Hadean growth of the continents

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The initial differentiation of the Earth (core – mantle – crust - atmosphere) accompanied and immediately followed accretion of the Earth and Earth-Moon formation. The mean continental crust content of SiO2 evolves with time from 4.5 Ga to present. The earliest "continents" control the abundance and distribution of the heat producing elements (K, Th and U) and control the power driving mantle convection. Heat production of Hadean continental crust is up to an order of magnitude greater than that of the present-day crust.

A half mass or more of continental crust may have formed by about 4 Ga, potentially accompanied by an equal amount of mass loss to the mantle by density foundering processes. Support for this model come from the multiple observations of silica-rich magmatism in the early solar system (e.g., Mars and asteroidal parent bodies) that dated to as early as 4.565 Ga. Geochemical models for the present-day continental crust composition demonstrate that the total mass of continental crust created over geologic time is 4 times the present mass and that crustal recycling processes has removed at least 3 crustal masses of lower crustal material. On top of this mass loss are those that occur at the top of the crust due to weathering and plate tectonic processes. Richard Armstrong's models from the 1980's, along with later isotopic modeling results, find that early (Hadean to Archean) growth of continents is consistent with the isotopic evolution of the silicate Earth. Importantly, these models identify significant, early crustal recycling and that this mass flux declines with time.

The archetype Nb-anomalies typical of continental crust do not provide unique interpretations to its tectonic settings of formation. Olivine-hosted, melt inclusions in Meso-Archean komatiites document that the mantle possessed marked depletions in Pb (>2 times fractionated from Primitive Mantle values) and relatively mild depletions in Nb (about 50% higher than Primitive Mantle values). These observations are consistent with Nb-anomalies being a product of second stage crustal melting processes, while Pb-depletion of the mantle is suggested to be a combination of first (mantle) and second stage melting processes.