Direct dating of hydrothermal copper-gold systems using calcite U-Pb dating, central Yukon Territory, Canada

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Economic metals can concentrate in fluids and magmas within the Earth's crust. For example, interaction between magmatic intrusions, fluids and surrounding rocks causes enrichment of metals such as Cu, Au, Ag and Mo in 'porphyry style' deposits. In these settings the metals are often intimately associated with quartz or calcite veins. In order to develop predictive models for mineralised systems it is imperative to understand the timing of emplacement of these veins. Dating of hydrothermal veins, however, has proved challenging due to the lack of suitable 'datable' material. Here we apply the newly-developed U-Pb calcite dating technique to test the capabilities of calcite dating for providing robust and critical timing constraints for ore-bearing fluids.

The Canadian Cordillera is one of the Earth's foremost examples of an accretionary mountain belt, formed over the last >200 million years. The central Yukon region of the northern Cordillera underwent a prolonged history of deformation, faulting, magmatism and related mineralisation during terrane accretion. The Dawson Range in the central Yukon is locally enriched in Au, Cu, Mo and other metals largely association with magma bodies (porphyry, epithermal and skarn type deposits) hosted within large continental-scale strike-slip fault zone systems, such as the Big Creek Fault (BCF) system.

Here, we use in-situ laser ablation U-Pb calcite dating to directly date mineralised carbonate veins from probable Late Cretaceous porphyry deposits associated with the BCF. Initial results indicate two unambiguous carbonate veining events, one during the Late Cretaceous (~73 Ma) and a second during the Paleocene (~60-55 Ma). This suggests that there were distinct hydrothermal associated with granitoid emplacement and faulting on the BCF.

Our results represent a significant contribution to tectonic and mineralisation models for the region and explore the role of major faults, such as the BCF, for channeling hydrothermal systems carrying economic Cu-Au deposits. Furthermore, our results demonstrate the potential for calcite U-Pb dating to provide timing constraints for hydrothermal mineralisation processes in a variety of deposit-type settings.