

Constraining Magma Evolution Associated with Alkalic Porphyry Mineralization in British Columbia, Canada: A Melt Inclusion Study

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As global copper demand rises, there is growing interest in relatively scarce but high-grade Cu-Au systems such as alkalic porphyries. This study aims to determine the source of alkalinity in magmas related with porphyry-style mineralization through the study of mineral chemistry and melt inclusions.

Alkalic porphyries are localized in two main metallogenic provinces worldwide: British Columbia, Canada and New South Wales, Australia. Although these share similarities with their calc-alkalic counterparts, a large question in alkalic porphyries is what is the source and/or processes that drive magma alkalinity, as this influences where metals are acquired and how they are enriched. Here we study mineralization-related volcanic and intrusive units from the Late Triassic – Early Jurassic Mount Polley alkalic deposit to determine such processes.

All magmatic pulses in Mount Polley show significant carbonate and sulfate components in melts responsible for clinopyroxene crystallization. Melt inclusions hosted in unaltered clinopyroxene crystals from four chronologically constrained units at Mount Polley (pre-, syn- and post-mineralization) contain up to 50% volume contents of sulfate and/or carbonate components. Additionally, one sample analyzed by Focused Ion Beam – Secondary Electron Microscope (FIB-SEM), revealed ~5%vol. of chloride, suggesting high chlorine content.

Calc-alkalic porphyry-related melts are known to become sulfate-saturated during crustal evolution. The presence of sulfate, carbonate, and possibly halides in Mount Polley melt inclusions suggests involvement of evaporitic material over a prolonged magmatic history. However, whether this reflects subducted evaporites or crustal assimilation at this point remains uncertain.

Melt sources, assimilation, and immiscibility determine whether porphyries are fertile or barren. The distinct metal and geochemical signatures of alkalic porphyries may reflect their unique source and/or magmatic evolution. In these deposits it is likely that magma interaction with evaporites could impart both alkalinity and a redox signature, which ultimately will influence metal partitioning and consequent metal endowment.