Detrital zircons record rigid continents after 2.5 Ga

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The Neoarchean-Paleoproterozoic boundary represents a milestone in Earth's history and is marked by fundamental changes in mantle, crust and atmosphere-hydrosphere compositions [1]. These transitions show that the evolution of Earth's deep interior and its exterior are linked, but the processes that lie behind the transitions are still cryptic.

The composition of the crust depends on magmatic processes and/or on the nature of the magma source(s), which can be revealed by the isotopic fingerprints locked in zircons. Monitoring how the composition of the magma sources change with time can help to unravel crustal evolution.

Here we present new oxygen and Hf isotope compositions of detrital zircons from 1.8 Ga turbidites from the North Australian Craton. The detrital zircons have local provenances and record a crustal source section for three subsequent magmatic events: 2.7 Ga, 2.5 Ga and 1.9 Ga. These ages straddle the Neoarchean-Paleoproterozoic boundary and correlate with the major peaks in the global zircon record [2].

The results portray complex reworking of crustal components with limited growth. At 2.7 Ga, bimodal ε_{Hf} (+6 to +4, 0 to -7) and mantle-like $\delta^{18}O$ values indicate both crustal growth and the reworking of infracrustal components. At 2.5 Ga a wide range in ε_{Hf} (+7 to -12) and $\delta^{18}O$ from 5 to 7‰ reflect limited crustal growth and the reworking of variably old infracrustal and supracrustal components. At 1.9 Ga the ε_{Hf} array contracts markedly (from +3 to -8) and is coupled with heavy oxygen ($\delta^{18}O$ from 7 to 9.5‰), reflecting partial melting of supracrustal sources.

The lack of a linear correlation between zircon ε_{Hf} and $\delta^{18}O$ at 1.9 Ga implies that the array does not reflect the simple mixing of contrasting magmas. The isotopic array at 1.9 Ga may instead represent the partial melting of sedimentary rocks derived from heterogenous 2.5 Ga crust that was blended by weathering and erosional processes.

This finding suggests more rigid behaviour of the crust after 2.5 Ga, allowing mountain building, uplift, mechanical erosion, transport and deposition.

[1] Barley et al. (2005) EPSL 238, 156-171. [2] Condie (1998) EPSL 163, 97-108.