Giant porphyry systems: products of large magma chamber or Cu-rich magmas?

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Cu mass balance constrains two end-member processes as possible responsible for the exceptional metal endowments of supergiant porphyry systems: a) huge magma reservoirs (>1000 km^3) with average metal contents, b) smaller magma reservoirs anomalously enriched in metals.

Porphyry-type mineralisation occurs towards the end of multi-Ma long magmatic activity characterized by a steady increase of Sr/Y values of magmatic rocks through time (e.g., Yanacocha, El Teniente, Los Pelambres). In contrast, magmatic cycles with a similar systematic increase in Sr/Y developed over a much shorter time (few ka) are apparently barren (e.g, Chachimbiro volcanic complex, Ecuador).

In this study we compare textural, geochemical and mineralogical changes of two magmatic complexes which follow a similar geochemical evolution over two different timescales: the long-lived, mineralised Yanacocha magmatic system (Peru) formed in ~4 Ma, and the short-lived, apparently barren, Chachimbiro volcanic complex (Ecuador), formed in less than 450 ka. Prior results of thermodynamic-constrained modelling [1] suggest that the long-lived magmatic maturation in the deep crust may play a key role in the generation of large magma reservoirs with high Sr/Y values.

Here we present evidence that Cu behaves compatibly during magmatic evolution in the barren Chachimbiro complex, with a drop from 44.3 ppm at 60.5 wt. % SiO_2 to 14 ppm at 65.2 SiO_2. This is the result of crystallization of Cu-rich nano-sulphide (0.1-0.5μm) inclusions found within amphiboles. In more evolved rocks (24.7 ppm at 68.6 wt. % SiO_2) Cu-rich sulphides become increasingly abundant and larger in size.

Further investigation and comparison with the mineralized Yanacocha system is needed in order to understand whether the observed continuous crystallization of Cu-rich sulphides at Chachimbiro might be responsible for its barren nature, or whether this could be a process for pre-concentrating Cu in sulphides that are later destabilized by subsequent magmatic pulses as recently suggested by other studies (e. g., [2]).

[1] Bellver-Baca and Chiaradia (2015) SGA Proceedings **1**, 259-262. [2] Wilkinson (2013) Nat. Geos. **6**, 917-925.