

Crust and uppermost mantle structure of the Japanese Islands inferred from receiver function analysis

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Recent travel time inversion analyses have elucidated crust and mantle structures of whole areas in the Japanese Islands. However, they estimated only spatial changes with relatively long wavelength, and it was difficult to extract clear velocity discontinuities. Also, the resolution of their S-wave velocity structures near the ground surface was insufficient than that of P-wave velocities. Therefore, the spatial distributions of the crustal velocity discontinuities and the Moho depths are poorly understood. In this study, we show the crust and uppermost mantle velocity structures and the velocity discontinuities beneath the Japanese Islands from receiver function analyses.

We improved an estimation method of crustal velocity structure beneath each seismic station by Igarashi et al. [2011]. This method searches the best-correlated receiver function between observed one calculated from teleseismic seismograms and synthetic one based on assumed crustal velocity structure by using a grid search method. We constructed velocity structures which consist of a sediment layer, one to three crustal layers and two upper mantle layers. They cover both the crustal velocity structures and Moho depths of the Japanese Islands estimated by previous researchers. We use seismic stations installed by the National Research Institute for Earth Science and Disaster Resilience, the Japan Meteorological Agency and Earthquake Research Institute, the University of Tokyo. We selected the 13,736 teleseismic events, which have the epicentral distance between 30° and 90°, magnitude greater than 4.5, and occurred in the period from September 1989 to February 2016.

The estimated crustal structure is characterized by areas with low-velocity layers. In several plains and basins, we identify a thick sediment layer. The surrounding areas of active volcanoes correspond to the low-velocity zones in the crust. The Itoigawa-Shizuoka Tectonic Line seems to a border of crustal velocity structure. The southwestern side has the relatively stable high-velocity areas, whereas the northeastern side is heterogeneous spatially. In the lower crust, low-velocity structures are distributed in the eastern part of the Niigata-Kobe Tectonic Line and some part of the Median Tectonic Line. There are low-velocity zones around the Moho discontinuity along the middle part of the island arc. The crustal thickness tends to increase in mountain regions and decrease toward the surrounding areas with some undulations. The Moho discontinuity of the subducting Philippine Sea plate has distinct velocity change near the southern coastline of the Japanese Islands, and the velocity contrast is larger than that of the overriding plate. We suggest that S-wave velocity transition layers exist in the uppermost mantle just beneath the Moho discontinuity in broad areas of the Japanese Islands. The transition layers probably indicate crustal evolution or melting around the Moho discontinuity of the island arc.