



Epigenetic hydrothermal origin for the copper mineralization in the Vista Alegre district, Paraná volcanic province, southernmost Brazil

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ABSTRACT

Deposits dominated by native copper are rare because reduced S-poor hydrothermal environments are uncommon. Continental flood basalts such as the Paraná volcanic province in South America may host native copper deposits in favorable conditions in spite of the near-absence of sulfur in the volcanic system. The widespread mineralization of native copper in the Paraná tholeiitic lavas occur both in cooling joints of the inflated pahoehoe lobe cores and in amygdaloidal upper crusts. Although economic copper ore has been exploited from basalts in several places (e.g., Keweenaw Province, USA; Zhaotong Province, China), little attention has been paid to the currently uneconomic mineralization in the voluminous and extensive Paraná basalts. These occurrences are presently designated the Vista Alegre district, straddling the border of the states of Rio Grande do Sul and Santa Catarina and reaching Paraná state, southernmost Brazil because of the large number of native copper occurrences (n = 85) in the region.

An industrial test was made on the copper mineralization from the Vista Alegre district in the 1990 decade by Companhia Brasileira do Cobre. Several thousand tons of selectively-picked native copper, copper oxides and chrysocolla from Realeza, SW Paraná state (300 km to the north of Vista Alegre town), were smelted with average 6% contained Cu. Two main hypotheses were presented for the origin of the native copper mineralization, namely epithermal/hydrothermal or syngenetic related to lava solidification.

The high average 220 ppm Cu content of the basalts resulted in ore of native copper, Cu oxides, abundant chrysocolla in the top of mineralizations and minor malachite and azurite. Native copper is associated with dioctahedral and trioctahedral smectites, zeolites (heulandite and clinoptilonite), quartz and calcite, typical of a low-T (100-150°C) hydrothermal alteration assembly. No evidence of sulfur or chlorine-rich fluids is seen in the Vista Alegre hydrothermal system. The deposition of copper preceded by smectites and siliceous zeolites indicates that the fluids responsible for the transport of Cu were rich in water. The PGE distribution shows enrichment in Pd in relation to Pt both in basalts and in native copper, supporting the hypothesis of hydrothermal origin of the mineralization. No evidence was found of direct precipitation of copper from the lava; based on field and petrographic evidence, integrated with BSE images, EPMA analyses, PGE contents of native copper and bulk rock analyses, this is an epigenetic hydrothermal copper mineralization, followed by supergene enrichment.