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Exhumation of Andean granites: implications for porphyry copper formation and enrichment

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necessarily representative of the ore-forming event. In turn, this can contribute to the overall genetic model of an ore deposit, and lead to potential applications in mineral exploration. The ubiquitous presence of iron-oxides in several deposit types suggests the method may have far reaching applicability.

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Exhumation of Andean granites: implications for porphyry copper formation and enrichment

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Porphyry copper deposits (PCDs) are typically thought to form only a few km beneath the Earth's surface, associated with the emplacement of granitic host rocks. They are subsequently exhumed to the surface, where they may undergo secondary enrichment by meteoric fluids or be completely removed by erosion. The rate at which exhumation occurs seems to be a critical factor in the potential for supergene enrichment, preservation at the surface, and possibly for primary hypogene mineralisation (McInnes et al. 2005). Rapid exhumation during the supergene enrichment stage leaves little time for the system to interact with the water table to produce mature enrichment blankets before the ore is eroded at the surface. Rapid exhumation during the hypogene stage may on the other hand result in telescoping of the ore, which can be of economic importance because of the potential to generate giant ore deposits by overprinting the deep porphyry mineralisation with shallow epithermal mineralisation (Sillitoe 1994).

We present a regional study of granite exhumation rates across northern Chile, focusing on spatial and temporal patterns of exhumation in both barren and mineralised systems along the Eocene-Oligocene metallogenic belt. Minimum exhumation rates for each intrusion are calculated by (1) combining U-Pb zircon geochronology with Al-in-hornblende geobarometry (Mutch et al. 2016) to pinpoint the time and depth of granite emplacement, and (2) assuming steady and continuous exhumation from emplacement to the surface.

Twelve new U-Pb zircon ages for granitic intrusions near the Collahuasi and Queen Elizabeth PCDs and BHP Billiton drill holes close to the Chile-Peru border, have been obtained using LA-ICPMS. Most of the plutons were found to be of Eocene age (39–51 Ma), but three yielded Triassic to Permian ages (240–294 Ma). Emplacement depths for eight of the intrusions were calculated using a revised version of the Al-in-hornblende geobarometer calibrated for shallow intrusions (Sillitoe 1994). The Eocene, Triassic and Permian plutons all show very similar emplacement depths of 5–7 km, yielding minimum average exhumation rates of 0.12–0.15 km/Ma for the Eocene plutons, and 0.02 km/Ma for the Triassic and Permian plutons. This suggests that little exhumation of the older plutons took place between the Permian and the Eocene, but exhumation accelerated during or after the Eocene, possibly related to increased rock uplift and erosion along the western Andean margin.

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