Intraplate seismic and volcanic activity and structural heterogeneity in the Eurasian continent

Dapeng Zhao[1]

[1] GRC, Ehime Univ

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Our recent studies have revealed significant structural heterogeneity in the crust and mantle beneath the Eurasian continent, which is associated with the intraplate seismic and volcanic activity in this region. High-resolution seismic images of the mantle down to 700 km depth are determined beneath the Changbai volcano in NE Asia and the Baikail rift zone by applying a teleseismic tomography method to relative travel time residuals recorded by dense portable seismic networks in the two regions. Our results show a columnar low-velocity (low-V) anomaly extending to 400 km depth under the Changbai volcano. High-velocity (high-V) anomalies are visible in the mantle transition zone, and deep earthquakes occur at depths of 500-600 km under the region, suggesting that the subducting Pacific slab is stagnant in the transition zone, as imaged clearly also by global tomography (Zhao, 2004). These results suggest that the Changbai intraplate volcano is not a hotspot like Hawaii but a kind of back-arc volcano related to the upwelling of hot asthenospheric materials associated with the deep subduction and stagnancy of the Pacific slab under NE Asia. A clear low-V anomaly (2-3%) is detected from the surface down to 700 km depth under Lake Baikal. The low-V anomaly is considered to represent a mantle plume, which contributed to the formation of the Baikal rift zone. The plume-like low-V zone is slightly tilting toward the northwest. Receiver function analyses show a normal depth of the 670 km discontinuity under this region, suggesting that the plume originates in the mantle transition zone, rather than from the lower mantle. But this is not conclusive, and future studies using a larger-aperture seismic network are needed to clarify this puzzle. A detailed 3-D seismic imaging of North China revealed a close relationship between large crustal earthquakes and lateral heterogeneity in the crust. In the middle to lower crust under the source areas of the large crustal earthquakes, low-velocity and high conductivity anomalies exist, which are considered to be associated with fluids that contributed to the generation of the large earthquakes.

Zhao, D. (2004) Global tomographic images of mantle plumes and subducting slabs: insight into deep Earth dynamics. Phys. Earth Planet. Inter. 146, 3-34.