

Enhanced cooling of the mantle caused by the launch of modern plate tectonics

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Earth's mantle has experienced a secular cooling process over geological history as suggested by most previous studies. However, the cooling model of the mantle is only roughly constrained due to the lack of sufficient samples formed by the melting of the hot ambient mantle. Here we apply a statistical analysis to the alkalinity of global-scale basalts formed in the intracontinental settings and produce a more detailed thermal evolution trend of the mantle based on the previous model. Our result reveals a remarkable mantle cooling event around the Cryogenian, coinciding with the Snowball Earth glaciation and the onset of modern plate tectonics. Before the Cryogenian, the mantle potential temperature (T_p) was almost constant for 1 billion years, consistent with the previously defined Earth's middle age. The Snowball Earth event might have kick-started the onset of modern plate tectonics. We conclude that the establishment of a globally linked network of plate boundaries and the transiently accelerated subduction at the beginning of modern plate tectonics could significantly enhance the cooling of the mantle by subducting a larger volume of cold oceanic slabs into the mantle. In contrast, the Earth's middle age represents a period of minimum subduction flux during the post-Archean time, and therefore corresponds to a relatively stable thermal state of the mantle.