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マントル最下層における沈み込みスラブの影響
Interaction of sinking slabs of the lowermost mantle

金子 岳郎 [1*], 中久喜 伴益 [1]
Takeo Kaneko[1*], Tomoeki Nakakuki[1]

[1] 広島大学大学院理学研究科地球惑星システム学専攻
[1]Department of Earth and Planetary Systems Science, Graduate School of Science, Hiroshima University

Mantle plumes that rise from the lowermost mantle generate the most hotspots. The lowermost mantle has complex seismic structure that consist long-wavelength seismic low- and high-velocity anomalies. These seismic anomalies are anticipated to correspond with respectively. In addition, the margins of Large Low Shear Velocity Provinces (LLSVPs) under the African and Pacific areas are related to hotspots, and have a sharp seismic discontinuity. In this study, we investigate roles of post-perovskite (PPV) phase transition and compositional stratification in the generation of observed heterogeneity of the lowermost mantle and the upwelling plume. We construct a 2-D integrated model of the mantle convection with a sinking slab.

The PPV phase covers over the whole area of the CMB when the compositional layering is not introduced. In the models with high-density stratification, the structure of the lowermost mantle and the plume generation change significantly. The sinking slab pushes the high-density layer so that the high-density layer is piled up in the outside of the subduction area. This is more distinct in the case with lower density contrast of the chemical layering. The PPV phases in the high-density layer distribute very locally. On the other hand, the PPV phase is stably maintained beneath the subduction zone. The top of the phase boundary reaches about 300 km above the CMB. The PPV phase boundary becomes vertical at the location where the slab contacts with the high-density layer. This is expected to form the steep seismic discontinuity at the margin of the LLSVPs.

The slab also produces disturbances of thermal boundary layer, which causes the plume generation. The plumes grow more rapidly in the case with the PPV phase than that without it. Although the high temperature anomaly is generated at the margin of the high-density layer, the upwelling plume is not generated because the slab climbs up above high-density layer. Thicker pile of the chemical layer with the lower density contrast used in our study may be required to generate plumes at the margin of LLSVPs.

Keywords: plume, slab, high-density layer, LLSVPs, post-perovskite phase transition