

Detection of deep low frequency tremor triggered by teleseismic surface wave based on matched filter technique

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Deep low frequency tremor in subduction zone is sometimes triggered by surface waves of teleseismic earthquakes. The triggered tremor can be easily recognized because of its correspondence to each phase of the surface wave whose period is about 30 seconds. The frequency of the triggered tremor is about 1-10 Hz. In Nankai subduction zone in southwestern Japan, triggered tremor was firstly reported for the 26 Sep. 2003 Mw8.3 Tokachi-oki earthquake, and the 26 Dec. 2004 Mw9.0 Sumatra-Andaman earthquake (Miyazawa and Mori, 2005; 2006). Such triggered tremors were observed in subduction zones where ambient deep low frequency tremor occurs associated with short-term slow slip events. However, the triggered tremor is not distributed in all source area of ambient tremor, but is concentrated in several fixed spots. In addition, recent studies have detected triggered tremor in some inland areas within the continental plate away from the subducting plate interface in Hokkaido, Kanto, and Kyusyu area. The triggered tremor and ambient tremor have difference in their activities. In this study, we investigated the relationship between triggered tremor and ambient tremor in detail, using the seismic waveform data.

We first compared the spectrum of tremor triggered by the 11 Apr. 2012 Mw8.6 Sumatra earthquake and that of ambient tremor that occurred at almost the same location in Mie prefecture, Central Japan, by using the waveform data recorded by densely distributed high-sensitivity seismograph network in Japan (Hi-net) operated by National Research Institute for Earth Science and Disaster Prevention. As a result, triggered tremor and ambient tremor showed almost the same spectral property.

Next, we applied the matched filter technique to waveform data with a passband of 2-8 Hz. As template events, we used low frequency events (LFEs) detected by Japan Meteorological Agency in 2014 with the epicentral distance from the triggered tremor of shorter than 30 km. The time length of each template event is five seconds including the arrival of S wave. The cross correlation between 355 template events and three-component waveform data recorded at 10 Hi-net stations including the surface wave of teleseismic earthquake were calculated. Then, we detected similar events to templates by using a threshold for the summed cross correlation coefficients.

We applied the matched filter technique for one hour-length data at 2012 Sumatra earthquake. Although the triggered tremor corresponding to each phase of the surface wave were clearly observed at the beginning part of the arrival of the surface wave from the band-pass filtered seismograms, no event having high cross correlation to the LFE templates was detected. On the other hand, after about 400 seconds from the beginning of triggered tremor, events with high cross correlation were detected. This result may suggest the change in waveform of triggered tremor due to migration during a sequence of triggered tremor.

Keywords: slow earthquake, deep low frequency tremor, triggered tremor, matched filter technique