

Slow earthquakes in microseism frequency band (0.1-2 Hz) off Kii peninsula

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Slow earthquakes are divided into deep tectonic tremors, very low frequency (VLF) events, short-term slow slip events (SSE), and long-term SSE, each of which is observed in a different frequency band. Tremors are observed above 2 Hz, and VLF signals are visible mainly in 0.01-0.05 Hz. It was very difficult to find signals of slow underground deformation at frequencies between them, i.e., 0.1-2Hz, where microseism noise is dominant. However, after a Mw 6.5 earthquake off Kii peninsula on April 1st, 2016, sufficiently large signals have been detected in the microseism band, accompanied with signals from active tremors and VLF events, by the ocean bottom seismometer network DONET, maintained by Japan Agency for Marine-Earth Science and Technology. Signals were well observed especially when the microseism noise was low, at a broadband frequency band from 0.01 to 10 Hz. This is the first observation of slow earthquakes in the microseism frequency band, which have no popular name, yet. Then, regarding these “events” as extensions of tremor signals, we determine the hypocenter locations in the same manner as tremor analysis, and compare them with the spatial and temporal distributions of ordinary tectonic tremors above 2 Hz and VLF events.

The data are broadband seismograms recorded at 20 stations of DONET, from April 1st to April 17th. We detected hypocenters by calculating arrival time differences between stations using an envelope correlation method of Ide (2010). Unlike ordinary applications, we repeated analyses for seismograms bandpass-filtered in four separated frequency bands, 0.1-1, 1-2, 2-4, and 4-8 Hz. For each band, we successfully detected events and determined their hypocenter locations. The number of detected events were 32, 44, 177, and 643 in 0.1-1, 1-2, 2-4, and 4-8 Hz, respectively. During the study period, tremors determined in the three high-frequency bands, 1-2, 2-4, and 4-8 Hz, migrated from a small spot near the source of Mw 6.5 event to a broader region in the south-east direction. In the 0.1-1 Hz microseism band, the hypocenters were determined mainly on April 10th, when microseism noises are exceptionally small. On this day, the numbers of events in the highest frequency band, 4-8 Hz, decreased, while that in lower frequency bands increased.

Many VLF events have been detected in this region in the frequency band of 0.03-0.05 Hz, with location and focal mechanism using a method of Nakano et al. (2008). These VLF events and tremors detected in this study appear to have occurred at the almost same time and locations.

Keywords: slow earthquake, microseism, hypocenter determination, tremor, VLF