

Geochemical and Mineralogical Footprints in the Porphyry-Lithocap Transition: Constraints From the Valeriano Cu-Au ± Mo Deposit, Chile

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Base cations (K^+ , Na^+ , Ca^{2+} , Mg^{2+}), which are structural components of both rock-forming and alteration minerals, are highly soluble under neutral to acidic pH conditions and decreasing temperature. The compositions and solid solution of main alteration minerals in porphyry deposits, such as feldspar, white mica, and alunite, are strongly controlled by alkali solubility in the fluid and the composition of the protolith, whereas their trace-element endowment appears to be influenced by the protomineral being replaced, among other variables. White mica (sericitic) alteration occupies a large volume of rock between the porphyry and lithocap environments. White mica, the dominant alteration mineral, displays a well-defined compositional zonation in response to progressive changes in temperature, pH, and redox conditions. Low-Al phengitic muscovite occurs at depth overprinting K-silicate alteration, grading upward into near end-member muscovite in the central parts of the white mica alteration zone, and further upward into high-Al, interlayer-deficient muscovite intergrown with pyrophyllite immediately below advanced argillic alteration. In contrast, distal white mica is also interlayer-deficient but is phengitic in composition. Several oxyanion-complexed elements, including Mo, W, Sn, As, Sb, and Te, are sequentially deposited along the hydrothermal plume. Some of these elements, together with lithophile elements such as Sn, Rb, and Tl, are deposited in patterns that mimic compositional variations in white mica, whereas other elements remain in the hydrothermal fluid and are transported farther outward. Upon reaching the most acidic parts of the system, within zones of massive to vuggy quartz alteration, Rb, Li, Cs, Tl, and other alkalis are extensively leached from the rock. These elements subsequently precipitate in adjacent rocks under lower temperature and near-neutral pH conditions, where they are fixed in clay minerals, and generate positive geochemical anomalies surrounding advanced argillic alteration zones.