Measurements of Rayleigh wave phase velocity by the multi-station method

Haruka Takezoe[1]; Kazunori Yoshizawa[2]; Kiyoshi Yomogida[3]

[1] Earth and Planetary Sci., Hokkaido Univ; [2] Division of Earth and Planetary Sciences, Hokkaido University; [3] Earth and Planetary Sci., Hokkaido Univ.

Phase and group velocities of surface waves have been utilized in many studies for retrieving a shear wave speed structure in the crust and uppermost mantle for decades. Press (1956) first measured phase velocities of surface waves observed at multiple stations in order to obtain a crustal structure in the southern California. Aki (1961) applied a similar technique as Press (1956) to the measurement of average phase speeds as well as arrival angles of surface waves observed by JMA stations in Japan. The multi-station method for surface waves is useful for obtaining localized phase speeds and arrival angles of an incoming wave packet of surface waves. However, the multi-station technique requires a dense seismic network to enhance a reliability of the measurements.

Nowadays, seismic records observed by a dense broad-band seismic network, F-net (NIED, Japan), are accessible to seismologists, and thus we are able to apply the multi-station method to such a dense seismic network. In this study, as a first attempt, we develop a technique to measure phase speeds as well as arrival angles of surface waves by using a set of several seismic stations. The method is applied to localized groups of F-net stations to investigate local seismic structures of the crust and uppermost mantle beneath the Japanese islands.

We use the fundamental-mode Rayleigh waves in a period range between 30 and 140 seconds. To avoid some unwanted effects caused by higher modes as well as ambient noises, we restrict seismic events with depth shallower than 30 km and with surface-wave magnitude larger than 6.0. In our multi-station analysis, we first consider grids with a 1 degree interval along both the longitude and latitude. Each grid point is supposed to be a center of a circle with radius of 200 km. F-net stations located in each circle are used as a group to measure a local phase speed dispersion, and one of the stations in each group are set to be a reference station. We then measure phase differences for the rest of stations in the group with respect to the reference station. In general, each group includes 3 - 6 stations. Phase speeds and arrival angles are expanded in a set of B-spline functions, whose coefficients are determined by a least-squares inversion. The measured phase speeds are compared with synthetic phase speeds calculated for a reference model (PREM with a crustal correction using a standard crustal structure in Japan by Aki (1961)). The preliminary results show that the phase speeds at a period shorter than 50 seconds in Hokkaido are comparable to those of the reference model, whereas, in Tohoku, the phase speeds are 2-3 % faster than the reference at the same period range, suggesting the differences between the uppermost mantle structure beneath Hokkaido and Tohoku. In the longer period range (longer than 80 seconds), phase speeds for both Hokkaido and Tohoku regions are 5 % faster than the reference, which suggests the effects of the subducting Pacific plate with higher wave speeds beneath these regions.