

Anatomy of a Moderately-Telescoped Porphyry–High Sulfidation System: Insights of a 2-km Vertical Profile of Alteration at Valeriano Cu-Au Deposit, Chile

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The Valeriano Cu-Au deposit is located within the El Indio metallogenic belt in the Chilean Central Andes. In the last decade, deep drilling beneath the Valeriano lithocap resulted in the discovery of a concealed Cu-Au ± Mo porphyry system at depth, providing a 2-km vertical profile of alteration from the shallow high-sulfidation epithermal to the porphyry environment. Porphyry-style mineralization was temporally and spatially associated with the emplacement of a series of hornblende-biotite-bearing porphyries of granodioritic composition, and related magmatic-hydrothermal breccias between 10.39 ± 0.19 and 10.12 ± 0.18 Ma, based on zircon U-Pb ages. These intrusions at depth produced Cu-Au ($>0.7\%$ CuEq) mineralization of chalcopyrite and lesser bornite and molybdenite coupled with K-silicate alteration between 10.55 ± 0.05 and 10.1 ± 0.04 , as determined by molybdenite Re-Os ages. K-silicate alteration is overprinted by classic quartz-muscovite ± chlorite (sericitic) alteration containing chalcopyrite and pyrite. This assemblage transitions upward to a thick zone of quartz-muscovite ± pyrophyllite at the base of the lithocap that is intimately associated with low-grade, high-sulfidation state Cu sulfides and Cu-As sulfosalts dominated by bornite, digenite, chalcocite, and minor covellite. The upper part of the lithocap consists of concentrically zoned advanced argillic alteration characterized by different proportions of quartz, alunite, kaolinite, and pyrophyllite, centered on stratiform or structurally controlled zones of massive and vuggy quartz. These zones host discrete Au-bearing enargite epithermal mineralization, which occurs in breccias, veins, as well as open space fillings, which seem to be the remnants of a larger eroded high-sulfidation system. Muscovite and alunite Ar-Ar ages from zones of sericitic and advanced argillic alteration, respectively, yielded ages between 10.151 ± 0.024 and 10.038 ± 0.014 , that overlap with the age of porphyry intrusion and associated mineralization, suggesting that porphyry and epithermal mineralization at Valeriano formed over a short period between 690–510 k.y.