Structure of the Earth's interior by using global tomography

Yuhei Ohta[1]; Dapeng Zhao[2]; Akira Yamada[3]

[1] Biology and Earth Sci., Ehime Univ; [2] GRC, Ehime Univ; [3] GRC, Ehime Univ.

In order to better understand the deep structure of the Earth's interior, we have attempted to develop a new model of whole mantle seismic tomography. We used a large data set of ISC (International Seismological Center) travel times (P, pP, PP, PcP, Pdiff) and newly measured data sets to determine a whole mantle P wave tomography. But only the ISC data (S, SS, ScS, Sdiff) are used to determine a whole mantle S wave tomography. We measured arrival times of seismic phases from seismograms which were recorded by temporary seismic networks. These seismic networks are located on oceanic and continental regions where few ISC stations exist. In total, we used about 900,000 P and 830,000 S arrival times in the tomographic inversions. The global tomographic method of Zhao (2004) is used. The topography of mantle discontinuities at 410 and 660 km depths is taken into account in the tomographic inversions. For the whole mantle, our new models contain the general features observed in the previous models. A significant difference from the previous models is that low-velocity anomalies are visible along the oceanic ridges. A low-velocity ring around the Pacific Ocean basins and high velocity anomalies under the old and stable continents are visible. Strong and wide high velocity anomalies are visible in the transition zone depth under the subduction zone regions, which suggests that most of the slab materials are stagnant for a long time in the transition zone before finally dropping down to the lower mantle. Plume-like slow anomalies are visible under the hotspot regions in most parts of the mantle. The slow anomalies under hotspots usually do not show a straight pillar shape, but exhibit winding images, which suggests that plumes are not fixed in the mantle but can be deflected by the mantle flows. In the depth range of 900 ~ 2400 km, the velocity variations are small compared with the upper mantle. Wider and more prominent slow anomalies are visible at the core-mantle boundary (CMB) than most of the lower mantle, and there is a good correlation between the distribution of slow anomalies at the CMB and that of hotspots on the surface, which suggest that most of the mantle plumes under the hotspots may originate from the CMB. In addition, we estimated two physical parameters from P and S wave velocities (Vp, Vs). One is the bulk sound velocity variations that show negative correlation with Vp and Vs in the lower-most mantle, which is considered to reflect compositional and thermal heterogeneity. The other is the temperature variation estimated from velocity perturbations and elastic properties of mantle minerals. In the mantle transition zone depth, low-temperature anomalies are visible under the subduction zone regions, which suggest the existence of cold stagnant slab materials. In addition, strong lateral thermal gradients are found in the lower-most mantle, suggesting the existence of chemical as well as thermal anomalies in the D" layer.