Measurements of Rayleigh wave particle motions beneath the Japanese islands: Implications for the crust and uppermost mantle structures

*Kengo Ikedo[1], Kazunori Yoshizawa[2], Kiwamu Nishida[3]

1. Seismology Laboratory, Earth and Planetary Dynamics, Natural History Sciences, Graduate School of Science, Hokkaido University, 2. Faculty of Science, Hokkaido University, 3. Earthquake Research Institute, The University of Tokyo

The amplitude ratio of horizontal and vertical components of Rayleigh waves can be used to investigate the relatively shallow Earth structure, such as the crust and uppermost mantle. Most of the earlier studies using surface wave are primarily based on the measurements of phase and/or group speed dispersion, and the Rayleigh wave ellipticity (or H/V ratio), which is more sensitive to shallow subsurface structure, has rarely been applied to the construction of the large-scale velocity structure. It has been well-known that such H/V ratios can be used to infer the internal structure of the Earth, but the spatial distribution of the H/V ratios of long-period Rayleigh waves with dense seismic arrays has yet to be investigated.
In this study, we analyzed the H/V ratios of intermediate to long period (30 –200 s) Rayleigh waves for all stations of the Japanese broadband seismic network (F-net), and discuss their relation with the crust and upper mantle structure beneath the Japanese islands.
The frequency-dependent variations of observed H/V ratios for each station are relatively mild. This reflect that the H/V ratios of Rayleigh waves are far more sensitive to the near surface structure irrespective of frequency even in the long period. Still, some slight changes in H/V ratios as a function of frequency can be observed, which is likely to reflect the large-scale structure in the uppermost mantle, since the sensitivity kernels of H/V ratios have a secondary peak below the Moho. Our results show that the observed H/V ratios in the shorter period than 60 s become larger than the regional average, particularly in the south of Hokkaido, the south of Kyushu and Kanto areas, while those in the south-western Japan show relatively smaller values. In general, high H/V ratios can be found in a region with strong vertical velocity gradients; for example, sedimentary areas above relatively fast velocity bedrock. Our results reflect such features well in shorter period range, and also coincide well with the velocity anomalies in the upper crust based on ambient noise analysis (Nishida et al., 2008); i.e., high H/V ratios in slow velocity regions, and low H/V ratios in fast velocity regions. In the longer period at around 100 s, the H/V ratios become large in Tohoku and Kyushu areas, just above the subducting plates. This may reflect the effects of secondary peak of the sensitivity profile of Rayleigh wave ellipticity. These results indicate that the Rayleigh wave ellipticity has a good potential to constrain the crustal and uppermost mantle structure, if we use them in conjunction with the conventional phase speed data.

