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# Characteristics of slab-derived fluids beneath Kii Peninsula inferred from seismic travel-time tomography

SHIBUTANI, Takuo[1*] ; HIRAHARA, Kazuro[2]

[1]DPRI, Kyoto Univ, [2]Science, Kyoto Univ

1. Introduction

Deep low frequency events (DLFEs) are distributed at the depths of 30 - 40 km near the subducting Philippine Sea plate widely from western Shikoku to central Tokai (Obara, 2002). 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). Arima-type deep thermal water with $CO_2$ and high salt contents is found at hot springs in the area. These phenomena suggest the process that $H_2O$ subducting with the oceanic crust dehydrates at the depths of 30 - 40 km, causes the DLFEs, and uprises to shallower depths.

2. Receiver function analyses

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 deployed seismometers along profile lines with an average spacing of ~5 km. We applied receiver function analyses and obtained images of S wave velocity discontinuities. We estimated 3D configurations of the continental Moho, the slab top and the oceanic Moho from receiver function images for four profile lines in the NNW-SSE direction which is the dip direction of the Philippine Sea plate and for two profile lines in the NNW-SSE direction that is almost perpendicular to the dip direction.

3. Seismic travel time tomography

We carried out the tomography with FMTOMO (Rawlinson et al., 2006) in which a robust wavefront tracking (de Kool et al., 2006) is implemented for the theoretical travel time calculation and the ray tracing. We used a velocity model with 3D geometries of the three discontinuities derived from the receiver function analysis. We also used observed travel times at temporary stations in the dense linear arrays in addition to permanent stations. A dense distribution of the temporary stations contributed to higher resolutions of tomographic images.

A result of the seismic tomography is shown in Figure 1. The generating area of the DLFEs (red circles) shows low velocity anomaly of ~5 %. As mentioned above, $H_2O$ is discharged from hydrous minerals in the oceanic crust at the depths of 30 - 40 km. This can cause the low velocity anomaly.

Another strong low velocity anomaly more than 10 % is widely distributed in the lower crust beneath northern Wakayama Prefecture (N34.0 - 34.5$^o$). It is known that seismic activity is very high in the upper crust above this low velocity anomaly. This can be explained by a mechanism that fluids upwelling from the low velocity anomaly in the lower crust increase the pore pressure in existing cracks in the brittle upper crust.

The Vp/Vs ratio of the low velocity anomaly in the lower crust beneath northern Wakayama Prefecture has small values near 1.6. Contrastingly the Vp/Vs ratio of the low velocity anomaly in and around DLFEs shows larger values 1.75 - 1.8. This difference in the Vp/Vs ratios of the two low velocity anomalies can be explained by the difference in the aspect ratios of the pores filled with the fluids. And/or the small Vp/Vs ratio in the lower crust beneath northern Wakayama Prefecture might be due to silica-saturated fluids (Manning, 1996).

We used waveform data from permanent stations of NIED; JMA; ERI, Univ. of Tokyo; Nagoya Univ. and DPRI, Kyoto Univ.

Keywords: tomography, receiver function, Philippine Sea slab, Kii Peninsula, slab-derived fluids, Nankai Trough megaquake

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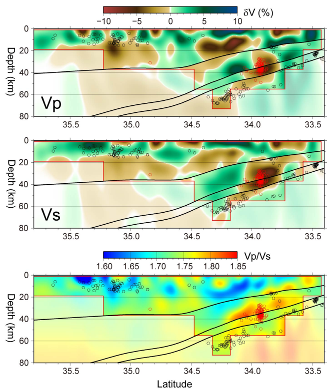


Figure 1 Resulting heterogeneous velocity field in the north-south cross-section along E135.7° for P wave velocity (Vp, uppermost), S wave velocity (Vs, middle) and Vp/Vs ratio (lowermost). The red and black circles are deep low frequency events and ordinary earthquakes, respectively. The three thick black lines are the continental Moho, the slab top and the oceanic Moho from shallow to deep.