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Seismic interferometry imaging of crustal structure using deep earthquakes in Tokai region

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Seismic reflection survey using artificial sources is generally used as an imaging method of subsurface structure. By using the theory of interferometry, a subsurface structure can be imaged from seismic wave records of natural earthquakes as well as those of artificial sources. Imaging deeper structures is expected by using the natural earthquakes because the energy is larger than the energy from artificial sources.

This study aims to image the structures in the crust and the plate under the Tokai region by applying autocorrelation analysis (Claerbout, 1968) of seismic interferometry to the natural earthquake records observed by Tokai Array observation (Kato et al., 2010) from April to August, 2008. Records of the 8 Hi-net stations near the Tokai Array were also added.

Auto-correlation analysis assumes that the wave is at normal incidence since it stands in one-dimensional wave field. Therefore deep earthquake records (about 200 - 300 km) occurred in Pacific plate slab under the Tokai region were used. According to Kato et al. (2010), the deepest depth of Philippine Sea plate boundary is about 40 km under the Tokai region. From the theory of the Fresnel zone, it is estimated that the angle of incidence up to about 10 degree can be considered as normal incidence in the frequencies used for analysis. Therefore, deep earthquakes whose incident angle of 10 degrees or less in all stations were selected.

From the deep earthquake records of Tokai Array Observationthat satisfy the condition of incidenct angle, we selected 11 events (Mj2.2 - 3.6) for the analysis. For Hi-net records, 40 events (Mj3.0 -) of the deep earthquakes were extracted during 2004 - 2012. We used waves after P-wave arrival to S-wave arrival of the UD component as P-wave record and waves after S-wave arrival in the NS and EW components as S-wave. In prior to auto-correlation, pre-processing such as correction of the frequency response of seismometer, band-pass filter (pass band : 0.5 - 1.0 Hz) and deconvolution of source wave were applied.

In the result of analysis, we found continuous reflectors dipping NW near the depth of plate boundary shown in Kato et al. (2010). The reflectors were also found in the result of Hi-net data. Our preliminary interpretation is that the reflectors correspond to the plate boundary. The continuous reflectors were clear in the NW side of the array. However, it became obscure in the SE side. This may be due to the effect of sedimentary layers and the man-made noise in the SE side of the array. Also, this may be due to the regional geology because it seemed that the lateral change in the section locates near Median Tectonic Line and Butsuzo Tectonic Line.

We will apply the crosscorrelation analysis to the record in order to improve S/N ratio, and then, apply the same processes to teleseismic records.

Keywords: seismic interferometry, autocorrelation analysis, crustal structure, subsurface imaging, deep earthquake