Lifetimes of Chilean Porphyry Copper Deposits

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Chile and Perú are currently the major copper producers in the world. During 2010, Chile produced 5.41 million tons of fine copper, which represents 33.7% of world copper production, and Perú produced 1.25 million tons of fine copper (7.7% of world production). The main source of copper is from porphyry Cu-Mo deposits, and in the central Andes these deposits are located within five metallogenetic belts. These belts are parallel to the Pacific margin, and their ages reflect the migration of the magmatic arc since the Cretaceous. Although all five belts have productive deposits, the late Eocene-early Oligocene and the late Miocene-Pliocene belts contain some of the largest porphyry Cu-Mo deposits in the world. The late Eocene-early Oligocene belt hosts several porphyry copper deposits, among which are some of the most important copper deposits in Chile, such as Chuquicamata, Escondida, and Collahuasi deposits. The late Miocene-Pliocene belt hosts the largest porphyry Cu deposit in the world (El Teniente) and other large deposits such as Rio Blanco-Los Bronces, Los Pelambres-El Pachón, and the recently discovered San Felipe-Pimentón cluster.

The Chuquicamata district, which includes the Radomiro Tomic, Chuquicamata, Mina Ministro Hales (MMH), the exotic Mina Sur, and the Toki cluster (Toki, Quetena, Genoveva, Miranda, Opache) formed over a period of 8 m.y. The Toki cluster formed within a very short period, probably within 2 m.y., with Toki, Quetena, and Genoveva emplaced early at ~38 Ma, followed by Opache at ~37 Ma, and Miranda at ~36 Ma. Compilation of previously published ages from Chuquicamata and new Re-Os molybdenite ages indicates that this deposit was emplaced over about 4 m.y. (35–31 Ma), possibly synchronously with Radomiro Tomic.

Geochronologic data for the Escondida district shows that Escondida Norte was emplaced first at 37 to 38 Ma, followed by Escondida (36–35 Ma). Zaldivar appears to have formed over a larger time span (37–35 Ma). At the Collahuasi district (Quebrada Blanca, Rosario, Ujina), combined dating techniques indicate that emplacement of these deposits occurred at 37 to 35 Ma, within a time span of 2 to 3 m.y.

In the late Miocene-early Pliocene belt, the El Teniente deposit was emplaced between 6.3 and 4.3 Ma, basically at the same time as the Rio Blanco-Los Bronces deposit (6.3–4.3 Ma). Farther north, the Los Pelambres deposit was emplaced at 12 to 10 Ma, followed by El Pachón at 9.2 to 8.4 Ma. The San Felipe-Pimentón cluster hosts several minor deposits with emplacement ages that range from 16 to 8 Ma (e.g., Novicio, 14–16 Ma; Vizcachitas, 12–10 Ma; Pimentón, ~10 Ma; Amos-Andrés, ~10–8 Ma; West Wall, ~9.8 Ma).

Although the new geochronologic data indicates that large porphyry systems appear to be the results of several episodes of mineralization over a short period of 2 to 4 m.y., it is clear that several interrelated factors such as the structural control, magma source, fluid/rock interactions, and climate also contribute in the deposit formation and evolution.