

Chlorite Trace Element Chemistry as an Exploration Tool: A Case Study from the Collahuasi Mining District, Northern Chile

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A common feature of many deeply eroded porphyry and epithermal deposits is the presence of laterally extensive (up to 5–10 km wide), zoned hydrothermal alteration halos. The propylitic alteration halos surrounding the Rosario and Ujina porphyry Cu-Mo deposits of the Collahuasi district in northern Chile are no exception. In this study we provide an evaluation of chlorite mineral chemistry within the propylitic alteration environment surrounding the Rosario and Ujina deposits and its potential as an effective tool for mineral exploration.

Rock chip sampling, conducted as part of AMIRA International research project P765A, detected elevated Cu and Mo concentrations up to ~1.5 km laterally from the center of both Rosario and Ujina. Anomalous concentrations of Pb and Zn also extend laterally to distances of ~2 km at both deposits. However, other trace metals such as Mg, V, Ti, As, and Sb do not show anomalous values in whole-rock geochemistry. Arsenic concentrations increase to > 0 ppm around the La Grande high sulfidation epithermal vein system, approximately 2 km south of Rosario.

In contrast, Ti, V, Zn, Mn, Mg, and Li concentrations in propylitic chlorite are significantly enriched relative to their whole-rock compositions, with some of these elements showing systematic spatial variation with increasing distance from the centers of porphyry mineralization. Zinc and Mn concentrations in chlorite deposits are generally greater than 2,500 and 5,000 ppm, respectively, and are detected 0.9 to 3.0 km from the deposit centers. Significantly, these peak concentrations were obtained from rock chip samples that contained on average less than 2,500 ppm Zn and 3,000 ppm Mn. Anomalous concentrations of Zn (up to 1.7 wt %) and Mn (up to 5.0 wt %) were also recorded in chlorite from the La Grande high sulfidation epithermal system. Titanium, V, and Mg concentrations were observed to generally decrease with increasing distance, whereas Li and Sr concentrations increase. Consequently, ratios of the above elements can be formed to provide useful vectoring parameters towards mineralization.

Systematic variation in Mg, Ti, V, Zn, Mn, Sr, and Li concentrations in chlorite provide effective exploration tools for locating the centers of the Rosario and Ujina porphyry Cu-Mo deposits, at distances greater than conventional rock chip assaying. Anomalous trace element concentrations in chlorite can also be used to distinguish areas of high sulfidation epithermal mineralization from the porphyry deposits. In addition, the concentrations of these elements can be used to distinguish chlorite formed through hydrothermal alteration processes from metamorphic chlorite formed by regional metamorphism, allowing for the outer fringes of porphyry-related hydrothermal systems to be confidently identified.