The sedimentary record of progressive continental growth

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The growth history of continental crust is the subject of a long-standing debate, with models ranging from early formation with little subsequent growth [1] to progressive growth with a near-steady rate [2] or with pulses at a high rate [3]. Here I examine models of continental growth using Hf isotope systematics of detrital zircons and Hf-Nd isotope systematics of terrigenous sedimentary rocks with various depositional ages.

A significant number of zircon Hf isotope data have been accumulated and revealed that Hf model ages of detrital zircons show a broadly bimodal distribution with Archean and Proterozoic populations and rarely exceeds 3.6 Ga [4]. The observation suggests that the preserved continental crust was mainly formed during the Paleo- to Mesoarchean and Proterozoic. Yet, as the growth of continental crust is the net result of the formation of new continental crust and crust–mantle recycling, the cumulative mass/age curve of the preserved continental crust can be remarkably different from the actual net growth curve. Specificially, the deviation between the two curves depends on not only the rate of crust-mantle recycling but also the age distribution of recycled crust: if only infant continental crust is available for crust–mantle recycling, then the two curves should be similar regardless of the recycling rate.

Given that sediment subduction is a primary agent of crust-mantle recycling, Nd-Hf model ages of sedimentary rocks set constraints on the age distribution of recycled crust. Notably, all <3.5 Ga terrigenous sediments have Nd and Hf model ages younger than 3.6 Ga [4], indicating little recycling of Hadean-Eoarchean crust since 3.5 Ga. Such crust-mantle recycling cannot reconcile the age distribution of the preserved continental crust with the early growth model where a near-present mass of continental crust was established within the first billion years [1]. Instead, the sedimentary rock data suggest significant recycling of Paleoproterozoic crust into the mantle over geologic history. Taken all together, the sedimentary record favors a model of net continental growth that stable continent crust was established in the Paleo- and Mesoarchean and significantly grew in the Paleoproterozoic.

[1] Fyfe (1978) *Chem. Geol.*; Armstrong (1981) *Phil. Trans.* [2] Hurley & Rand (1969) *Science*; McCulloch & Bennett (1994) *GCA*. [3] Patchett & Arndt (1986) *EPSL*; Condie (1998) *EPSL*. [4] Iizuka et al. (2017) *Lithos*