Seismic Images of Mantle Plumes, Subducting Slabs and the Core-Mantle Boundary

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Global and regional tomographic studies are made to determine the 3-D velocity structure of the mantle, particularly for imaging mantle plumes, subducting slabs and lateral heterogeneities of the D" layer. To improve the ray path coverage in the mantle, we used various transmitted and reflected waves in the mantle and outer core. The diffracted waves (Pdiff) at the core-mantle boundary (CMB) are very useful for constraining the structure of the D" layer. A better grid parameterization than that of our previous studies (Zhao, 2001, 2004) is adopted so that the mantle structure under the polar regions can be better imaged. Plume-like slow anomalies are clearly visible in the whole mantle under the major hotspot regions, such as Hawaii, Iceland, Kerguelen, South Pacific and Africa. The slow anomalies under South Pacific and Africa have lateral extent over 1000 km and exist in the whole mantle, representing two superplumes. The Pacific superplume has a larger spatial extent and stronger slow anomalies than that of the Africa superplume. The Hawaiian plume is not part of the Pacific superplume but an independent whole-mantle plume. The slow anomalies under hotspots usually do not show a straight pillar shape, but exhibit winding images, suggesting that plumes are not fixed in the mantle but can be deflected by the mantle flow. There is a good correlation between the distribution of slow anomalies at the CMB and that of hotspots on the surface, suggesting that most of the strong mantle plumes under the hotspots originate from the CMB. However, there may be some small-scaled, weak plumes originating from the transition zone or mid mantle depths. Most of the slab materials are stagnant in the mantle transition zone before finally collapsing down to the CMB as a result of large gravitational instability from phase transitions. The active intraplate volcanoes in East Asia continent (such as Changbai and Wudalianchi volcanoes) are a kind of back-arc volcanoes whose formation was closely related to the deep subduction of the Pacific slab and its stagnancy in the mantle transition zone. For the D" layer, P-wave tomographic models from different groups are quite similar, and S-wave models are also similar to each other. However, there are large differences between the P and S models, which may be caused by large lateral variations in Poisson's ratio possibly related to the existence of partial melts and compositional variations such as iron and perovskite to post-perovskite phase change.

References

[1] Zhao D. (2001) *EPSL* **192**, 251-265.
[2] Zhao D. (2004) *PEPI* **146**, 3-34.