Rates of generation, destruction and growth of the continental crust

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Less than 25% of the volume of the juvenile continental crust preserved today is older than 3 Ga, there are no known rocks older than ~4 Ga, and yet a number of recent models of continental growth suggest that at least ~60–80% of the present volume of the continental crust had been generated by 3 Ga. Such models require that large volumes of pre-3 Ga crust were destroyed and replaced by younger crust since the late Archaean.

To address this issue, we evaluate the influence on the rock record of changing the rates of generation and destruction of the continental crust at different times in Earth's history. We adopted a box model approach in a numerical model constrained, from geochemical data, by the estimated volumes of continental crust at 3 Ga and the present day, and by the distribution of crust formation ages in the present day crust.

The data generated by the model suggest that continental growth occurred in four main stages: (1) 4.5–3 Ga: rapid growth, with ~65% of the present volume of continental crust (PVCC) at 3 Ga; (2) 3–2.5 Ga: crustal destruction and continental shrinking, with ~50% of PVCC at 2.5 Ga; (3) 2.5–0.5 Ga: crustal growth with gradually decreasing rates of growth, and with ~110% of PVCC at 0.5 Ga; (4) 0.5–0 Ga: slight decrease in the volume of continental crust, as crustal destruction rates exceeded crustal formation rates.

About 2.6–2.3 times of the present volume of continental crust has been generated since Earth's formation, and thus ~1.6–1.3 times of this volume has been destroyed and recycled back into the mantle since the onset of plate tectonics at ~3 Ga. This opens new perspectives for models of mantle evolution and mantle–crust interaction through time, including testing the scenarios offered by our box model by modelling of radiogenic isotope systematics in the mantle–crust system.