Characteristics of slab-derived fluids beneath Kii Peninsula inferred from seismic traveltime tomography (2)

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1. Introduction

In order to investigate behavior and nature of slab-derived fluids discharged from the Philippine Sea plate subducting beneath Kii Peninsula, we have carried out seismic observations, receiver function analyses and seismic travel time tomography mentioned below. We estimated the geometry of the slab and the seismic velocity structure beneath the Kii Peninsula, and discussed the behavior of the fluids with the distribution of low velocity anomalies. We are now understanding relations between the fluids and deep low frequency events (DLFEs) and active micro seismicity beneath the northern Wakayama Prefecture.

2. Previous results

We carried out linear array seismic observations in the Kii Peninsula from 2004 to 2013. We deployed seismometers along profile lines with an average spacing of ~ 5 km. We applied a receiver function analysis 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. A new knowledge obtained by the analysis is that the continental Moho dips upward in the southeast direction above the Philippine Sea slab.

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 the 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. By analyzing travel time data for 74 months from May 2004 to the middle of 2010 we found that (1) DLFE areas show low velocity anomaly of ~5 % and (2) another strong low velocity anomaly (> 10 %) is widely distributed in the lower crust beneath the northern Wakayama Prefecture.

3. New attempts

Automatic picking of P and S times was carried out for the remaining waveform data in and after 2010. Travel time data for 33 months were added. They almost doubled the numbers of earthquakes and travel times utilized in the tomography. The result showed the similar features to (1) and (2) above. The result of checkerboard tests was improved in 22 –34 km depths. (1) can be due to discharged H_2O from hydrous minerals in the oceanic crust at 30 –40 km depths. (2) 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 beneath the northern Wakayama Prefecture has small values near 1.6. This might be due to silica-saturated fluids (Manning, 1996). The Vp/Vs ratio in the DLFE areas should be re-examined. We will contrive ways to estimate the Vp/Vs ratio by referring to Ramachandran and Hyndman (2012, Solid Earth).

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

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