Global features of slabs inferred from regional low- and high-frequency body waves of deep earthquakes

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We show that high-frequency P and S phases from deep earthquakes arrive at fore-arc stations after low-frequency phases, with increasing delay with thermal parameters in subduction zones. The observation in Tonga may be associated with the metastable olivine wedge (MOW) as well as in northern Japan.

By analyzing features of P and S waves radiated by deep earthquakes, we can elucidate the nature of slabs where the seismic waves have passed. One of the features is difference in arrival time between low-frequency ($f < 0.25$ Hz) and high-frequency ($f > 2$ Hz) signals. This can be observed clearly in the fore-arc side of the volcanic front in northern Japan. Furumura and Kennett (2005) showed that the P and S waves from deep earthquakes beneath the Sea of Japan have low-frequency onsets with high-frequency long-duration signals, suggesting that they are the result of small-scale quasi-laminar heterogeneity within the subducting Pacific slab. The late arrivals of high-frequency P and S signals can be enhanced for earthquakes deeper than 400 km due to the low-velocity MOW in the slab (Furumura et al., 2016).

In this study, we examined seismograms worldwide for the features suggested by Furumura’ s studies. We collected waveform data of P and S waves from IRIS and F-net broadband seismometers in fore-arc sides of subduction zones where deep earthquakes occur. We measured separation time between low- and high-frequency arrivals. By comparing it with several physical parameters of subduction zones, we found that the separation time could increase with the thermal parameter. The result is consistent with Kennett et al. (2014) who suggested that the quasi-laminar heterogeneity within the oceanic lithosphere can guide high-frequency Po and So waves more efficiently in the older, cold areas of the Pacific. Therefore, the observed correlation between the separation time and thermal parameter may arise from the dependence of the quasi-laminar heterogeneity on temperature. In the areas except for Tonga and northern Japan, we did not find observations that are likely to be evidence for MOW. Large separation time was observed in Tonga, and it tends to be increased for earthquakes deeper than 500 km.

