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Hydrous state of the Philippine Sea plate inferred from receiver function analysis using onshore and offshore data

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Exploring fluid distribution in subduction zones is an intriguing topic because it is considered that the fluids affect the occurrence of non-volcanic tremors, slow slip events, microearthquakes, and even the rupture area of the megathrust earthquakes. The fluid generating strong contrast in seismic velocity, many studies have utilized scattered teleseismic body waves, or receiver functions (RFs), to infer the hydrous state in worldwide subduction zones [*e.g., Kawakatsu and Watada*, 2007; *Audet et al.*, 2009]. General consensus among these studies is that subducting oceanic crust hosts abundant fluids, which is supported by overlying positive and underlying negative RF amplitudes. Most of the studies, however, conducted analysis by limiting their study area into two-dimensional vertical sections beneath inland area. Lateral variety and seaward extension of the fluid distribution remains uninvestigated. In this study, we conducted RF analysis using ocean-bottom seismometers (OBSs) and on-land permanent stations deployed around the Kii Peninsula in the southwestern Japan.

OBS vertical component records contain dominant water reverberations, so conventional method fails to estimate correct RFs. We hence developed a method to remove the reverberations using a linear filter, which were constructed from the deconvolution of OBS vertical records by source wavelets. We estimated the source wavelets from stacked traces of on-land station records. Resultant RFs by removing water reverberations with the filter show an improvement on later phase identification, compared with those from conventional method. Using these RFs, we constrained the geometry of the subducting Philippine Sea plate and inferred the hydrous state of the oceanic crust.

Our RF image shows negative RF amplitudes on the plate interface and positive RF amplitudes on the oceanic Moho, which we inferred as hydrous oceanic crust. The hydrous oceanic crust seems to extend seaward to ~5 km depth from our results. We found the RF amplitude reduction on both sides of the oceanic crust at the belt-like region of non-volcanic tremors, while the long-term slow slip patch [*Kobayashi*, 2014] is located at the adjacent place with strong RF amplitudes. This contrasting features suggest that difference in pore fluid pressure or permeability of the plate interface controls the slip behavior of the plate interface. The comparison between microseismicity [*Akuhara et al.*, 2013] and the configuration of the subducting plate modeled in this study reveals that the oceanic crust becomes aseismic as slab subducts deeper, and that the transition depth varies laterally. This may provide some constraints on the process of slab dehydration although detailed simulation of thermal structure is necessary in the future.

Keywords: Subduction zone, fluid distribution, ocean-bottom seismometer, receiver function