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Observation of Non-Volcanic Tremor in Southwest Japan Subduction Zone Using Vertical Seismic Array Network

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Geological Survey of Japan, AIST has recently started an integrated borehole observation of water levels, strains, tilts, water temperatures and seismic waves in southwest Japan for monitoring the anticipated Tokai, Tonankai and Nankai earthquakes. At each observatory, we have drilled three boreholes with different depths (about 30 m, 200 m and 600 m) and installed high-sensitivity seismometers at a bottom of every borehole. Fourteen observatories are in operation at present (Fig. 1). This vertical seismic array network will be a useful tool for better understanding the nature of non-volcanic tremor (NVT) whose signals are characterized by a very low signal-to-noise ratio.

We applied a semblance analysis to the vertical seismic array data for investigating wave-field properties of NVT. A semblance coefficient were calculated for an adequate range of values in apparent velocity space using one minute long moving windows with 50 % overlap. High semblance coefficients continuously appear at apparent velocity near *S*-wave velocity for horizontal components during NVT activities (Fig. 2a). This observation suggests that we observed incident *S*-wave of NVT signals in horizontal components. As seen in Fig. 2a, the resolution of the best apparent velocity is poor and the semblance coefficient is small in vertical component. We infer that they originate partially in small radiation energy of *P*-wave relative to *S*-wave and partially in an insufficient sampling interval for *P*-wave velocity. Therefore we focus on the results of horizontal components in this study. We estimated a total duration of each NVT episode by counting the time that the semblance coefficient of the best apparent velocity in horizontal components exceeds a specific threshold. A comparison with the envelope correlation method (ECM) revealed that our semblance method detected about ten times long in duration than that by ECM, showing a better improvement of NVT detection capability.

We then tried to determine focal mechanisms of NVT, which are a key to reveal geodynamic processes on the plate interface. The polarization angle of *S*-wave depends not only on a source location but also on a focal mechanism. If we assume a location of NVT, therefore, we can constrain a focal mechanism of NVT. We determined average *S*-wave particle motions of NVT for a given time window (5 s) from two horizontal components. The same analysis was also applied to seismic data recorded by NIED Hi-net. In spite of a low signal-to-noise ratio, the scatter in estimated polarization angles becomes small in accordance with a period of NVT activity (Fig. 2b). We confirmed that the polarization estimates could be improved by combining information from individual sensors of vertical seismic array, which is useful for a detailed analysis. By comparing polarization angles measured at multiple stations with theoretical ones, we could determine focal mechanisms of NVT whose locations were estimated by ECM. A preliminary result suggests that NVT is characterized by low angle thrust faults whose strike and dip angles are generally consistent with a geometry of the Philippine Sea plate.

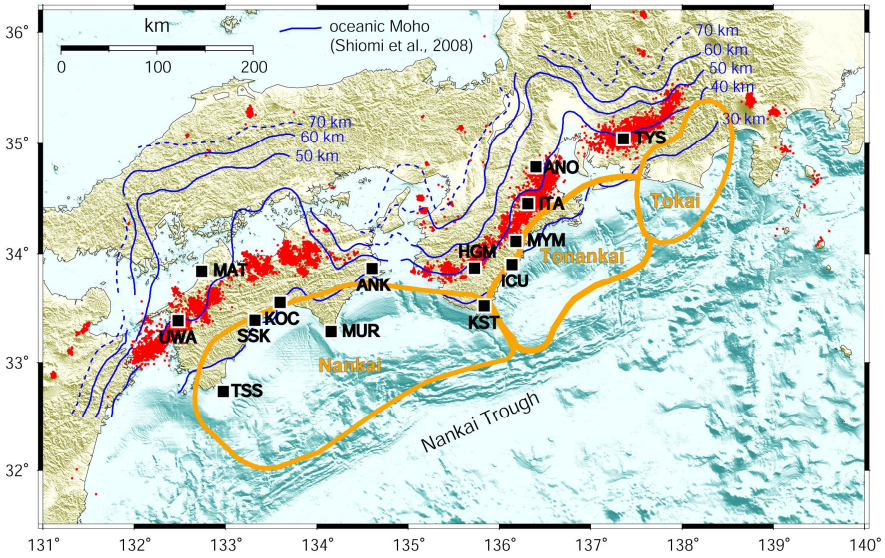

Figure 1. Distribution of vertical array network of Geological Survey of Japan, AIST. Low frequency earthquakes (LFE) reported by Japan Meteorological Agency are shown by red circles. Blue curves represent oceanic Moho depth derived from reciever function analysis (Shiomi *et al*., 2008). The source regions of the anticipated Tokai, Tonankai and Nankai earthquakes are shown by orange curves.

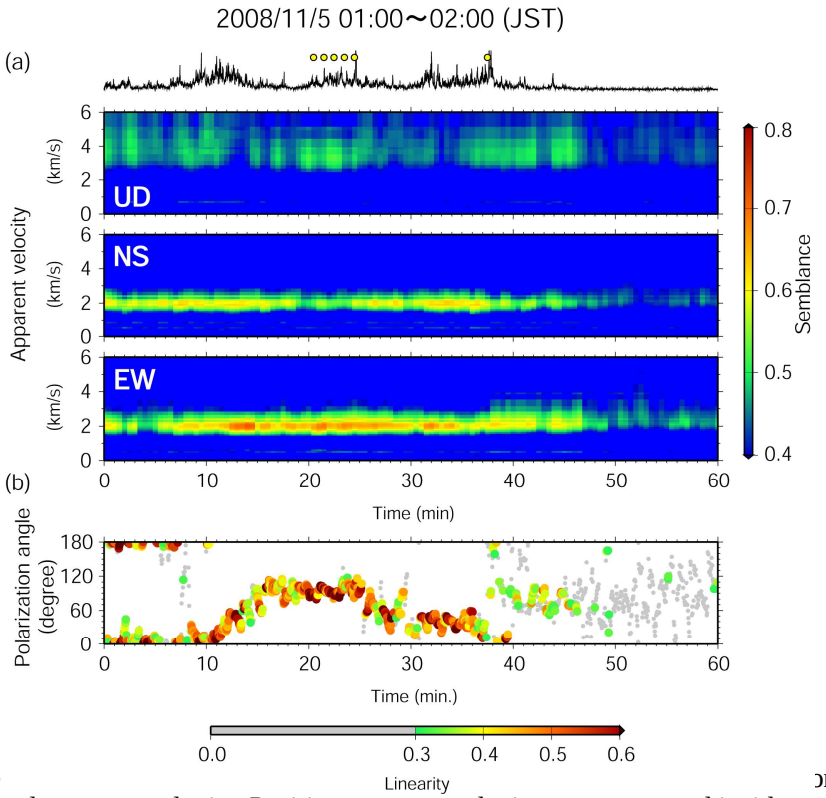

Figure 2. Example ons of semblance coefficients at assumed apparent velocity. Positive apparent velocity means upward incident signals. The color scale at the right shows a semblance coefficient. (b) Polarization angles. The color scale at the bottom shows a linearity of particle motion, where a unit corresponds to a perfectly linear wave.