Tectonic erosion and subduction of continental materials to mantle transition zone: The role of volatiles and heat-producing components for plume generation

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Absence of old anorthosite on the current Earth's surface suggests that significant portion of primordial continental crust might have been subducted into the mantle (e.g., Kawai et al., 2009; 2013). Subduction of continental materials via tectonic erosion is possible during further Earth's history as was shown for Pacific-type convergent margins (e.g., Yamamoto et al., 2009; Safonova et al., 2015). Here we review current models for subduction of continental materials to the depths below 270 km (coesite/stishovite transition boundary) taking into account experimental and theoretical estimations of material density and seismic velocities. We focus on the possible evidences for presence of TTG or anorthositic crust in the mantle transition zone (MTZ) and consequences of melting of these materials triggered by volatiles and heat-producing components. Anorthositic crust can explain velocity anomalies at the bottom of MTZ, which cannot be modeled by peridotite and eclogite lithologies (Nishi et al., 2018). Ca-rich series of inclusions in superdeep diamonds (e.g., Kaminsky, 2017) is often considered as carbonatitic, because abundant appearance of carbonate phases. This may indicate not only Ca-carbonate subduction, but also Ca-rich nature of anorthosite-like crust accumulated near 660 km in the MTZ. Litasov et al. (2013) proposed a model for MTZ carbonatitic plumes, which can easily penetrate through the upper mantle and form enriched source regions at the lithosphere-asthenosphere boundary. However, the balance between H_2O and CO_2 in subducted materials is still poorly constrained. We propose several key directions for further high-pressure experimental works to eliminate uncertainties in continental crust subduction and move towards self-consistent models for mantle magmatism with source regions in the MTZ.
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