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Shallow Moho with aseismic upper crust and deep Moho with seismic lower crust beneath the Japanese Islands obtained by seismic tomography using data from dense seismic network

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P-wave seismic velocity is well known to be up to 7.0 km/s and over 7.5 km/s in the lower crust and in the mantle, respectively. A large velocity gradient is the definition of the Moho discontinuity between the crust and mantle. In this paper, we investigates the configuration of Moho discontinuity defined as an isovelocity plane with large velocity gradient derived from our fine-scale three-dimensional seismic velocity structure beneath Japanese Islands using data obtained by dense seismic network with the tomographic method (Matsubara and Obara, 2011). Japanese Islands are mainly on the Eurasian and North American plates. The Philippine Sea and Pacific plates are subducting beneath these continental plates. We focus on the Moho discontinuity at the continental side.

We calculate the P-wave velocity gradients between the vertical grid nodes since the grid inversion as our tomographic method does not produce velocity discontinuity. The largest velocity gradient is 0.078 (km/s)/km at velocities of 7.2 and 7.3 km/s. We define the iso-velocity plane of 7.2 km/s as the Moho discontinuity. We discuss the Moho discontinuity above the upper boundary of the subducting oceanic plates with consideration of configuration of plate boundaries of prior studies (Shiomi et al., 2008; Kita et al., 2010; Hirata et al, 2012) since the Moho depth derived from the iso-velocity plane denotes the oceanic Moho at the contact zones of the overriding continental plates and the subducting oceanic plates.

The Moho discontinuity shallower than 30 km depth is distributed within the tension region like northern Kyushu and coastal line of the Pacific Ocean in the northeastern Japan and the tension region at the Cretaceous as the northeastern Kanto district. These regions have low seismicity within the upper crust. Positive Bouguer anomaly beneath the northeastern Kanto district indicates the ductile material with large density in lower crust at the shallower portion and the aseismic upper crust.

The Moho discontinuity deepens over 35 km in the collision zone like as Kanto Mountains, the volcanic underplating zone as the Tohoku backbone range, and non-tension region like as Chugoku Mountains. These regions associated with deep Moho are characterized by the crustal seismicity within the depth range from 20 to 30 km. The iso-depth contour of 35 km beneath the southwestern Japan is consistent with that derived from the receiver function method (Shiomi et al. 2006). There are nonvolcanic tremors and short-time slow slip events (SSE) beneath the southwestern Japan (eg. Obara, 2002). Matsubara et al. (2009) consider that the tremors and SSEs occur along the contact zone of Moho discontinuity beneath the Eurasian plate and the subducting Philippine Sea plate beneath southwestern Japan. Our Moho model is consistent with this since they exist along the southern edge of the Moho discontinuity of the continental Eurasian plate.

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