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Refining crust formation ages using Hf isotopes from detrital zircon - a case study from Sweden

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Isotope data from a growing number of Archean–Proterozoic terranes show indications of not being compatible with a conventional linear evolution from a primordial composition at ca. 4.5 Ga and modern radiogenic MORB composition. Tracing the most radiogenic Hf isotope signatures in the Fennoscandian Shield through time generates a line that intersects the chondritic reference at ca. 3.5 Ga. In the Fennoscandian Shield the oldest identified crust, Siurua gneiss of the Pudasjärvi gneiss complex in Finland, and hence the time of initial differentiation of incompatible elements, is ca. 3.5 Ga. This suggest initial mantle depletion underneath the Fennoscandian Shield at 3.5 Ga. Interpreting Hf isotope data in the context of a model mantle source that corresponds to the existing knowledge of the region, rather than applying a generic global linearly depleted MORB mantle source since 4.5 Ga, eliminates the requirement of long residence times between initial crust extraction and differentiation to produce felsic crust. Further, it yields crustal growth peaks that correlate with known orogenies, i.e. the 2.8–2.6 Ga Lopian/Karelian orogeny and 2.0–1.8 Ga Svecokarelian orogeny, with a minor peak during the Gothian orogeny. A similar scenario is seen in the East Pilbara Terrane, Australia, and in southern West Greenland, where initial crustal growth at ca. 3.6 and 3.85 Ga respectively, coincides with chondritic zircon Hf isotope signatures of the oldest identified rocks. Using regional mantle reference curves also aligns crustal growth peaks with known periods of intense magmatic activity and rifting.