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Lithosphere-Asthenosphere boundary beneath NW Pacific Ocean detected with seismic waveform data

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We have conducted seismic observation around the Shatsky Rise in the northwest Pacific Ocean at 18 stations equipped with a broadband ocean bottom seismometer (BBOBS) for understanding the structure of the Earth's interior and the mechanism of plate motion (Normal Mantle Project). It is important to estimate the upper mantle structure beneath these stations, for revealing existence of partial melt and water in the oceanic upper mantle.

We calculated P-wave and S-wave receiver functions (PRF, SRF) with waveform data obtained from the BBOBSs. We analyzed teleseismic events occurring between June 2010 and September 2014, whose magnitudes are over 5.5. Epicentral distances of the events used for calculating PRF are between 30^o and 90^o, and those for calculating SRF are between 55^o and 90^o. Careful handling is required for the data obtained at stations northwest side of the Shatsky Rise because the data are largely affected by reverberations in the thick sediments (Abe and Kawakatsu, 2014, SSJ Fall Meeting). We eliminated frequency components higher than 0.1 Hz from SRF with a Gaussian filter because noise level of the observed waveforms in the frequency domain around 0.2 Hz is high. Frequency components higher than 0.05 Hz were eliminated from PRF for preventing contamination by reverberations in the sediments. We averaged PRFs and SRFs for each station, and obtained a broad negative peak on averaged PRFs and a broad positive peak on averaged SRFs, between 5 s and 10 s. Both these peaks correspond to velocity decrease with depth in the upper mantle. We synthesized PRF and SRF with a model, which contains a discontinuity at depths between 30 km and 150 km, where velocity decreases between 0% and 20% with depth, and searched a model that explains both PRF and SRF obtained at each station. From the search, a model with 8% drop in velocity at 85 km in depth and a model with 4% drop in velocity at 125 km in depth explain the data observed at the northwest and southeast side of the Shatsky Rise the best, respectively. Kawakatsu et al. (2009 Science) detected a discontinuity with downward decreasing velocity at 80 km in depth by an RF analysis of waveform data from borehole BBOBS on north side of Shatsky Rise, and they interpreted the discontinuity as the Lithosphere-Asthenosphere boundary (LAB). The discontinuity detected in this study may also correspond to LAB. The structure of the oceanic crust and sediments and water depth of a station may affect the waveform of RFs. Therefore, we now check how correctly we can constrain the depth and the drop in velocity with different assumptions of the shallower structure.

Keywords: oceanic plate, receiver function, Northwest Pacific Ocean, Lithosphere-Asthenosphere boundary