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Spatio-temporal distribution of non-volcanic tremor estimated by polarization analysis

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A detail monitoring of non-volcanic tremor activity is significantly important to forecast the occurrence of future large earthquake in subduction zone. At present, the most effective approach to clarify a sequence of tremor activity is an envelope cross correlation method (ECC) developed by Obara (2002). The ECC is carried out with the moving window of 1min, so that the locations of tremors are calculated once every 1 min. This suggests that it is difficult to investigate a short-time scale tremor activity based on the ECC. In this study, we try to estimate a spatio-temporal distribution of non-volcanic tremor in a short-time scale by using a polarization analysis.

Analysis of wavefield properties revealed that non-volcanic tremor is mainly composed of S-wave. As is different from P-wave, a polarization angle of S-wave depends on not only a source location but also a focal mechanism. Following growing evidence, we assume that tremors represent shear slip on the plate interface and have a low-angle thrust type focal mechanism. The procedure of the polarization analysis is as follows. (1) Seismograms are band-pass filtered between 4 and 8 Hz, (2) For 5 second long time window, a covariance matrix is calculated from a three-component seismogram, (3) The eigenproblem for the covariance matrix is solved to determine a polarization azimuth of S-wave particle motion, (4) By moving the time window, the procedure of (2) and (3) is repeated. In order to reduce the estimation variance of polarization azimuth, we average covariance matrices for the different sensors of the AIST vertical seismic array.

We applied the polarization analysis to the tremor sequence at Kii Peninsula that occurred in November 2008. It should be noted that the polarization azimuth gradually change over time, implicating that the tremor gradually migrates. By comparing the estimated polarization azimuth with theoretical one, we could constrain the tremor locations. In particular, we found a lot of fast and short-time scale migrations in the slab dip direction whose duration is an order of 10 minutes. The migration rate is an order of 100 km/hr, which is much faster than that of the along-strike migration (a few 10 km/day) (e.g., Obara, 2002). At present, observations of similar migration are limited to Western Shikoku (Shelly et al., 2007), Tokai region (Takeda et al., This meeting), and a part of Cascade area (Ghosh et al., 2009). Although it has not yet been clear whether such a migration is a general character of slow slip event, it will become important information for better understanding the mechanism of slow slip event.

Keywords: polarization analysis, non-volcanic tremor, spatio-temporal distribution