Significance of sediment reverberations on receiver functions of broadband OBS data

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We attempted to estimate the depth of the lithosphere-asthenosphere boundary (LAB) and velocity contrast at LAB with a receiver function (RF) analysis of waveform data observed by a broadband ocean bottom seismometer (BBOBS) installed in the northwest Pacific Ocean under the OHP project. Beneath the station (WPAC), thickness and several physical properties of the sediment layer were revealed from a boring core (Kanazawa *et al.*, 2001, *Proceedings of the Ocean Drilling Program, Initial Reports*). The oceanic crustal structure was precisely estimated by a seismic experiment (Shinohara *et al.*, 2008, *PEPI*). Using waveform data observed at the bottom of a borehole just beneath WPAC, depth of the LAB and S-wave velocity contrast at LAB were estimated to be 82 km and 7.2%, respectively (Kawakatsu *et al.*, 2009, *Science*; Kumar *et al.*, 2011, *JGR*).
We calculated P-wave RFs (PRFs) and S-wave RFs (SRFs) from teleseismic waveforms, and obtained averaged PRF and SRF. To calculate RFs, a Gaussian low pass filter, $G(\omega)=\exp(-(\omega/2\alpha)^2)$, was applied. We obtained four pairs of PRF and SRF with different values of α, 0.25, 0.5, 1.0, and 2.0. We synthesized PRF and SRF using the known structural parameters revealed from the studies shown above. However, the synthetic PRF and SRF cannot explain the observed ones. The synthetic PRF has several peaks caused by reverberation of S-wave in the sediment layer with larger amplitudes than the observed one. Amplitude of the first peak of the synthetic SRF is much larger than that of the observed one.
We showed that the observed PRF can be explained when we assume attenuation and velocity gradient of S-wave in the sediment layer in addition to the known parameters. Although the observed SRF cannot be explained even if we assume them, we showed that they can be explained when we calculate an SRF from synthetic waveforms added with large noise. Velocity gradient and attenuation of S-wave in the sediment layer and noise are necessary to be taken into account for explaining RFs obtained from BBOBSs.
The observed waveforms would contain noise that largely changes amplitude of SRF, and it is difficult to constrain subsurface structure from SRFs. Only from PRF, we searched structural parameters from the ocean bottom to the asthenosphere, where attenuation and velocity gradient in the sediment layer were contained. The depth of LAB and S-wave velocity contrast at LAB are constrained to be 73-129 km and 6-25%, respectively. Thick sediments beneath WPAC (377 m; Kanazawa *et al.*, 2001) would make the analysis difficult. New BBOBSs have been developed to reduce noise (*e.g.* BBOBS-NX: Shiobara *et al.*, 2013, *IEEE J. Ocean Engineering*). At other stations, where the condition is better, the parameters might be constrained better.

Keywords: receiver function, oceanic sediments, broadband ocean bottom seismometer

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