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Shear-wave anisotropy in the crust and uppermost mantle beneath Japan from broadband array analysis of surface waves

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Recent deployments of dense seismic networks enable us the broadband array analysis of surface waves such as the noise correlation analysis (1-30 s), and the array analysis of teleseismic waveforms (30-100 s). As a result, we can reduce the influence of crustal structure to the estimation of radial anisotropy ($V_{SH} <$ or $> V_{SV}$) in the mantle. The dense seismic networks are also useful for measuring phase velocities of surface waves as a function of azimuth. We can then estimate azimuthal anisotropy in the mantle, whose spatial coverage and depth resolution are much higher than body-wave studies. Although the estimation of seismic anisotropy beneath Japan is essential for discussing the stress, deformation and flow related to the subduction process, the broadband phase velocities of surface waves and their azimuthal dependences have not been reported yet. We analyze broadband surface waves recorded by Hi-net tiltmeters (two-component high-sensitivity accelerometer) for obtaining radial and azimuthal anisotropy beneath Japan.

The analysis is performed for each of 120 arrays, where an array is an aggregate of 5-10 stations within a circle with a radius of 50 km. For each array, we first measure average phase velocities of Rayleigh and Love waves (1) by applying the spatial auto correlation method (Aki, 1957) to continuous records at periods of 3-20 s, and (2) by applying an array analysis method to teleseismic waveforms at periods of 30-100 s. Using these phase-velocity measurements, we estimate one-dimensional radially anisotropic structure beneath each array. In addition, the azimuthal dependences of Rayleigh-wave phase velocities are estimated from teleseismic waveforms.

The preliminary results show the presence of radial anisotropy ($V_{SH} > V_{SV}$) in the crust beneath southern part of southwest Japan. In the uppermost mantle, the radial anisotropy ($V_{SH} > V_{SV}$) exists beneath entire regions expect for the coastal region near the Pacific Ocean. The fastest direction of Rayleigh-wave phase velocity is east-west at a period of 35 s where the wave has sensitivity to depths of about 30-70 km. The direction becomes north-south at a period of 75 s where the sensitivity exists at depths of about 70-150 km. Along the Itoigawa-Shizuoka tectonic line (ISTL), the direction is south-north at a period of 35 s, whereas the direction becomes east-west at a period of 75 s. In the western part of Hokkaido and eastern part of Tohoku, the direction is north-south at both 35 and 75 s.

For interpreting these results, we need to consider tectonics beneath Japan such as (1) the flow in the mantle due to subduction of the Pacific and Philippine Sea plates, (2) the paleo deformation frozen in the subducting plates, and (3) the east-west compression around the Hidaka Collision Zone and the ISTL. We will examine the uncertainty of estimated anisotropy, and will discuss the origin of anisotropy after comparing our results with previous results obtained by surface-wave tomography (Yoshizawa et al., 2010), S-wave splitting analysis (e.g., Nakajima and Hasegawa, 2004) and P-wave tomography (Ishise et al., 2005, 2008).

Keywords: anisotropy, crust, mantle, surface wave, noise correlation analysis