Hypogene Alteration and Mineralization at the Conchi Porphyry Cu-Mo Deposit, Northern Chile: Assemblages, Zoning, and Age

J. Perelló,[†] G. Saldías, M. Gonzalez, R. Henríquez, and S. Giglio

Antofagasta Minerals S.A., Apoquindo 4001, Piso 18, Santiago, Chile

[†]Corresponding author: e-mail, jperello@aminerals.cl

The Conchi porphyry Cu-Mo deposit is centered on a composite, W- to NW-trending dike swarm of granodioritic to rhyodacitic composition emplaced into andesitic volcanic rocks of the late Carboniferous-Early Triassic Collahuasi Formation. The porphyry system has been studied over a vertical extent of ~1,500 m and remains open at depth.

Three main porphyry phases (A, B, and C) are present, with the first two (A and B) associated with the bulk of the Cu-Mo mineralization. Porphyry C is a barren, late-mineral phase. At ~800 m depth, the shallow porphyry dikes coalesce to form a larger, more coherent porphyry body, several hundred meters in diameter. All three porphyry phases contain phenocrysts of plagioclase, quartz, biotite, and amphibole in a fine-grained groundmass of similar composition. Porphyry C is coarser grained and flow banded, and sanidine bearing in its shallower parts.

Conchi is characterized by a vertically zoned alteration-mineralization geometry. The sulfide-bearing assemblages overprint barren, premineral biotitization, which generated a broad halo of biotite hornfels in the andesitic country rocks. Deeper parts of the system (>800 m) preserve early, productive alteration defined by quartz, K-feldspar, biotite, chlorite, sericite, andalusite, and corundum. Partly coalesced, halo-dominated EDM-type veinlets, containing chalcopyrite, bornite, and magnetite, are conspicuous within this zone. At intermediate levels (400–800 m), this early assemblage is dominated by quartz and sericite (± K-feldspar and chlorite), which totally overprint porphyry phases A and B. Disseminated and hairline fracture-controlled chalcopyrite is characteristic, together with moderate amounts of pyrite and trace bornite. Higher in the system, this alteration grades both laterally and vertically to sericite-chlorite assemblages, with increased pyrite contents, which at shallow levels favored the formation of a supergene chalcocite blanket.

A second stage of more conventional potassic alteration is accompanied by A and B veinlets containing quartz and K-feldspar. These veinlets cut all previous assemblages at deep, intermediate, and shallow levels, with veinlet intensity increasing notably with depth. Deep-seated (>800 m) A and B veinlets cutting porphyry A in the central parts of the system are poor in Cu sulfides, although the B veinlets continue to carry appreciable molybdenite. At the intermediate levels (400–800 m), A and B veinlets contain abundant chalcopyrite, which, together with chalcopyrite of the early stage, constitutes the main hypogene Cu-Mo mineralization in the deposit.

A third event defined by quartz-sericite ± chlorite alteration is associated with pyritic D veinlets. This event also produced local, lithologically controlled, andalusite-bearing advanced argillic alteration in tuffaceous horizons of the Collahuasi Formation. Late-mineral, polymetallic quartz ± calcite veins, with wide sericitic halos, contain massive to semimassive fillings of chalcopyrite, pyrite, sphalerite, and galena plus subordinate molybdenite and trace Au and Ag. There is a spatial association between these veins and late-mineral porphyry C and pebble dikes. Anhydrite is an integral component of all veinlets and alteration generations, from the early, halo-rich EDM to late, sulfide-bearing sericitic veinlets.

Porphyry phases A, B, and C were emplaced between 36.8 ± 0.6 and 35.2 ± 0.5 Ma (seven samples; U-Pb zircon ages), contemporaneously with molybdenite-bearing B and D veinlets with ages between 36.47 ± 0.15 and 35.45 ± 0.14 Ma (four samples; Re-Os).