

Petromineragraphic Analysis and Vectoring of Hydrothermal Sources in the Intermediate-Sulfidation Epithermal Deposit of the El Santo Mine, Caylloma, Arequipa, Peru

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The study of the El Santo mine enabled the comprehensive characterization of an intermediate-sulfidation epithermal deposit, hosted in volcanoclastic and andesitic rocks of the Tacaza Group, in normal contact with limestones of the Yura Group, as well as with intrusive bodies surrounding the Caylloma caldera. Mineralization is structurally controlled by the Yuliana and El Santo veins. The research included the analysis of 295 rock samples (hand specimens and drill core), complemented by 20 thin sections and 2 polished sections, using spectral techniques (PIMA–Terraspec and LabSpec4), in addition to petrographic and mineragraphic studies.

Spectral analysis identified white micas with Al–OH absorption features between 2200 and 2215 nm, highlighting the presence of phengite as an indicator of high-temperature conditions. Variations toward wavelengths close to 2215 nm indicate more phengitic compositions and suggest proximity to deeper hydrothermal fluids. Although a classical epithermal zonation is not recognized, the predominance of phengite constitutes a vector toward higher-temperature zones within the system.

Mineragraphic studies revealed the presence of sillimanite and garnet, associated with an initial brecciation event followed by hydrothermal fluid circulation, indicating a dynamic system controlled by structural and thermal processes. Additionally, a predominant NE–SW orientation with a plunge of 60°–70° was defined, supported by the distribution of Pb, Zn, Ag, and Cu isovalues, as well as spectral mapping of white micas.

The integration of these results represents a significant contribution, as it allows the definition of exploration vectors at depth and improves the understanding of the mineralizing system. In this context, the study demonstrates a high potential for mineralization continuity and suggests a transition toward skarn- or porphyry-type deposits, significantly increasing the prospective value of the deposit and its relevance for future mineral exploration programs.