Multi-band Receiver Function Analysis Including Local Deep-focus Events in Northeastern Kii

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Slow earthquakes play important roles in the occurrence of megathrust earthquakes in subduction zones. It is still unclear what sort of seismological structures exhibits each slow earthquake activity, although an increasing number of seismic networks have contributed to significant findings and the detection of slow earthquake activities. We have developed the multi-band receiver function (RF) method, in which the RFs are composed of different higher-frequency contents. We, here, calculate the multi-band RFs using records both of tele-seismic events and local deep-focus events that occurred in the Pacific slab. We also reveal smaller-scale structures around the Philippine Sea plate boundary in Southwestern Japan, where numerous slow earthquakes have been detected (e.g., Obara, 2002; Ito et al., 2007; Nishimura et al., 2013).

The records of deep-focus earthquakes, frequently occurring in the Pacific slab below Southwestern Japan, can apply to the multi-band RF analysis because the local deep events and tele-seismic events have similar slowness of the first-arrival phases. Local deep-focus events, however, have different variations in back azimuths from tele-seismic events, which enables us to estimate seismological structures in a wider range of azimuths by stacking traces from both events. We carefully select the deep-focus events with S-P time longer than 40 sec and exclude triplication phases from mantle transition zones. Here we apply the method to short-period 3-component seismograms of Hi-net (NIED, Japan) in the Northeastern Kii Peninsula, where short-term slow slip events (SSEs) and episodic tremors are very active (e.g., Obara et al., 2010; Nishimura et al., 2013; Yabe & Ide, 2014).

Cross-sections of higher-frequency RFs (up to 2 Hz) show large and narrow negative phases from the plate interface shallower than 35 km depth, which is one of the most active regions of episodic tremors (Obara et al., 2010). This suggests that the velocity steeply decreases from the lower continental crust to the low-velocity oceanic crust. The basaltic oceanic crust releases much amount of fluid by dehydration (e.g., Hyndman & Peacock, 2003). This indicates that the low permeable continental crust (Katayama et al., 2012) is in contact with the oceanic crust and the released fluid is building up there. We conclude that episodic tremors, accompanied by short-term SSEs, occur on the interface between the continental crust and the oceanic crust. On the other hand, the higher-frequency RF at the deeper portion of the plate interface shows the mantle-wedge structure and the negative phases are relatively small and broad, suggesting that a hydrous mantle wedge stably exists with gradual velocity change from plate interface to the bottom of the continental crust. The minor and continual tremors, reported by Obara et al. (2010), may occur the plate interface between the oceanic crust and the wedge mantle. These results indicate overriding materials above the area of tectonic tremors is possibly one of the components to control their activities.

Keywords: Receiver function, Tectonic tremor, Deep-focus earthquake

