

## **The Bongarà Zn-Nonsulfides District in Northern Peru: Mineralogical and Geochemical Characteristics**

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The Bongarà complex of deposits (Cia. Minera Pilar del Amazonas S.A.) is located in the Amazonas District, near the Yambrasbamba Village (Peru). It consists of a stratabound Pb-Zn sulfide mineralization, hosted by Mesozoic limestone (Toarcian) of the Pucarà Group (Condorsinga Formation), which is almost totally weathered to nonsulfides. The primary mineralization is considered an MVT, similar to the recently discovered Florida Canyon deposit nearby (Compañia Minera Milpo S.A.A.) and to the San Vicente mineralization in central Peru. There are multiple distinct ore concentrations scattered over a large area (Mina Grande, Mina Chica, Rio Cristal, and others), and the mineralization appears to be open-space filling and/or manto replacement locally associated with karstification. The economic value is currently considered as related to the concentrations of nonsulfide Zn minerals. The ore grade is quite high (up to 35% Zn), with the metal mostly contained in hydrozincite (Mina Grande), smithsonite, and hemimorphite (Rio Cristal). The Mina Grande deposit comprises several, partly exploited mineralized areas, where the ore consists of nonsulfide concentrations (mainly hydrozincite >> hemimorphite-smithsonite and Zn clays) mixed with brown soil. The mineralized body is 1.5 km long, 0.4 km wide, and extends to depths of 20 to 60 m below surface. The economic mineralization is concentrated in karstic cavities and earthy-looking mantos. The zinc "oxides" form a residual cap along the crest of an anticlinal structure. This mineralization can be classified as belonging to type 3 (residual in karsts cavities) among the supergene nonsulfide deposits. The Rio Cristal prospect is probably the most extensive area of zinc mineralization occurring at Bongarà to date. Diamond drilling has encountered both near-surface primary base metal sulfides and oxidized mineralization at depths of over 50 m down-hole, with grades of up to 20 to 30% Zn. The mineralization occurs in a sigmoidal zone, approximately 1.5 km long by 0.5 km wide. Several subhorizontal manto-like bodies have been detected, which dominantly consist of masses of zinc "oxides," which include smithsonite, hemimorphite, Zn clays, and Fe-(Zn) hydroxides with minor to trace sulfides occurrence.

A mineralogical, petrographic, and isotope geochemical study of the Bongarà complex of deposits is being conducted by our research group. To calculate the temperature of smithsonite precipitation at Rio Cristal, a mean  $\delta^{18}\text{O}$  value has been considered between those of rain and groundwater in the area. To calculate the temperature of calcite (and cogenetic hydrozincite) at Mina Grande, the mean  $\delta^{18}\text{O}$  annual value of the meteoric water (IAEA) has been considered. The temperatures resulting from stable isotopes geochemistry are comparable with the mean annual temperature values in the Bongarà district (21°–23°C). Therefore, the supergene mineralization should be related to weathering episodes (Tertiary to Recent) occurring under a climate not very different from that of today.