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Expansion of TIMS U-Pb geochronology tools for direct dating of ore deposits and critical minerals.

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Determining the timing and duration of ore deposit formation is fundamental for developing robust deposit models and therefore key to improving exploration strategies and outcomes. The most precise and accurate method for dating minerals is isotope dilution thermal ionization mass spectrometry (ID-TIMS). However, common uranium bearing minerals (e.g. zircon) do not ubiquitously form part of the ore-associated mineral assemblage. Therefore, determining the robustness of less routinely used geochronometers in a wide variety of ore systems will inform future research on how to target different mineralizing systems for geochronology.

Two different case studies are explored here:

- Archean Orogenic Gold Systems: Orogenic gold systems have historically been dated through laboriously refining ages based on cross-cutting relationships or by direct dating sulfide minerals associated with gold mineralization. With recent successes of dating the mineral scheelite ($CaWO_4$) in mineralizing systems (Wintzer et al., 2022), we are exploring scheelite's applicability for directly dating Archean gold mineralization in the Abitibi greenstone belt of Canada. Preliminary data show that scheelite in these ancient orogenic gold systems commonly lacks significant uranium, which contrasts with other ore systems (e.g., Cenozoic Au-Sb-W ore deposits) in which scheelite is more enriched in uranium (e.g. Wintzer et al., 2022).

- Lithium-bearing Pegmatites: Pegmatites are more evolved than typical granitic bodies such that they may lack zircon, or where present, may be metamict or xenocrystic. Non-conventional geochronological tools may therefore be needed when dating highly evolved pegmatitic bodies. To assess the robustness of different minerals occurring in such rocks, we are investigating pegmatites from southern British Columbia and Western Ontario in Canada that contain zircon ± apatite ± monazite ± cassiterite ± columbite-tantalite.

References:

Wintzer, N. E., Schmitz, M. D., Gillerman, V. S., & Vervoort, J. D. (2022). U-Pb scheelite ages of tungsten and antimony mineralization in the Stibnite-Yellow Pine district, Central Idaho. *Economic Geology*.