Slab-derived fluid distribution beneath Kii Peninsula inferred from receiver function analysis

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1. Introduction

Deep low frequency events (DLFEs) are distributed widely from western Shikoku to central Tokai (Obara, 2002; Kamaya and Katsumata, 2004; Obara and Hirose, 2006). Results from seismic tomographies and receiver function analyses revealed that the oceanic crust of the Philippine Sea plate has a low velocity and a high Vp/Vs ratio (Hirose et al., 2007; Ueno et al., 2008). Hot springs with high 3He/4He ratios are found in an area between central Kinki and Kii Peninsula despite in the forearc region (Sano and Wakita, 1985). These phenomena suggest the process that H2O subducting with the oceanic crust dehydrates at the depths of 30 - 40 km, causes the DLFEs, and uprises to shallower depths.

We carried out seismic observations in Kii Peninsula since 2004 in order to estimate the structure of the Philippine Sea plate and the surrounding area. We deploy seismometers in linear order with the average spacing of ~5 km and record waveforms of teleseismic events. We applied receiver function analyses shown below to the waveform data, and obtained images of S wave velocity discontinuities. We almost finished the analyses for three profile lines in the NNW-SSE direction along which the Philippine Sea plate is subducting, and obtained images in the cross-sections along the profile lines. In this presentation we will discuss the distribution of slab-derived fluids beneath Kii Peninsula based on the images.

2. Receiver function analysis

Receiver functions are calculated by deconvolving the vertical component from the horizontal component of teleseismic P codas. They consist of PS converted waves generated at S wave velocity discontinuities beneath stations. The relative travel times between the PS converted waves and the direct P wave depend on the depths of the discontinuities and the P and S wave velocities above them, and the relative amplitudes depend on the S wave velocity jump at the discontinuities. Therefore, we can estimate the velocity structure beneath stations from the receiver functions. In this study we converted the time axis of the receiver functions to the depth axis with the velocity model JMA2001 (Ueno et al., 2002), stacked the amplitudes of the receiver functions on the common conversion points, and obtained images of S wave velocity discontinuities. Figure 1 shows the resulting images.

3. Slab-derived fluids distribution

In Fig. 1 the pair of the blue and red lines dipping to northwest can be interpreted as the upper surface of the Philippine Sea slab and the oceanic Moho, respectively. The oceanic crust sandwiched in between them shows remarkable low velocity up to the depths of 30 - 40 km where the DLFEs occur. The degree of the low velocity in the oceanic crust decreases beyond the depths. Another blue line which branches off near the DLFE area and extends in the mantle wedge also indicates the upper surface of a low velocity region. These features in the receiver function images show that fluids dehydrated from the oceanic crust flow in the mantle wedge at the DLFE area, and reduce the velocity in relatively wide region. We cannot answer directly from our results in what condition the fluids are distributed in the mantle wedge. However, a certain amount of the fluids serpentinize peridotite, and are incorporated in the serpentinite (Kamiya and Kobayashi, 2000).

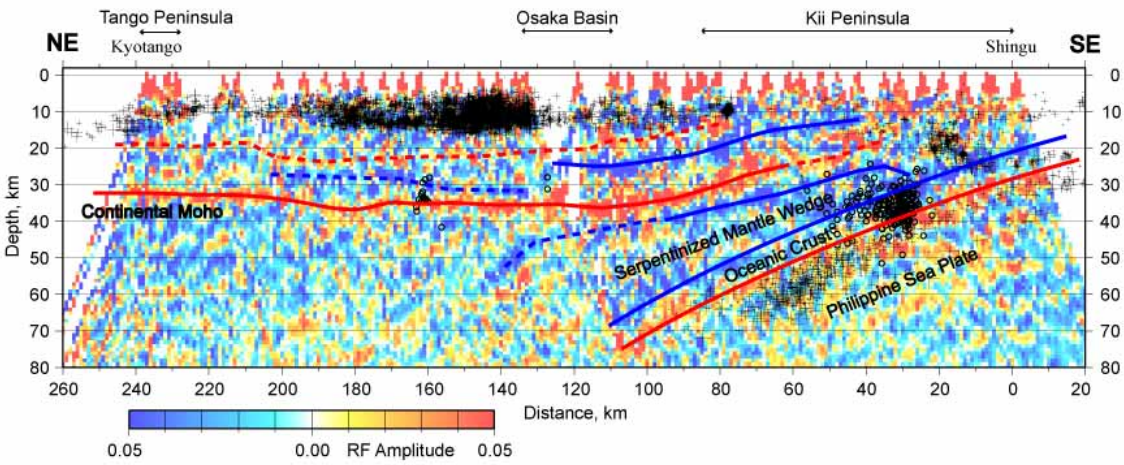

Figure 1 Receiver function image along a profile line from Shingu City to Kyotango City. Blue and red lines indicate the upper surfaces of the low and high velocity layers, respectively. Open circles denote deep low frequency events. Crosses are ordinary earthquakes.