Four million years of thermal history – the Bajo de la Alumbrera porphyry Cu-Au deposit, Argentina

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The Bajo de la Alumbrera porphyry deposit formed at shallow crustal levels (2-3 km) during the emplacement of a cluster of silicic intrusions. Copper-gold-bearing veins and associated potassic, phyllic and propylitic alteration assemblages formed within and around the P2 and P3 group plagioclase-biotite-hornblende-phyric porphyries, with most mineralisation associated with P3.

Following on from previous studies [1,2], we have used multiple radiogenic isotopic techniques (U-Pb, Ar/Ar and (U-Th)/He), together with stable (δD and $\delta^{18}O$) isotopic analyses and fluid inclusion microthermometry to constrain the timing and duration of ore deposition and hydrothermal alteration, and to help infer fluid evolution through the history of hydrothermal activity.

Magmatic-hydrothermal fluids dominated the early stages of the Bajo de la Alumbrera complex [1,2], during the emplacement of the P2 (U-Pb ages of 8.02 ± 0.14 Ma, 7.98 ± 0.14 Ma) [3] and P3 porphyries (U-Pb age of 7.10 ± 0.07 Ma) [3], and continued for up to another million years, based on our new Ar-Ar ages for biotite and K-feldspar.

White mica and clay alteration occurred in two stages. Quartz-sericite-pyrite alteration was caused by 400 – 300ºC magmatic-hydrothermal fluids [1], and occurred between 7.1 and 6.6 Ma. Radiogenic isotopic analyses indicate that the system cooled below 300ºC by 6.5 Ma, when a low temperature meteoric phase of illite alteration occurred.

Stable isotopic modelling shows that the fluids above 200ºC were largely of magmatic derivation. (U-Th)/He chronology reveals that the system cooled below 200ºC (zircon blocking temperature) by 5 Ma. It then took another million years for the system to cool below 70ºC (apatite), thereby defining a ~4 m.y. history of thermal anomalism. This protracted history of thermal activity and persistence of the magmatic-hydrothermal system implies episoidic release of fluids and heat from magmas beneath this deposit.

References

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