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Mapping seismic heterogeneity and anisotropy in the mantle

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Recently we have made new advances in tomographic imaging of the mantle heterogeneity and anisotropy, which shed new light on the mantle dynamics. We improved our global tomography model by adopting a flexible-grid parameterization to express the 3-D Earth structure (Zhao, 2009). Compared with the previous tomographic model (e.g., Zhao, 2004), the new model has a better resolution for the polar regions, which enables us to examine the mantle structure and dynamics in Arctic and Antarctica. The intraplate volcanoes in NE Asia (e.g., Changbai and Wudalianchi) are caused by the hot and wet upwellings in the big mantle wedge (BMW) above the stagnant slab in the mantle transition zone (Zhao, 2004; Zhao et al., 2009). Our new tomography model shows that the subducting Pacific slab becomes stagnant in the mantle transition zone under Western Alaska, Bering Sea, Sea of Okhotsk, Japan Sea, and Northeast Asia. Many intraplate volcanoes exist in these areas, which are located above the low-velocity zones in the upper mantle above the stagnant slab, suggesting that BMW exists in not only NE Asia but also in broad regions under the northern and western Pacific, and those intraplate volcanoes are related to the dynamic processes in the BMW above the stagnant slab. The Tengchong volcano in SW China is caused by a similar process in BMW above the subducting Burma microplate (or Indian plate). In contrast, the Hainan volcano in southernmost China is a hotspot fed by a lower-mantle plume associated with the Pacific and Philippine Sea slabs' deep subduction in the east and the Indian slab's deep subduction in the west down to the lower mantle (Zhao et al., 2011). We have also used P-wave anisotropy tomography and shear-wave splitting to map seismic anisotropy in the mantle under East Asia. The results show that the fast velocity direction in the upper mantle under East Asia is generally oriented in the NW-SE or E-W directions, suggesting the existence of mantle flow in the BMW, in consistent with the tomographic images and stress regime in the subducting slab as estimated from the focal mechanism solutions of deep earthquakes under the Japan Sea and East-Asia margin (Zhao et al., 2009, 2011).

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