

Chlorite and Epidote Mineral Chemistry as Vectoring and Fertility Indicators for IOCG Deposits: The Candelaria-Punta del Cobre District, Chile

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Chlorite and epidote mineral chemistry are viable tools for porphyry copper deposit (PCD) exploration. However, these minerals also occur in iron oxide–copper–gold (IOCG) systems, including the Candelaria deposit in Chile. Here, we present systematic spatial trends of chlorite and epidote relative to the deepest zone (root) of the mineralized bodies from 42 samples in the Candelaria–Punta del Cobre district, analyzed by SEM-EDS and LA-ICP-MS.

Chlorite is a late-stage alteration mineral, whereas epidote occurs in multiple stages. Early epidote is rare earth element (REE)-rich and is associated with actinolite, sulfides, and garnet. Later epidote is REE-poor and occurs with chlorite.

Nickel in chlorite shows an exponential decrease with distance from the root of the Candelaria orebody, whereas Cu increases in distal samples. In chlorite, Mn and Li define halos at ~700–1,000 m from the root, and similar halos occur in epidote for Mn, B, As, and Sb. Titanium shows no clear trend, although some distal sheared samples have high Ti (>1,000 ppm).

Increased incorporation of Mn and Li in chlorite may be linked to cooling, whereas lower distal sulfide abundance may enhance As and Sb incorporation in epidote and Cu in chlorite. Element depletion in the fluid may explain decreasing concentrations away from halo maxima. Early-formed minerals such as oxides and sulfides may control element availability through sequestration or remobilization, potentially explaining the lack of a systematic trend in Ti and high Ni content (>1,000 ppm) in chlorite.

Compared to PCD systems, IOCG-related chlorite and epidote display similar Mn, As, and Sb abundances, commonly used as fertility indicators, low base metal contents (Zn, Pb), and enrichment of Ni, U, REE, and Li, the latter likely reflecting a basinal brine component. These results highlight the potential of chlorite and epidote chemistry as vectoring and fertility indicators in IOCG exploration.