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Three-dimensional shear-wave speed structure beneath the Philippine Sea by land and ocean bottom broadband data

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We obtained three-dimensional shear-wave speed structures beneath the Philippine Sea and surrounding region from seismograms recorded by land-based and long-term broadband ocean bottom seismographic stations.

As a part of the Stagnant Slab Project, twelve broadband ocean bottom seismometers (BBOBSs) were deployed in the period from 2005 to 2006 in and around the northern Philippine Sea region. The BBOBS stations improved the spatial distribution of seismic stations in the Philippine Sea.

We measured phase speeds of the fundamental and first three higher modes of Rayleigh waves for the source-station pairs within a latitudinal range from -10?S to 55?N and a longitudinal range from 110?E to 165?E, using a fully non-linear waveform inversion method by Yoshizawa and Kennett (2002). We obtained 4814, 468, 838 and 835 phase speed dispersion curves of the fundamental and first three higher modes of Rayleigh waves in a period range between 40 and 167 second, respectively. The measured multi-mode phase speeds are inverted to a 2-D shear wave phase speed structure using the inversion technique by Yoshizawa and Kennett (2004), which allows us to incorporate the effects of finite frequency as well as ray path deviation from the great-circle. The use of the multi-mode phase dispersion data should resolve better the depth variation of shear wave speed than the conventional analysis method of fundamental mode dispersion. Corrections for the off-great circle propagation and finite frequency effects should improve resolution and accuracy of a 2-D phase speed model as in the present case where the lateral variation in seismic wave speed is large and sharp.

We inverted the multimode dispersion curves of phase speed maps to the shear wave speed model. The reference 1-D model is based on PREM except for the crust for which we adopted the CRUST2.0 model.

We obtained a shear speed structure under the Philippine Sea region with resolution better than that by Isse et al. (2006), because the number of phase dispersion curves and BBOBS stations are increased, particularly in the southern part of the Philippine Sea region. The inverted model has a good resolution in the upper 240 km of the mantle. In the upper 120 km, the shear wave speed structure is well correlated with the age of provinces. At depth greater than 160 km, the patterns is dominated by fast anomalies of the subducted slabs of the Pacific plate and three slow anomalies beneath the center of the Philippine sea plate, the west Caroline basin and the Caroline islands.