Building up the first continents: a message from integrated zircon U-Pb/Lu-Hf isotopes, granitoid petrology and geochemistry

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The mechanisms of early continental crust formation are still elusive. Approaches based on bulk-rock petrology and geochemistry are now known to provide ambiguous and incomplete information; and the lately acquired, huge paired U-Pb and Lu-Hf isotope datasets in zircon are equally difficult to interpret because the nature of the rocks in which zircon crystallized is generally insufficiently documented or unknown (e.g. detrital zircons).

Here, we stress out that coupling zircon Hf isotopic data with field, petrological and geochemical data from their host granitoids represents a comprehensive approach to unravel Precambrian crustal evolution. Petrogenetic data on granitoids are necessary to interpret the zircon Hf isotopic record and, in turn, the latter can be used to constrain crustal architecture, the respective contribution and volumes of crustal and mantle components involved in successive igneous events.

We present such integrated data on three case studies from domains recording altogether >2 Ga of continental evolution: the Kaapvaal Craton (3.7-2.0 Ga), the West African Craton (3.5-2.0 Ga) and the West Troms Complex in North Norway (3.0-1.6 Ga). Individual terranes with distinct crustal evolutions can be identified in all areas and represent either (1) early, small “proto-continents” nucleated in a non-actualistic, purely intraplate setting; or (2) younger domains formed in the context of plate convergence and amalgamation of the former proto-crust to build up wider continents – notably leading to the formation of larger volumes of felsic magmas than the first phase. The transition between these regimes is diachronous from one place to another, but globally occurs at 3.2-2.8 Ga. Late tectono-magmatic events (≤2.7 Ga) related to sub-continental mantle or crustal delamination represent an essential stage of stabilization leading to present-day structure of the cratonic lithosphere.