In situ U-Pb dating of diagenetic apatite and xenotime: Paleofluid flow history within the Thelon, Athabasca and Hornby Bay basins

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Results of *in situ* ion probe dating of diagenetic fluorapatite and xenotime are reported for sandstones from the Paleoproterozoic Thelon, Athabasca and Hornby Bay intracontinental, uraniferous basins of northwestern Canada.

Diagenetic fluorapatite occurs at multiple stratigraphic levels within the Thelon and Athabasca basins as interstitial cements and in veins and breccias that cut across bedding. Fluorapatite occurs as euhedral, oscillatory-zoned crystals interpreted to have formed during mesogenesis. A previous U-Pb TIMS study of bulk apatite interpreted three discrete events within the Thelon Basin at 1.72, 1.68 and 1.65 Ga [1]. However, 52 *in situ* analyses from five samples, including a subset from the earlier study, define a single population with an age of 1.667 ± 0.006 Ga and no evidence of multiple depositional events. This age is older than the 1.64-1.61 Ga ages reported for the Athabasca Basin [2, this study] indicating independent fluid-flow histories and timing of fluorapatite cementation in the two basins. The drivers of the fluid-flow events are unknown but could include orogenesis in southern Laurentia (e.g. Mazatzal-Central Plains-Labradorian orogeny), or possibly mafic magmatism, evidence for which is preserved in upper part of the Thelon Basin.

Fluorapatite cement also occurs within the Hornby Bay Basin. U-Pb data yield a less precise age of 1.16 ± 0.08 Ga due to lower uranium contents. Localized xenotime cement, in corrosive contact with detrital quartz and early quartz cement, yields an age of 1.284±0.011 Ga. Phospate cementation is significantly younger than the depositional age but similar to a reported uraninite age of ~1.05 Ga [5]. Fluorapatite and xenotime cementation most likely occurred during a fluid-flow event driven by 1.267 Ga Mackenzie magmatic activity. Fluid-flow driven by regional magmatism is recognized in other Proterozoic basins [3, 4].

[1] Miller *et al*. (1989) *CJES* **26**, 867-880. [2] Rainbird *et al.* (2003) *SIR Open House*, 6. [3] Ray *et al*. (2008) this volume. [4] Rasmussen *et al.* (2007) *Geology* **35**, 931-934. [5] Triex Minerals Corp. – 43-101 report.

Cave-analogue calcite growth in the laboratory: Calibrating stalagmite palaeoproxies

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An increasing number of studies report stable-isotope and trace-element records in speleothems. This variation is controlled by diverse environmental variables including the climatically important variables, temperature and rainfall. There is, however, a paucity of laboratory studies attempting to understand the influence of these environmental controls on stalagmite geochemistry. Quantitative data from such studies would dramatically improve our ability to reconstruct palaeoclimate from stalagmites.

We have completed a new series of carbonate growth experiments in karst-analogue conditions in the laboratory. The setup closely mimics natural processes (e.g. precipitation driven by CO_2 degassing, low ionic strenth solution, thin solution film) but with a tight control on growth conditions (temperature, pCO_2, drip rate, calcite saturation index and the composition of the initial solution).

Calcite is dissolved in deionized water in a 20,000 ppmV pCO_2 environment. Mg, Sr, Ba, Li, Na, U, Cd and Co are added to the initial solution, such that X/Ca is maintained constant between experiments. This solution is then dripped onto glass plates (coated with seed-calcite) in a lower pCO_2 environment (<2500 ppmV pCO_2). Experiments were performed at 7, 15, 25 and 35ºC. At each temperature, calcite was grown at three drip rates (2, 6 and 10 drips per minute), on separate plates within the same environment.

Oxygen isotope values are close to equilibrium given $\delta^{18}O_{solution}$ and temperature, but show small deviations from equilibrium, which are consistent with the relative drip rate and growth mass of the experiments. Trace metal relationships are also systematic with, for instance, Mg and Cd both showing relationships to temperature that are consistent with thermodynamic trends and demonstrating a predictable response to drip rate.

The integrated data provides significant new insight into the way that stalagmite carbonate responds to climatically important environmental variables.