Seismic quiescence of deep very low frequency earthquakes from later 2014 in western Ehime prefecture, southwest Japan

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Deep very low frequency earthquakes (VLFEs) are frequently associated with episodic tremor and slip (ETS) at the downdip region of the megathrust seismogenic zone along the subducting plate interface (Ito et al., 2007; 2009). As a member of slow earthquake family associated with slow slip, VLFE activity is expected to be a proxy of interplate slipping. However, the time change of the deep VLFE seismicity has not been investigated well compared to deep low frequency tremor (e.g., Obara et al., 2010). In this study, we investigated long-term changes of the activity of deep VLFEs in western Shikoku where ETS and long-term slow slip event (SSE) frequently occurred.

We used continuous seismograms of 13 F-net broadband seismometers operated by National Research Institute for Earth Science and Disaster Resilience (NIED) from 2nd April 2004 to 29th September 2016. After applying the band-pass filter with a frequency range of 0.02—0.05 Hz, we adopted the matched-filter technique (Shelly et al., 2007) in detecting VLFEs. The synthetic waveforms calculated by the wavenumber integration method (Takeo, 1987) with the fault mechanisms obtained by Ide and Yabe (2014) at multiple grid points in the Bungo channel and its neighboring inland region are used for templates. The velocity structure for calculating synthetic waves is a one-dimensional model in Japan by Kubo et al. (2002). The time window of each template is 150 seconds. We defined the detection threshold as eight times as large as the median absolute deviation (MAD) of the distribution.

We detected 700—1000 VLFEs at each grid point for 12 years. In inland region, the cumulative number of detected VLFEs increases steeply every half a year. This stepwise change is caused by ETS. In the Bungo channel, the cumulative number of detected VLFEs increases gradually in 2010 and 2014 influenced by long-term SSEs. Interestingly, the activity of deep VLFEs has been low since the latter half of the year 2014 in this region. To investigate the effects of detection rates to the seismic quiescence, we estimated detection rates for events with moment magnitudes of 3.1 by synthetic tests using real seismograms as noise. The detection rate is around 0.7 constantly during the period of analysis. Therefore, we concluded that the seismic quiescence of VLFEs in western Shikoku was not the influence of detection rates. The long-term SSEs in 2014 may influence the seismic quiescence of VLFEs.

キーワード：Slow earthquake、Deep very low frequency earthquake、Seismic quiescence
Keywords: Slow earthquake, Deep very low frequency earthquake, Seismic quiescence

