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## RE-OS ISOTOPE SYSTEMATICS OF SULFIDES AND KOMATIITES ASSOCIATED WITH GOLD MINERALIZATION FROM THE QUADRILÁTERO FERRÍFERO, BRAZIL

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**Resumo:** The Re-Os isotopic systematics of sulfides, oxides and komatiites associated with gold mineralization in the Quadrilateral Ferrífero (QF) of the Minas Gerais state, Brazil (southern São Francisco Craton), were investigated. These mafic/ultramafic rocks are part of the basal sequences of the Rio das Velhas *greenstone belt* and may represent a potential source of gold mineralization in metamorphic secretion models. Least altered komatiites from the western QF (Morro da Onça) preserve original magmatic textures, elemental distributions, and Os isotopic composition, whereas high degrees of serpentinization and chloritization have largely eliminated these features in komatiites from the eastern QF (Mina Francisco and Jaspe). The western komatiite with the highest concentration of Os (less susceptible to later hydrothermal alteration), has the least radiogenic  $^{187}\text{Os}/^{188}\text{Os}$  ratio and yields a model age of 3054 Ma. This age is significantly older than the ca. 2700 Ma age of upper felsic units of the Nova Lima group, but is consistent with ages as old as 3450 Ma recorded in detrital zircons within volcanoclastics of the Rio das Velhas *greenstone belt*. Alternatively, the unradiogenic  $^{187}\text{Os}/^{188}\text{Os}$  ratios of the komatiites can be explained by their derivation from a previously depleted lithospheric mantle ( $\gamma_{\text{Os}}$  of -2.3 at 2700 Ma). In contrast to the komatiites, sulfides associated with gold mineralization have highly radiogenic Os isotopic compositions, typical of continental crust lithologies. Sulfides from the Lamego mine are BIF-hosted (banded iron formation), have very low Os concentrations (0.02-0.06 ppb) at relatively high Re concentrations (0.23-1.81 ppb) and highly radiogenic  $^{187}\text{Os}/^{188}\text{Os}$  ratios (2.1-24.5). The Re-Os data of metapelite-hosted mineralization of the Córrego do Sítio (CS) mine form two distinct groups; the As/Au-rich sulfides have relatively high Os (0.45-0.48 ppb) and Re (5.09-5.45 ppb) concentrations, whereas paragenetically later As/Au-poor sulfides and magnetite have lower Os (0.1-0.06 ppb) and Re (0.71-0.22 ppb) concentrations with overlapping and relatively low  $^{187}\text{Os}/^{188}\text{Os}$  ratios (0.88-2.67). Regressing the isotopic data to likely ages of mineralization (2700, 2000, 600 Ma) yield negative Os isotopic compositions for all ages with the exception of a Brasiliano event at ca. 600 Ma. When combined with Os concentration data, two distinct linear trends are apparent, indicating mixing at ca. 600 Ma of Os between a source with high Os concentration and unradiogenic Os isotopic composition similar to the QF komatiites and one of two different upper crustal sources. In the case of CS As/Au-rich sulfides, this crustal source has a Re-Os signature similar to metaliferous shales with the metapelite host rocks being the likely mixing end-member. The crustal source of the later, non-mineralized sulfides and magnetite of CS as well as the sulfides of Lamego, has a Re-Os signature more typical of upper continental crust and this end-member likely represents metamorphic fluids derived from the Brasiliano orogeny. It is unclear at this time whether Os and by analogy Au was introduced to the host rocks as a result of Brasiliano-age fluids or if rather the Re-Os data records the final in a series of isotopic remobilization and gold redistribution events.

**Palavras-chave:** Re-Os; sulfides; gold.

## SHALLOW IRON OXIDE-COPPER-GOLD HYDROTHERMAL SYSTEMS IN THE CARAJÁS MINERAL PROVINCE, BRAZIL: EXAMPLE OF THE ALVO 118 DEPOSIT

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**Resumo:** The Alvo 118 iron oxide-copper-gold (IOCG) deposit (170 Mt @ 1,0 wt% Cu, 0,3 g/t Au), together with the world-class Sossego and Cristalino deposits, lie in the southern sector of the Carajás Mineral Province (CMP) along a steeply-dipping, WNW-ESE-striking, 60 km-long shear zone, close to the contact of the Itacaiúnas Supergroup metavolcano-sedimentary sequence (~2,76 Ga) and the basement (Xingu Complex; ~3,0 Ga).

The Cu-Au mineralization at the Alvo 118 is hosted by mafic and felsic metavolcanic rocks and crosscutting granitoid and gabbro bodies that have been subjected to the following alteration sequence towards the ore zones: (1) sodic alteration represented by albite and scapolite, indicating the circulation of hot (>500°C) and highly saline fluids; (2) potassium alteration dominated by biotite or K-feldspar, respectively, in mafic and felsic volcanic and intrusive rocks, accompanied by the formation of magnetite and silicification; (3) chlorite alteration spatially associated with carbonate-quartz ore breccia and vein stockworks that commonly display open-space filling textures; (4) local post-ore quartz - sericite alteration. The ore assemblage is dominated by chalcopyrite (80%), accompanied by bornite (10%), magnetite (10%), hematite (10%), and traces of Au-Ag tellurides, galena and cassiterite.

Preliminary fluid inclusion studies in quartz and calcite point to a fluid regime in which hot brine solutions, represented by < 10 vol.% of salt-bearing aqueous inclusions, are progressively cooled and diluted by lower temperature, low-salinity (< 10 wt% NaCl eq.) aqueous fluids defined by two-phase aqueous inclusions, by far the dominant type.  $\delta^{18}\text{O}_{\text{H}_2\text{O}}$  values between -1.9‰ and 10.7‰ calculated at 300°C from  $\delta^{18}\text{O}$  values obtained in calcite suggest strong interaction the ore fluids with the host rocks, as well as prolonged mixing with meteoric fluids. The  $\delta^{34}\text{S}$  composition of chalcopyrite (5.1‰ to 6.3‰) differs from a mantle/magmatic source adding the possibility of heavier sulfur sources (e.g., evaporite sulfate?) for the ore breccia and vein sulfides.

The restricted high temperature sodic alteration, the pervasive overprinting of the potassic alteration minerals (biotite and K-feldspar) by chlorite proximal to the ore zones, quartz-calcite-chlorite ore breccias/veins with open-space filling textures in brittle structures, and the  $\delta^{18}\text{O}$  data collectively indicate that the Alvo 118 IOCG system developed at structurally higher levels and experienced the influx of evolved meteoric water.

In this context, the Alvo 118 resembles the Sossego orebody of the Sossego IOCG deposit. However, the ore geochemistry of the Alvo 118 deposit [Fe-Cu-Au-(Te-Ag-Pb-Sn)-P-F-ETR] differs from the Sossego IOCG ore by the absence of Co-Ni-Pd-bearing phases and presence of F. Dissimilar from other IOCG deposits of the CMP where LREEs are commonly enriched in apatite, allanite and monazite, the Alvo 118 ore displays enrichments of HREEs. In this deposit the HREEs are mainly concentrated in apatite and in an Al-poor, Be-B-HREE silicate of the gadolinite group which has never been reported in IOCG systems worldwide.

**Palavras-chave:** Carajás Mineral Province; Alvo 118 deposit; Gadolinite.