Interstation phase speed measurements of surface waves in the Sea of Japan using broadband seismic arrays

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Seismic structure in the crust and upper mantle beneath the Sea of Japan reflects its complex tectonic history including back-arc spreading and the subsequent formation of the Japanese islands. The seafloor topography and the crustal thickness of this marginal sea are quite variable, characterized by several basins and rises. Although the upper mantle structure beneath the Sea of Japan has been investigated with surface wave tomography using permanent broadband seismic networks in Japan and in East Asia by Yoshizawa et al, (2010, PEPI), the horizontal resolution of this earlier model was limited due to the small numbers of ray paths across the marginal sea.
A temporary broadband seismic array, which has recently deployed across Northeast China (NECESSArray) from 2009 to 2011, can be of great help in enhancing the ray coverage across the Sea of Japan, by employing interstation dispersion measurements of surface waves. In combination with the Japanese permanent broadband network (F-net), a large number of interstation phase speeds information across the Sea of Japan can be extracted. In this study, we employ a fully non-linear waveform fitting technique to measure interstation phase speeds using a method developed by Hamada & Yoshizawa (2015, GJI). Through the waveform analysis of the combined data sets in the period range between 20 and 150 seconds, we collected about 5000 new measurements of phase speeds using seismic events with moment magnitude greater than 6.0 during the temporary deployment of NECESSArray (2009-2011). With the additional data set, we are now able to resolve the smaller scale heterogeneity of about 1.5 degrees or less in the Sea of Japan. The updated preliminary phase speed maps of Rayleigh waves show significant fast phase speed anomaly beneath the Japan Basin in the period shorter than 45 s, while, in the longer periods, slow anomalies are found in most areas beneath the Sea of Japan, suggesting relatively thinner lithosphere (about 60 km) compared with the typical oceanic plate like the Pacific. One of the striking features of the new model is that the phase speed maps at shorter period than 45 s shows conspicuous regional variations in the Sea of Japan; i.e., phase speeds beneath southwestern areas, including the Tsushima Basin, tend to be slower, while the northeastern half of the sea, including the Japan Basin, is characterized by faster phase speeds, which may reflect the lateral variations of the lithospheric thickness. Furthermore, a localized fast phase speed anomaly is found beneath the Yamato Rise in the period shorter than 60 s, which may suggest relatively thicker lithosphere of about 80-90 km beneath it.

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