Plume-induced subduction and crustal growth in precambrian Earth

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Modern crustal growth is intimately related to subduction and plate tectonics, however how and when this tectonic regime started remain controversial. Most present-day subduction initiation mechanisms require acting plate forces and/or pre-existing zones of lithospheric weakness, which are themselves the consequence of plate tectonics. In contrast, spontaneous plume-induced subduction initiation does not require pre-existing lithospheric fabric and is viable for both stagnant lid and mobile/deformable lid conditions. Here, we present results of 3D numerical modelling of plume-induced subduction and associated crustal growth resulting from tectono-magmatic interaction of an ascending thermal mantle plume with oceanic lithosphere. We demonstrate that weakening of the lithosphere by plume-induced magmatism is the key factor enabling subduction initiation at the margins of a crustal plateau growing above the plume head. We argue that frequent plume-arc interactions recorded in Archean crust could reflect either plume-induced self-sustained subduction or plume-induced episodic lithospheric drips predicted by our models for hotter mantle conditions. We furthermore suggest that such plumes set up conditions favouring global plate tectonics initiation in Precambrian Earth possibly resulted from interaction of multiple subduction zones created by several nearly simultaneous vigorous mantle plumes during enhanced mantle activity periods and peaks of juvenile crust formation.