In situ U-Pb dating and element mapping of very low grade metamorphic monazite

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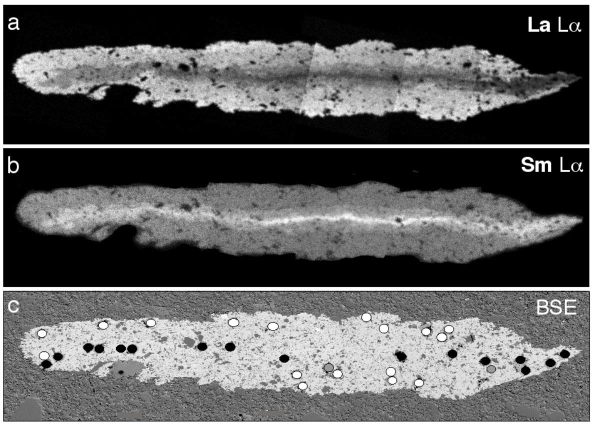
The movement of ancient fluids in the Earth's upper crust may be exceedingly difficult to detect using traditional methods. Any evidence that may exist is readily destroyed by isotopic, chemical and mineralogical overprinting during later episodes of fluid flow. In situ U-Pb dating and element mapping of metamorphic monazite in a mid-Archean shale from the central Pilbara Craton provides evidence for three episodes of growth: at 2.88 Ga, 2.16 Ga and 1.65 Ga. Element mapping of monazite for La and Sm reveals distinct cores and rims that closely correlate with different generations of monazite (Fig. 1).



Figures 1. (a, b) X-ray La and Sm maps of monazite (~0.7 mm long) in a Pilbara shale. (c) Location of SHRIMP analytical pits revealing an older core (~2.88 Ga; black fill) surrounded by younger rim (~2.16 Ga; white fill).

The U-Pb ages derived from metamorphic monazite span more than one billion years and are interpreted to record cryptic thermotectonic events related to reactivation of long-lived crustal structures that transect the craton. Despite repeated episodes of crustal fluid flow, the isotopic system in each generation of monazite remained unperturbed. The previously unrecognized history of crustal fluid flow in the Pilbara Craton has implications for geochemical and isotopic studies seeking to infer conditions on the early Earth.