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Do ‘vertical arrays’ in zircon $\varepsilon Hf_{(t)}$–age space systematically reflect mantle additions to the continental crust?

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Considerable debate remains about the timing for the onset of plate tectonics and the secular changes in the tectonic settings of continental crust formation. The increase in zircon $^{176}Hf/^{177}Hf$ ratios at the time of crystallisation (expressed as $\varepsilon Hf_{(t)}$ with respect to chondrite evolution) is commonly interpreted as a change in magma generation, from source(s) dominated by the remelting of ancient crust, to source(s) dominated by juvenile inputs from the mantle. The extent to which this approach can be used to unlock complex mantle–crust interactions in the early Earth remains debated, and there is an increasing need for high-quality data in cratons that experienced protracted crustal evolution over billions of years.

Here we report *in situ* U-Pb and Hf isotope analyses of zircons with Eoarchaean to Palaeoproterozoic ages, from high-grade metamorphic rocks from the Anabar shield (Siberian craton). The continental crust in the area was formed in the Eoarchaean and Paleeoarchaean and a conspicuous metamorphic event occurred at 2.0–1.9 Ga. We show that 2.0–1.9 Ga zircon ages reflect recrystallisation during the breakdown of high Lu/Hf minerals (i.e. garnet and pyroxene) under subsolidus conditions. This implies that the 2.0–1.9 Ga $\varepsilon Hf_{(t)}$ shift towards more radiogenic values may not be related to a change in magma sources from crustal- to mantle-derived, but rather to the resetting of the Lu-Hf system in existing rocks in response to heating and metamorphic reactions on a mineral scale.

Our findings challenge the widely-evoked mechanism of changes in tectonic style and magma sources to account for vertical arrays in the $\varepsilon Hf_{(t)}$–time space, and call for considering alternative options when interpreting Hf isotope variations in Hadean/Archaean detrital zircons.