Discovery and Geology of the Undeveloped Codelco’s Gaby Copper Deposit

Angelo Aguilar, Marco Gomez, and Pedro Pérez
Codelco-Chile, Gerencia Corporativa de Exploraciones. Huérfanos 1270. Santiago, Chile (AAguilar@codelco.cl)

The Gaby Project is a porphyry copper deposit with a well-developed oxide orebody. The project lies in the same metallogenic belt that hosts Chuquicamata and La Escondida in the Antofagasta Region, northern Chile, and ~100 km south of the Chuquicamata mine. Discovery was the result of an extensive exploration program undertaken by CODELCO that focused in areas with important post-mineralisation cover, and used airborne magnetics, regional mapping, stream sediment sampling, detailed mapping of surrounding outcrops and reverse circulation drilling as main tools. Copper mineralisation was discovered by a drill hole in April of 1996, which intercepted 78 m @ 0.69% Cu beneath 42 m of barren gravel. Since then, approximately 100,000 m of drilling (63% DDH) distributed in a 100x100 m grid with local in-filling at 50-m have been drilled and used for geological modeling and ore resource estimation. Recently, a shallow exploration shaft (85 m deep plus additional 400 m of horizontal underground developments) gave access to the upper part of the oxide zone, and helped to confirm the horizontal continuity of the high-grade mineralisation. At 0.20%Cu cut-off grade, total leachable resources are 890 Mt @ 0.40% Cu. Primary sulphide resources remain poorly explored to date.

The deposit is entirely buried by a 40 to 50-m thick gravel cover. Country rocks to the porphyry system include the Pampa Elvira granodioritic complex (280 Ma) and the Carboniferous Quebrada Escondida metavolcanic and metasedimentary rocks. Two Tertiary-aged (40-43 Ma) porphyry and breccia bodies, including the dike-like Gaby and Crowed porphyries are thought to have been responsible for the primary, low-pyrite mineralisation and associated potassic (biotite >K-feldspar) alteration. Phyllic alteration assemblages occur laterally to the potassic core and are controlled by structures. Main structures of the area include a splay of the Domeyko Fault Zone and an intersecting NE-trending fault. Both have been proposed as the main controls for the emplacement of the copper-bearing porphyries, in intimate association with Eocene (Incaic) compression.

The deposit consists of an approximately 1,200 m (EW) by 2,200 m (NS), 250-m thick oxide orebody formed at the expense of a low-pyrite, chalcopyrite-bornite protore. Mixed ore and secondary enrichment products (chalcostite) are scattered and form a several-meter thick irregular blanket at the redox interface. No leached capping occurs, and the mineralisation lies directly at the contact between the 10-Ma gravels and bedrock. Within the oxide zone chrysocolla is the main economic mineral, occurring both as fracture fillings and disseminations, accompanied by minor amounts of atacamite and traces of malachite, pseudomalachite, brochantite, cuprite, and native copper (the “green oxides”). Black copper oxides (neotocite, copper wad/pitch,) are widespread throughout the deposit. K and Na cation replacement by Cu\textsuperscript{0} and Cu\textsuperscript{+2} in biotites has also been determined. Copper solubility (measured as the ratio between assayed acid-soluble copper and total copper) decreases as the black/green oxides ratio increases. Limonite occurs laterally, associated with the pyrite halo.

The copper oxide assemblage is characteristic of a moderate-pH weathering environment in a reactive host rock, with limited lateral copper mobility. An early, poorly developed chalcocite blanket would have been formed in association with erosion of a phyllic assemblage overlaying the main potassic core. The process responsible for the distribution of the oxide minerals included oxidation associated with fluid flowing in the vadose zone and oxide enrichment near a fluctuating paleo-watertable. The presence of dominating potassic alteration and the lack of a pyrite-rich phyllic assemblage favored this process and the preservation of the oxide orebody. Due to the nature of this process, a mineralogical zoning that includes a shallow, central zone, dominated by chrysocolla and a peripheral zone in which chrysocolla decreases and the black/green oxide ratio increases, is apparent. This zoning is schematically shown below:

\[ \text{High} \Rightarrow \text{Medium} \Rightarrow \text{Low Chrysocolla intensity} \Rightarrow \text{Chrysocolla+Black Oxides} \Rightarrow \text{Black Oxides} \]

Todas las contribuciones fueron proporcionados directamente por los autores y su contenido es de su exclusiva responsabilidad.