EVOLUTION OF THE LOS PELAMBRES – EL PACHÓN PORPHYRY COPPER-MOLYBDENUM DISTRICT, CHILE/ARGENTINA

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World-class porphyry Cu-Mo mineralization in the Mio-Pliocene sub-province of Central Chile and contiguous Argentina was initiated in the Los Pelambres – El Pachón district. These adjoining deposits, centred respectively at Lat. 31°42’S, Long. 71°29’W and 31°45’S, 70°26’W, constitute a behemothian (e” 31.62 Mt Cu: Clark, 1993) concentration, and the occurrence of tonalite porphyry dykes and K-silicate alteration in the intervening 7 km has led to the assumption that ore formation took place simultaneously in the two centres (e.g., Sillitoe, 1973; Sillitoe and Perelló, 2005). However, new multi-sample geochronological data for magmatic (LA-ICPMS zircon), hydrothermal (Re-Os molybdenite) and supergene (40Ar/39Ar jarosite) events, integrated with (U,Th)/He (zircon and apatite) and 40Ar/39Ar thermochronology, delimit an extended period of Middle to Late Miocene magmatic-hydrothermal activity and demonstrate that mineralization at El Pachón occurred significantly later than that at Los Pelambres. Moreover, the data clarify the late-Neogene tectonic environment in the Cordillera Principal at this latitude and permit temporal correlation with Cu-Mo mineralization further south at Río Blanco-Los Bronces (4.5 to 5.9 Ma; Deckart et al.,
Field observations and detailed mapping suggest that local and regional N-S extensional structures delimit and probably controlled the intrusion emplacement at Los Pelambres during their reactivation. This tectonic fabric, also evident on the eastern slope of the Cordillera Principal, comprises numerous, N-S–elongated, structural blocks bounded by high-angle, east-vergent, contractional faults. Hypabyssal intrusions, including intra-mineralization porphyry bodies at Los Pelambres, were emplaced in a block overlain by lowermost-Miocene, Abanico Formation, volcanic units translated by high-angle faults over a footwall basement block on the east.

The Middle Miocene Los Pelambres tonalitic–dioritic intrusive complex is hosted by strongly deformed volcano-sedimentary successions of the Neocomian Los Pelambres (139 Ma) and Upper Cretaceous Salamanca (118 Ma) Formations, enclosing tectonic slivers of the rhyolitic Choiyoi Group (265 Ma). Precursor intrusion was initiated at 13.92 Ma and continued to 12.51 Ma. Cu-Mo mineralization overlapped with the emplacement of small bodies of “A” (11.56 Ma) and “B” (11.24 Ma) dioritic to dacitic porphyry. 13 Re-Os molybdenite dates, conforming strictly with newly-refined paragenetic relationships, show that Mo mineralization at Los Pelambres extended at least from 11.66 to 11.00 Ma. Ore formation coincided with intense tectonic contraction, during which the large phaneritic Las Gualtatas quartz dioritic-granodioritic pluton (21.6-18.4 Ma), west of Los Pelambres, was juxtaposed over coeval volcanic and sedimentary units of the Abanico (21-25 Ma) and the older Los Pelambres (139 Ma) Formations.

$^{40}\text{Ar}^{39}\text{Ar} > 90\%$ apparent age plateaux for igneous and hydrothermal minerals (biotite, muscovite and hornblende) in and immediately surrounding the Los Pelambres deposit range overall from 9.52 to 10.58 Ma. These ages do not conform with U-Pb or Re-Os dates, and are interpreted as recording cooling during tectonic uplift and exhumation shortly following hypogene mineralization. The $^{40}\text{Ar}^{39}\text{Ar}$ dates overlap extensively with zircon and apatite ($U$, Th)/He ages of 8.15 to 10.37 Ma which define the cooling trajectory of the Los Pelambres deposit over a vertical interval of 1 km. In turn, four paragenetically constrained Re-Os molybdenite dates from El Pachón (8.43-9.16 Ma)
demonstrate that this centre represents a distinct magmatic-hydrothermal system which was emplaced during the uplift and exhumation of the more northwesterly Los Pelambres deposit.

The youngest event recorded by this study is the supergene leaching and sulphide enrichment of the Los Pelambres deposit. $^{40}\text{Ar}/^{39}\text{Ar}$ age spectra for jarosite-group minerals confirm that the deposit had been unroofed by 5.34 Ma, prior to the onset of major alpine glaciation, but was most intense from ca. 3.06 to ca. 0.93 Ma. The supergene upgrading of the Los Pelambres deposit thus began simultaneously with the development of hypogene mineralization at Río Blanco and El Teniente. However, numerous new apatite and zircon (U, Th)/He data from Río Blanco (3.8 Ma), El Teniente (3.3 Ma) and other intrusions along this province coincide with the initiation of major enrichment at Los Pelambres, suggesting common exhumation and uplift conditions ascribable to an orogen-wide Pliocene contractional event.

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REFERENCES


