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Receiver function imaging of the Philippine Sea slab beneath Kyushu, southwest Japan

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In subduction zones, the subducting slabs are thought to convey fluid into the mantle wedge and to cause arc volcanism. It is revealed that serpentinized layer in the mantle wedge beneath NE Japan subducts along the Pacific slab, releases its fluid at about 150 km in depth, and the released fluid moves to the volcanic front, with seismic tomography, receiver function (RF) analysis and geochemical simulation (Hasegawa et al., 2008; Iwamori, 2007; Kawakatsu & Watada, 2007). Oceanic plates subducting beneath Kyushu (west Philippine Sea basin: 50Ma. Shikoku basin: 27Ma) are younger than the Pacific plate subducting beneath NE Japan (130Ma), and an island arc crust, Kyushu-Palau ridge, is subducting beneath Kyushu. The mantle wedge structure beneath Kyushu has been estimated and fluid distribution has been elucidated by tomographic studies (Zhao et al., 2000; Honda & Nakanishi, 2003; Wang & Zhao, 2006). It is revealed that the subducted oceanic crust exists at 60 km in depth and the Philippine Sea slab (PHS) conveys fluid down to this depth beneath the central part of Kyushu (Okamoto et al., 2008). However, it has not been elucidated where the hydrated portion extends along PHS. It is important to estimate the structure of PHS and reveal hydrated portion for better understanding of fluid transportation by a young slab. We estimate the geometry of seismic velocity discontinuities of PHS with RF analysis.

We use 439 teleseismic waveforms (origin time: Aug.1996-Feb.2009, epicentral distance: 30-90^o, magnitude: greater than 5.5) observed at 78 Hi-net stations and 61 J-array stations. Transverse RFs which hail from the southeast are constructed with the extended-time multitaper method (Shibutani et al., 2008). We use the fast-marching method (de Kool et al., 2006) to stack RFs with taking account of refraction at dipping interfaces (Abe et al., submitted). RFs are stacked in a region (31-34^{o}N, 129-132^{o}E and 0-300 km in depth), which includes the Wadati-Benioff zone of PHS beneath Kyushu, and projected on sections perpendicular to the strike of PHS. We assume a 1-d model of ak135 (Kennett et al., 1995), and stack RFs several times with assuming varying geometries of conversion surfaces, so that the assumed interface geometry coincides with that obtained from RF sections.

We obtain discontinuities with upward decreasing velocity along the Wadati-Benioff zone of PHS. These discontinuities extend to 80-150 km in depth. Discontinuities with upward decreasing velocity along a slab are expected to be the oceanic Moho or the bottom interfaces of serpentinized mantle (Kawakatsu & Watada, 2007). Since these obtained discontinuities extend up to 150 km, shallower and deeper portions of them are interpreted as the oceanic Moho and the bottom interfaces of serpentinized mantle, respectively, although we do not distinguish the two interfaces. Therefore, these discontinuities are expected to be the bottom of hydrated portion, and fluid transportation along PHS is revealed.

We obtain discontinuities which are interpreted as the top surface of PHS only in the region, at 32^{o}N, 60-80 km in depth. They might be the top surface of the island arc crust (Kyushu-Palau ridge), and the structure of this region should be examined more in detail. Discontinuities interpreted as the top surface of PHS do not detected beneath the other region. This fact indicates that seismic velocity contrast at the top surface of PHS is small, and is consistent with the fact that the fore-arc mantle wedge has low seismic velocity (Zhao et al., 2000; Honda & Nakanishi, 2003; Wang & Zhao, 2006).

We use waveform data observed by the National Research Institute for Earth Science and Disaster Prevention, Kyushu Univ., Kagoshima Univ. and Japan Meteorological Agency, and hypocentral data collected by Japan Meteorological Agency. We use FMTOMO (de Kool et al., 2006) to calculate travel time fields with the fast-marching method.

Keywords: receiver function, Philippine Sea slab, Kyushu, fast-marching method