Surface-wave phase velocity distribution beneath the Japanese islands and its surrounding area by the two-station method

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S-wave velocity structure in the crust and uppermost mantle has been studied extensively with surface wave tomography, based on a single station method exploiting ray average information for source-receiver paths. Such studies require relatively longer paths for surface wave analysis and thus are not appropriate to reconstruct a local velocity structure such as in the Japanese islands. With the recent development of high-density and high-accuracy broad-band seismic networks, it is now possible to reconstruct a high-resolution local model utilizing array-based approach. We have previously obtained a model of Rayleigh wave phase velocity distributions of Japan and its surrounding area in the period range between 20 and 150 seconds with the two-station method: a method to measure phase velocity from phase difference between two stations (Yoshizawa et al., JGU meeting, 2007). In this study, we reconstruct higher-resolution phase velocity models of the fundamental-mode Rayleigh and Love waves employing a larger data set in the Japanese islands and its surrounding area.

In this study, we employ F-net broad-band seismic network (NIED) in Japan as well as FDSN stations in East Asia. Seismic events over the world for 2 years from 2005 to 2006 with moment magnitude greater than 6.0 and depth shallower than 100 km are chosen. At first, the response characteristics of all the seismograms are corrected for that of an STS-1 broad-band seismometer. Surface-wave arrivals are automatically picked, depending on epicentral distance based on appropriate group velocity ranges (Rayleigh: 2.6-3.1 km/s; Love: 3.0-5.5 km/s). Unwrapped phase spectra for seismograms are then used to calculate average phase velocities between two stations. Two-station pairs are selected with the following criteria: difference in azimuth from a source to two station is less than 0.5 degrees, and distance between them are longer than 50 km. The average station interval of F-net is less than 100 km, which is appropriate to estimate local phase speed dispersion between two stations down to a relatively short period range of 20 seconds (whose wavelength corresponds to about 70 km in the Rayleigh wave case).

Phase velocity distributions of Japan and its surrounding area are retrieved from 4500 paths for Rayleigh and 1600 paths for Love waves in the period range between 20 and 150 seconds. In the north east Japan (Tohoku) and Hokkaido region, we can identify high phase velocity anomalies corresponding to the subducting Pacific plate in the period range between 20 and 70 seconds. In the central Japan (the Chubu region) and Hokkaido region, partially in the Tokachi region, slow anomalies exist at periods shorter than 50 seconds, which is likely to be related to thick island-arc crust beneath these regions. The phase velocity perturbations of Love waves from an isotropic reference model are systematically larger then those of Rayleigh waves in Japan, implying the existence of a certain degree of transverse isotropy in the uppermost mantle.