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The conceptual model of Earth's proto-crust formation

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The conceptual model of Earth's proto-crust formation

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The difficulty in direct differentiation of the felsic crustal components from Earth's mantle peridotite leads to a requirement for the presence of a large amount of hydrated mafic precursor of TTG in Earth's proto-crust, the origin of which, however, remains elusive. The mafic proto-crust may have formed as early as ~ 4.4 Ga ago as reflected by the Hf and Nd isotopic signals from Earth's oldest geological records, i.e., zircons. The Archean continents, primarily composed of the felsic tonalite–trondhjemite–granodiorite (TTG) suite, were formed or conserved since ~ 3.8 Ga, with significant growth of the continental crust since ~ 2.7 Ga. Such a significant time lag between the formation of the mafic proto-crust and the occurrence of felsic continental crust is not reconciled with a single-stage scenario of Earth's early differentiation.

Here, inspired by the volcanism-dominated heat-pipe tectonics witnessed on Jupiter's moon Io and the resemblances of the intensive internal heating and active magmatism between the early Earth and the present-day Io, we present a conceptual model of Earth's early crust-mantle differentiation, which involves an Io-like scenario of efficient extraction of a mafic proto-crust from the early mantle, followed by an intrusion-dominating regime that could account for the subsequent formation of the felsic continents as Earth cools. We argue that an episodic cooling of the early mantle could be a realistic way. By this way, most of ancient rocks would be easily destroyed and a habitable earth required conditions would be appeared in such a short time.