# 全マントルトモグラフィーから見たマントルプルームとスラブの深部構造

# Deep structure of mantle plumes and subducting slabs from whole-mantle tomography

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In our first global tomographic model (Zhao, 2001), we applied a novel approach to a large data set of ISC travel times (P, PP, PcP, pP, Pdiff) to determine a whole-mantle 3-D P-wave velocity structure. In this new approach, a grid parameterization is adopted to express the Earth structure; depth variations of the Moho, 410 and 660 km discontinuities are taken into account in the inversion; ray paths and travel times are computed with an efficient 3-D ray tracing scheme. Here the model of Zhao (2001) is improved significantly by adding a large number of teleseismic data recorded by four portable seismic networks and one permanent network (Ocean Hemisphere Project, OHP) which are newly installed in regions where few ISC stations exist.

We picked 12,664 high-quality arrival times from 442 teleseismic events recorded by 236 seismic stations of the five seismic networks. The epicentral distances are 0-100 degrees for P and pP and 50-180 degrees for PP and Pdiff. The new data sets are as follows: (1) 2609 P, pP and PP data from 78 events recorded by 19 portable stations and 3 new permanent stations in northeast China; (2) 671 P, pP, PP and Pdiff data from 88 events recorded by 14 stations of the OHP located in western Pacific; (3) 3820 P data from 93 events recorded by 113 stations in South Africa; (4) 1616 P data from 83 events recorded by 30 stations in Iceland; and (5) 3948 P data from 100 events recorded by 57 stations in Tibet. These new data are added to the ISC data set (about 1 million arrival times) for a new tomographic inversion.

The overall features of our new tomographic model are quite consistent with that of Zhao (2001). In the shallow mantle, a low-velocity ring is visible around the Pacific Ocean basins and high-velocity anomalies exist under the old and stable continents in the depth range of 0-300 km. Stronger and wider high-velocity anomalies are visible in the transition zone depths under the subduction regions suggesting that most of the slab are stagnant in the transition zone before finally collapsing down to the lower mantle as a result of large gravitational instability from phase transitions. Very slow anomalies exist in the upper mantle right beneath the Wudalianchi and Changbai active volcanoes in Eastern China, right above the stagnant Pacific slab in the transition zone, suggesting that the origin of the intraplate volcanism in East Asia is closely related to the Pacific plate subduction process. Plume-like slow anomalies are clearly visible under the major hotspot regions in most parts of the mantle, in particular, under Hawaii, Iceland, South Pacific and Africa. The Pacific superplume has a larger spatial extent and stronger slow anomalies than that of the Africa superplume. 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.

One new feature we found from the new model is that the oceanic ridges are also well imaged as belt-like low-velocity anomalies. This is considered to be possible due to the additional rays from the new networks that pass through the shallow mantle under the oceanic regions as well as the later phase such as PP. Previous studies using surface wave tomography suggested that slow anomalies extend down to about 300 km under oceanic ridges. However, the present model shows that slow anomalies extend down to 550 km under the East Pacific Ridge and the Indian Ocean Ridge. In the lower mantle all the ridge-related features disappear. These results suggest that the upwelling flows under the oceanic ridges may exist in the entire upper mantle, even down to the mantle transition zone. This new findings may have important implications for the understanding of the flow patterns of mantle convection and deep Earth dynamics.

Zhao, D. (2001) Seismic structure and origin of hotspots and mantle plumes. Earth Planet. Sci. Lett., 192, 251-265.