A simple Hf isotope-age array despite complex Archean geodynamics: Example from the Pietersburg block (RSA)

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Combined U–Pb and Lu–Hf isotope data of detrital zircons are widely used to constrain the mechanisms of Hadean-Archean continental crust formation and reworking. Linear Hf isotope-age arrays are interpreted to reflect the protracted, internal reworking of single crustal reservoirs, and related $^{176}Lu/^{177}Hf$ are used to place constraints on the composition of the reworked crust. Results of this study, however, indicate that straight Hf isotope-age arrays can result also from complex geodynamic processes and crust-mantle interactions, as shown by U–Pb and Lu–Hf isotope analyses on zircons from granitoids of the Pietersburg Block, Kaapvaal Craton (South Africa).

Besides scarce remnants of Paleoarchean crust, most granitoids with ages between 2.97 and 2.03 Ga (n=32) define a straight Hf isotope-age array, although they show a wide compositional range, were derived from various sources and emplaced successively in different geodynamic settings [1]. This evolution occurred in five stages: (I) mafic and minor felsic crust formation in an intra-oceanic environment (3.4–3.1 Ga); (II) formation of voluminous, juvenile TTG crust (εHf_t of ca. +3) in an early accretionary orogen (3.0–2.92 Ga); (III) intracrustal reworking and subduction of TTG-derived sediments in an Andean-type setting (2.89–2.75 Ga); (IV) (post-)collisional magmatism derived from a metasomatized mantle source (~2.68 Ga); and (V) alkaline magmatism in an intra-cratonic environment (~2.05 Ga).

The Hf isotope-age array requires $^{176}Lu/^{177}Hf$ of 0.0027 ± 0.002. Persistance of this low value during ~1 Ga in a complex geodynamic framework shows that the lithospheric Hf budget was controlled by the dominant crustal lithology, i.e. ~2.95 Ga-old TTGs. Those later contributed to granitoid petrogenesis by (i) direct assimilation by younger TTG magmas (2.89–2.84 Ga); (ii) intracrustal anatexis between 2.84 and 2.75 Ga; and (iii) melting of mantle domains (~2.68 and ~2.05 Ga) previously enriched by subduction of TTG-derived sediments.

[1] Laurent, O., et al., 2014. *Lithos* **205**, 208–235.