南極と北極地域の地震波トモグラフィーとマントルダイナミクス

Seismic tomography and mantle dynamics under the polar regions

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The 3-D seismic structure of the crust and mantle under the polar regions has not been investigated well because of the lack of seismic stations. In our previous model of P-wave global tomography (Zhao, 2004), the 3-D mantle structure under the polar regions was expressed inadequately because the grid nodes were set up along the latitude and longitude lines and so the grid interval in the east-west direction becomes too small in the polar regions. In order to resolve this problem, recently we used a flexible-grid approach to conduct global tomographic inversions. A 3-D grid net was set up in the mantle, and velocity perturbations at every grid nodes were taken as unknown parameters. The iasp91 velocity model (Kennett and Engdahl, 1991) was taken as the 1-D starting model for the tomographic inversion. We selected more than 10,000 earthquakes from the events that occurred in the last forty years from the ISC (International Seismological Center) data set. About 1.6 million arrival-time data of five-type P phases (P, pP, PP, PcP, and Pdiff) were used to conduct the tomographic inversion. In our flexible-grid approach, the lateral grid intervals in the polar regions are arranged nearly the same as the other portions of the mantle. As a result, the tomographic images in the polar regions are remarkably improved. Our new tomographic model shows huge low-velocity (low-V) zones in the entire mantle under Tahiti and Lake Victoria, which reflect the Pacific and African superplumes, being consistent with the previous studies. A clear low-V zone is revealed down to the mid-mantle depth under Mt. Erebus volcano in Antarctica, which is consistent with recent regional tomography under Erebus (Gupta et al., 2009; Zhao, 2009). Other major hotspots also exhibit significant low-V zones in the mantle under their surface locations. Beneath Bering Sea, we found that the Pacific slab is subducting from the Aleutian Trench and it is stagnant in the mantle transition zone. In Bering Sea and the Alaska region, there are several intraplate volcanoes such as St. Paul Island. Given the existence of the stagnant Pacific slab and very low-V mantle wedge above the slab, we consider that the origin of the intraplate volcanoes in Bering Sea is most likely related to the deep subduction of the Pacific slab and its stagnancy in the mantle transition zone, similar to the Changbai and Wudalianchi volcanoes in Northeast Asia (Zhao, 2004; Zhao et al., 2009).

References

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