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Crustal structure beneath the Tokyo metropolitan area inferred from receiver function

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Seismic activities are very high around the Tokyo metropolitan area, Kanto district. This area often experiences large earthquakes occurred at various places including the subducting Philippine Sea plate (PSP), the subducting Pacific plate (PAP), and inland earthquake. To interpret the heterogeneous structure and heterogeneous distribution of seismicity is the key to understanding the stress and strain concentration process. In particular, investigation on configurations of the subducting plates is important to mitigate future earthquake disasters in this area. Many researchers have proposed seismic velocity structures and configuration models of the subducting plates beneath the Kanto district. However, very few studies have paid attention to the deep crustal structure and the Moho boundary. Therefore, the seismic velocity structure of the crust and the uppermost mantle did not completely construct the whole image of plates. A receiver function (RF) analysis is widely used to extract velocity discontinuities in crust and mantle beneath each seismic station. The spatial resolution is theoretically higher than that of seismic tomography, if we use frequency bands up to several hertz. Igarashi [2009] has already estimated geometries of the Moho in the overriding plate and the subducting PSP and PAP from RF analysis and repeating earthquake data by using a telemetric seismographic network in the Kanto district. However, crustal structure beneath the Kanto plain could not be analyzed with RFs because we did not use deep borehole stations. Recently, comprehensive surveys are conducted as the Special Project for Earthquake Disaster Mitigation in Tokyo Metropolitan area from 2007. The Metropolitan Seismic Observation network (MeSO-net) is constructed under this project. In this study, we applied the RF analysis with a sediment layer correction using the MeSO-net data and teleseismic waveform data to estimate seismic velocity discontinuities in the crust and the uppermost mantle beneath the Tokyo metropolitan area. We selected events with magnitudes greater or equal to 5.5 and epicentral distances between 30 and 90 degrees based on USGS catalogues. MeSO-net data are used for the period from April 2008. We also used telemetric seismographic network data operated by NIED, JMA and ERI and analyzed by Igarashi [2009]. We made the vertical cross-sections of depth-converted RFs. RF amplitudes within a width range of 20 km were stacked and projected at each cross-section. We applied low-pass filtering with a squared cosine-taper having a cutoff frequency of 3 Hz. The JMA2001 structure model was used to convert the lapse time of time series to depth. As preliminary results, many discontinuities were detected in the crust and the uppermost mantle from the cross-sections. They improve geometries of discontinuities beneath the Tokyo metropolitan area. The Moho discontinuity in the overriding plate exceeds 40 km in depth in the northwestern mountain area and changes sharply at the boundary between the mountain district and the plain. It contacts the subducting PSP in the southern Kanto. The upper boundary of the PSP as a whole subducts to the northwest, but it is concave to the northeast in the southern Boso Peninsula. Plate thickness gradually decreases toward the northeast after contact is made with the underlying PAP. The margin of the PSP is indicated in a part of the northeastern edge. The dip direction of the PAP changes beneath this area with some undulations. We suggest that the low-velocity mantle wedge may be indicated on the top of both subducting plates. We will estimate more reliable crust and uppermost mantle velocity structures by collecting more waveform data.

Keywords: Receiver function analysis, Crustal structure, Plate configuration, the Tokyo metropolitan area