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Multiple Centers of Mineralization in the Indio Muerto District, El Salvador, Chile

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Abstract

The porphyries that formed copper deposits in the Indio Muerto district include both 44 Ma rhyolitic subvolcanic intrusions and 42 to 41 Ma granodioritic stocks and dikes. All are aligned for 4 km along a north-northeast trend, which is the apparent hinge line of a 58 Ma trap-door caldera. Three separate centers of mineralization were associated with the earlier rhyolites, Cerro Pelado, Old Camp, and probably M Gulch-Copper Hill. Four separate centers were associated with the later granodiorites, M Gulch-Copper Hill, O Nose, Turquoise Gulch, and Sector Granito. Patterns of lithology, structure, mineralization, and alteration in the various centers, which have been documented by systematic mapping partially supported by studies of mineralogy and geochemistry, are presented and compared to the previously described Turquoise Gulch center.

Cerro Pelado is a 750-m diameter rhyolitic volcanic neck, intruding host andesite at the northeast end of the district. Very weak Cu but much stronger Mo mineralization, with analogies to Climax-type deposits, is associated with this intrusion. Surficial sericitic alteration with weak pyrite-(chalcopyrite-bornite)-specularite-gold mineralization shows decreasing sericite, pyrite, Cu, and Au contents downward. This strong vertical zonation grades downward to alkali feldspar-biotite alteration with increasing molybdenite and magnetite content below an abrupt top of quartz veining. The Old Camp is a 250-m diameter, roughly cylindrical body of disseminated chalcopyrite-bornite and quartz veining with K feldspar-biotite alteration, centered within a rhyolitic quartz porphyry dike. This dike was emplaced and mineralized within 1 m.y. of Cerro Pelado. Mineralization zones outward through chalcopyrite-pyrite to pyrite with sericite-chlorite and then chlorite-epidote-albite alteration. A supergene sulfide enrichment blanket has been largely oxidized. M Gulch-Copper Hill was first mineralized in and around quartz porphyry dikes with quartz veining, disseminated chalcopyrite-bornite, and K feldspar-biotite alteration.

Roughly 1 m.y. later, intrusion of a series of feldspar porphyries and igneous breccia displaced the center of the mineralization at M Gulch-Copper Hill. Late-stage hydrothermal activity reworked earlier mineralization and superimposed pyrite-chalcopyrite assemblages with sericite. Aside from some rich D veins containing pyrite-bornite-digenite, economic grade in the M Gulch-Copper Hill pit is mostly due to supergene enrichment. Ore at O Nose was largely supergene chalcocite-covellite on chalcopyrite-pyrite, centered on early QG feldspar porphyry and brecciated and biotized andesite. Subsequent intrusion of intramineral L feldspar porphyry and late hydrothermal activity apparently reworked earlier mineralization. At the contact, this produced a fringing chalcopyrite-pyrite zone in andesite, which is sharply zoned upward to pyrite-bornite-chalcopyrite with higher grade. This is apparently the same L porphyry that intruded the center of the main Turquoise Gulch orebody and controlled transitional and late patterns of alteration and mineralization described previously. The supergene enrichment blanket which makes ore in Sector Granito, to the southwest of Turquoise Gulch, is connected to the main orebody but primary mineralization is spatially separate and related to a different set of intrusions. Although less well known than other centers, a chalcopyrite-bornite core is apparently related to unusually intense, texture-destructive K feldspar alteration in early equigranular X porphyry and later

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G feldspar porphyry. This core mineralization grades outward to pyrite-sericite and abruptly upward to pyrite-bornite-chalcopyrite with sericite-andalusite-pyrophyllite-diaspore. Extending the trend to the southwest is the barren Granite Gulch feldspar porphyry, emplaced between the two mineralizing periods.

$^{40}Ar/^{39}Ar$ dating demonstrates that two episodes of mineralization associated with the early rhyolitic and later granodioritic intrusions each lasted approximately 1 to 1.4 m.y., from 44.5 to 43.5 and 42.3 to 40.9 Ma, respectively. The barren Granite Gulch porphyry and perhaps the early and equigranular X and O porphyries were intruded between 43 and 42 Ma. Magmatic activity, therefore, occurred episodically over at least 3 m.y. The individual centers are best explained as expressions of different cupolas on a magma chamber, which evolved from granitic to granodiorite to quartz diorite with progressive injection of new magma. Despite our best efforts to date 16 carefully selected samples, it was not possible to define the sequence and duration of the partially overlapping centers within each of the larger mineralization periods. The different centers exhibit a wide diversity of characteristics, which mirror variations on the general theme of porphyry Cu-Mo development. Changing hydrothermal input from an evolving and growing magma chamber and major remobilization of early mineralization by both intrusion and hydrothermal activity are major factors in this diversity.□