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Maria Lázara gold deposit (Goiás State, Brazil): An example of intense fluid/rock interaction associated with a triple point structure

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ABSTRACT : Since 1970, the Crixás region has been the aim of important gold exploration targets. The Maria Lázara gold deposit is one of the more recently exploited ore fields, and shows structural, mineralogical and geochemical features which reveal keys to the gold mineralization processes in the Guarinos greenstone belt. These include the remarkable Au-Bi-Te-S mineral association characterized by the uncommon geothermometer gold + maldonite, and the link between shear zone deformation processes in greenstone belts and local ballooning strain fields which result in the development of transtension zones providing sites for gold concentration.

1 GEOLOGICAL SETTING

The Maria Lázara gold deposit is situated in the Guarinos greenstone belt 45 km from Crixás city (Goiás, Brazil). The Archean volcano-sedimentary formation of the Guarinos forms a belt about 40 km long and 6 km wide, stretching in a NW-SE direction (Saboia & al 1979). It comprises a komatiite and metabasalt sequences with intercalations of metapelites, bifs, orthoquartzites and carbonaceous phyllites.

Maria Lázara gold mineralization is restricted to mylonitized metabasalts which mark the tectonic contact between the Guarinos greenstone belt and the granite-gneissic Moquem block. The shear zone evolution process is marked by the intrusion of successive granitoïd rocks of variable dimensions. The Guarinos dome is one such syntectonic trondjhemitic intrusion emplaced during the regional transcurrent shear zone system formation which induced an active deformation by a ballooning effect near the contact of the Guarinos greenstone belt and the Moquem block. The Guarinos dome intrusion resulted in the formation of transtension zones in which intense quantities of fluids percolated. Important fluid/rock interactions led to the formation of widespread hydrothermal alteration haloes within the reactive metabasalts, expressed by the closed superposition of carbonatization, chloritization, biotitization, sericitization, sulphidization and tourmalinization alteration processes.

2 TIMING OF THE MINERALIZATION

The Maria Lázara gold deposit occurs into a triple point structure (Brun & Pons 1981) developed by the Guarinos trondhjemitic intrusion during a wrench deformation (Pulz 1990). The Guarinos dome is elongated parallel to the stretching lineation of the shear zone and the regional foliation is often parallel to pluton boundaries. The long x axis of the strain ellipsoid is sub-horizontal in almost all the shear zone, except in a small zone in which gold mineralization was deposited, on the inner side of the triple point where the x axis shows a rake of 60°-70°S. This deposit is epigenetic and gold deposition is synchronous with shear zone deformation: (i) hydrothermal alteration is developed along the mylonitic foliation, i.e the fluids were canalized by the shear structure; (ii) the sulphidization is restricted to the ultramylonites; (iii) the sulphides exhibit deformational microstructures which are coeval with the crystallization of undeformed sulphide crystals; (iv) the structure in the "chocolate slab" of the auriferous veins enclosed within the mylonitic foliation.

Additionally, higher finite strains expressed by C-C' fabrics in intense hydrothermal alteration halos, compared with S and S-C foliations in less altered zones, also require a synchronism between the hydrothermal fluid circulation and shear zone deformation.

3 STYLES OF MINERALIZATION

Gold-bismuth-tellurium disseminated mineralization of the Maria Lázara deposit is found in : (i) hydrothermal alteration halos (potassic and sericitic zones) (ii) quartz-carbonate veins (iii) albite-carbonate veins. Irregular zoning, abundant crack-seal fractures (Ramsay 1980) and the presence of numerous fragments of wall rock alteration halo in the veins, illustrate the polycyclic episodes of mineralization related to shear deformation.

4 ORE MINERALOGY

Arsenopyrite is the dominant sulphide mineral and constitutes up to 60% of the associated metallic phases i.e. pyrite, and subordinate proportions of chalcopyrite, pyrrhotite and galena. Bismuth minerals (native bismuth, maldonite, bismuthinite) and Bi-Te-S complex species are the common mineral association. Bismuthinite, joseïte-B (Bi_4TeS) and csiklovaite (Bi_2TeS_2) were also identified.

Two main types of arsenopyrite occur: a S-rich early variety, forming the core of the crystals with numerous inclusions of silicates, sulphides, carbonate and ilmenite, and a later As-rich variety occurring either at the border of the early variety, or as free-crystals in the gangue. SEM analyses indicate monazite inclusions in arsenopyrite and gangue fractures.

Gold occurs as stringers and microveinlets in fractures through and between the gangue minerals. It also occurs in contact and inside the arsenopyrite. No combined state gold in arsenopyrite was revealed by QEM analyses (detection limit of 800 ppm).

Maldonite (Au_2Bi) is intergrown with native gold and suggests a low temperature formation(i.e. between 116°-371°C (Okamoto & Massalski 1983)), during gold precipitation.

5 DISCUSSION

At the regional scale, the intrusion of the synkinematic Guarinos dome, during the evolution of the transcurrent shear zone permitted the development of a triple point structure favourable for intense fluid-rock interaction.

At the gold district scale, the occurrence of small trondhjemitic dykes transformed into albite-carbonate veins, and the association of gold with a Bi-Te-S-As-B-P-Mo paragenesis within a potassic and sericitic alteration zone, suggests that these magmatic intrusions played a notable contribution in ore genesis.

Otherwise, the wide propylitic zone developed around the mineralized area, indicates a probable participation of metamorphic fluids (dynamic metamorphic fluids).

Additionally, textural and structural mineral features (Pulz 1990) marked by successive episodes of growing, deformation and recrystallization, the systematic crack-seal fractures in the veins and the high temperature (monazite) and low temperature (native Bi, gold + maldonite) mineral associations, indicate polycyclic mineral growth under episodic fluid pulses with variable fluid pressure and temperature conditions. Gold deposition occurred in low-hydrothermal conditions as shown by the Au_2Bi-Au geothermometer.

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