



Selective lithospheric preservation: a hypothesis for the transitions between the Hadean and the Archean and the Archean and the Proterozoic

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On a global scale, Earth appears to have at least two major transitions in generation of continental crust. The first transition was at about 4 Ga from which we have the oldest remaining fragments of continental crust. No rocks have been found from the first 500 million years of Earth history. The second transition was between about 2.8 and 2.3 Ga and was a transition from continental crust characteristic of older Archean terrains to crust characteristic of younger terrains. Continental heat flow has three basic components, heat flowing into the base of the lithosphere, heat generated in the lithosphere by radiogenic heat production, and heat transfer associated with tectonic and magmatic processes, including erosion and sedimentation. Heat flow in Precambrian lithosphere is dominated by heat flowing into the base of the lithosphere, and radiogenic heat production within the lithosphere. Geochemical studies of Archean upper crust show that this crust is statistically depleted in the main heat producing elements, U, Th, and K, with respect to younger crust, and this observation is quantitatively supported by heat flow data. Such depletion results in a cooler average geotherm for Archean lithosphere relative to the average geotherm for younger lithosphere. Geotherms have been back calculated to 4.5 Ga and lithospheric strength curves have been calculated for each of these geotherms. These models can be interpreted to show that before about 4.0 Ga, all continental geotherms resulted in strength curves so weak that no continental lithosphere resisted recycling. Between about 4.0 and 2.5 Ga, only lithosphere with cooler (low heat production) geotherms had sufficient strength to resist recycling. After 2.5 Ga, the crustal heat production was no longer a significant factor in raising the geotherm to reduce significantly lithospheric strength, and almost all continental lithosphere was preserved.