT/C %	TOT/S %	Sum %
3.72	3.74	0.023	9.91	0.21	3.94	0.71	0.53	0.04	23.3	0.2	4.3	<0.02	15.91	50.63
Ba ppm	Be ppm	Ce ppm	Co ppm	Cs ppm	Dy ppm	Er ppm	Eu ppm	Ga ppm	Gd ppm	Hf ppm	Ho ppm	La ppm	Lu ppm	Nb ppm
243	3	8.8	89.6	0.4	1.12	0.66	0.44	6.2	1.37	1.4	0.26	6.4	0.11	2.6
Nd ppm	Ni ppm	Pr ppm	Rb ppm	Sc ppm	Sm ppm	Sn ppm	Sr ppm	Ta ppm	Tb ppm	Th ppm	Tm ppm	U ppm	V ppm	W ppm
5.7	119	1.23	6.6	5	1.19	74	79.2	0.2	0.18	1.3	0.13	0.2	76	< 0.5
Y ppm	Yb ppm	Zr ppm	Ag ppm	As ppm	Au ppm	Bi ppm	Cd ppm	Cu ppm	Hg ppm	Mo ppm	Ni ppm	Pb ppm	Sb ppm	Se ppm
8.2	0.85	41.5	60.5	<0.5	53.5	1.2	>2,000	25.0	2.03	2.6	41.9	>10,000	41.6	>100
Tl ppm	Zn ppm													
0.8	>10,000													

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