An attempt to estimate the migration pathway of slab-derived fluid using shear wave splitting analysis

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It is known that hot springs with high temperature exist in Kii peninsula although it is non-volcanic region. Based on the distribution of high $^{3}He/^{4}He$ ratios in Kii peninsula, Morikawa et al. (2016) pointed out the possibility that slab-derived fluid pass through mantle wedge and ascend along pre-existing faults in the crust. According to seismic tomography, it is suggested that slab-derived fluid serpentinize mantle wedge directly above subducting Philippine Sea slab and contributes to the occurrence of non-volcanic swarm activity near Wakayama city (Kato et al., 2014). This is supported by the existence of highly conductive zone in mantle wedge directly above subducting Philippine Sea slab imaged by magnetotelluric (MT) method (Umeda et al., 2006). Pre-existing faults and highly cracked zone in the crust are candidate for the migration pathway of slab-derived fluid, and they are expected to show more significant seismic anisotropy than surrounding areas. In this study, we attempt to estimate the configuration of pre-existing faults and highly cracked zone as a migration pathway of slab-derived fluid using shear wave splitting analysis.

We used seismic waveform data recorded at stations of Earthquake Research Institute (ERI), University of Tokyo, Japan Meteorological Agency (JMA), Geological Survey of Japan (GSJ) and Hi-net data operated by the National Research Institute for Earth Science and Disaster Resilience (NIED) and analyzed the events occurred from April 2004 to March 2009 with focal depth shallower than 80 km and magnitude from 1.5 to 3.5. We estimated the leading shear wave polarization direction (LSPD) and arrival time difference between leading and lagging shear waves (DT) using the method of Silver and Chan (1991). In order to minimize the effect of phase conversion from S to P waves at the free surface, we restricted ray paths to those having incident angle to ground surface are less than 35˚(Booth and Crampin, 1985).

The results can be summarized as follows. Most of LSPD is trending NW-SE direction in the southern Kii peninsula, which is sub-parallel to convergence direction of Philippine Sea Plate along Nankai trough. This result indicate that tensile cracks are aligned parallel to maximum regional stress direction due to plate convergence. In contrast, from central part of Wakayama prefecture to southwestern side of Nara prefecture, some LSPD is trending ENE-WSW direction. Based on three-dimensional ray tracing, we calculated the normalized DT values per unit path length and investigated the spatial distribution of them. As a result, we found that the normalized DT values in the crust tends to be larger than those in the mantle wedge. Especially large normalized DT values per unit path length tends to be concentrated from central part of Wakayama prefecture to southwestern side of Nara prefecture.

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