Detection of tectonic tremor using a monitoring method of seismic anisotropy

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We have been investigating temporal variations in seismic anisotropy around the source region of low-frequency tremor, one of the families of slow earthquakes associated with the Nankai trough mega-thrust earthquake [e.g., Ishise and Nishida, 2015 JpGU, 2015 SSJ, 2015 AGU]. Seismic anisotropy has close relationships with stress state and physical properties of the medium such as water content. Therefore, a temporal change in seismic anisotropy is a good proxy for the temporal and spatial evolution of tremor activity, which is related to temporal changes in the stress state and various physical properties.

In this study, we investigated tremor episodes in the eastern part of Shikoku by applying the monitoring method of seismic anisotropy. As a result, we detected that temporal variations in anisotropy and polarization directions of incoming waves occasionally indicate an event with a characteristic temporal pattern. Further, we found that the spatio-temporal distribution of the detected events includes all located spatio-temporal distribution of tremor activities in the study area [e.g., world tremor database, Idehara et al., 2014]. Therefore, we interpreted that the events with characteristic temporal patterns are manifestations of tremor activity and assumed that the monitoring method can be used to detect tremor activity.

As briefly mentioned above, we estimate back azimuth and incident angle of incoming wave from the polarization direction through this monitoring. Therefore, given the depth of tremor source regions from other studies, we could determine the source location of tremor with the aid of known back azimuth and incident angle of the incoming wave. Under an ideal situation, even source locations of the tremor may be possible using only a single-station data. This method is complementary to conventional source location determination methods that require observation of coherent seismic signals at several stations [e.g., Obara, 2002]. Then, it is expected that the tremor detection method with the seismic anisotropy monitoring provides a detailed spatio-temporal distribution of tremor activities. In addition, this tremor detection method is feasible for a study of offshore tremor activity, because the quality and quantity of marine observation data is limited in various aspects compared with those of land-based observation data. This will eventually discover some unknown phenomena.

Then, we started to study on offshore tremor activity by applying the seismic anisotropy monitoring method to ocean bottom seismometer data. As a first step, we applied the monitoring method to seismograms of an offshore seismic network, DONET, off southwest Japan along the Nankai trough, and examined the efficiency and validity of the offshore tremor study. In this presentation, we show a preliminary result of the investigation of tremor activity associated with the Mw 6.0 earthquake offshore the Kii Peninsula of southwest Honshu, Japan on 1 April 2016.

Keywords: low frequency tremor, seismic anisotropy monitoring, tectonic tremor detection method

