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Constraints of Magma, Metal and Sulfur Sources Provide Insight into the Formation of the Taca Taca Bajo Cu-Mo-Au Porphyry Deposit (NW Argentina)

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The Taca Taca Bajo Cu-Mo-Au porphyry deposit is a rare, well-mineralised (2203.3 Mt @ 0.43% Cu, 0.012% Mo, 0.09 g/t Au) back-arc expression located in an early Eocene to Oligocene metallogenic belt and is the largest known Oligocene porphyry deposit in Argentina. Mineralisation at Taca Taca Bajo is spatially and temporally correlated with NE-SW trending rhyodacitic porphyry dikes, which show protracted crystallisation from 30.5 ± 0.3 to 29.0 ± 0.3 Ma (U-Pb SHRIMP; 95% confidence). Hydrothermal alteration can be defined spatially into four zones: potassic (29.1 ± 0.1 Ma; Re-Os molybdenite), early phyllic, late phyllic and supergene (24-21 Ma; Ar-Ar alunite). The Cu sulfides chalcocite, chalcopyrite and locally bornite are predominantly in the early and late phyllic alteration zones within monzogranite (459.4 ± 2.0 Ma; U-Pb SHRIMP; 95% confidence). *In-situ* sulfur isotopes of pyrite reveal mantle-like sulfur isotope $\delta^{34}\text{S}$ values (‰), from -1.1 ± 0.3 in the potassic zone to $+1.7 \pm 0.1$ (2 standard error) in the late phyllic zone, which may indicate a relationship between increasing $\text{H}_2\text{S}/\text{SO}_4$ ratio and metal endowment. Also, magmatic zircons from the rhyodacitic porphyry dikes display mantle-like $\delta^{18}\text{O}$ values of 5.6 ± 0.1 ‰ to 5.9 ± 0.1 ‰, and strongly positive initial $\epsilon_{\text{Hf}} = +5.6 \pm 0.4$ to $+7.4 \pm 0.2$ (2 standard error). These values indicate a dominant contribution from mantle or juvenile crustal source, perhaps with input from older, meta-igneous crust. The copper may be derived from the same source as the rhyodacites, as whole rock geochemistry reveals that unmineralized Oligocene intrusions to the west of the deposit have elevated Cu (ppm). In summary, isotopic and geochemical data from this study suggest that the rhyodacitic porphyry dikes were emplaced from ~31 to 29 Ma, from an underlying Cu-enriched magma chamber with a mixed juvenile and crustal source and mantle-derived sulfur.