Toward the comprehensive detection of shallow very low frequency earthquakes off the Pacific coast of Tohoku, Japan

*馬場 慧[1]、竹尾 明子[1]、小原 一成[1]、前田 拓人[1]
*Satoru Baba[1], Akiko Takeo[1], Kazushige Obara[1], Takuto Maeda[1]

1. 東京大学地震研究所
1. Earthquake Research Institute, University of Tokyo

On the plate interface near the seismogenic zone of megathrust earthquakes, various types of slow earthquakes have been detected including non-volcanic tremors, slow slip events and very low frequency earthquakes (VLFEs). The predominant period of VLFEs is tens of seconds. VLFEs are classified into deep VLFEs, which occur in the downdip side of the seismogenic zone, and shallow VLFEs, occur in the updip side. Matsuzawa et al. (2015) found shallow VLFEs off the Pacific coast of Tohoku by visually checking the continuous seismograms of F-net broadband seismometers, and detected other events by calculating the cross correlations between waveforms of detected events and continuous data of F-net seismometers from 2005 to 2013. However, the detection of the VLFEs might be limited because of the limited number of known VLFE templates. In this study, we attempt more comprehensive detection of shallow VLFEs off the Pacific coast of Tohoku in longer period than previous studies by the matched-filter technique using synthetic seismograms as templates.

We used continuous seismograms of F-net seismometers in northeast Japan from April 2004 to March 2017. A band-pass filter with a frequency range of 0.02–0.05 Hz was applied to all traces. We set a grid of virtual source in 36.6˚N, 142.0˚E off the Pacific coast of Tohoku, and assumed the fault mechanism from the geometry of plate boundary (Nakajima and Hasegawa, 2006; Hirose et al., 2008; Nakajima et al., 2009) and plate motion model, Nuvel-1A (DeMets et al., 1994). We computed synthetic waveforms by the wavenumber integration method with a velocity structure of Kubo et al. (2002) with the assumed fault mechanisms. We then calculated correlation coefficients between templates and continuous F-net seismograms every 1 s in all components. An event is regarded as detected if the average of correlation coefficients exceeds the threshold. We defined the detection threshold as eight times of the median absolute deviation of the distribution.

We detected about 5000 events. Most of the detected events are regular earthquakes which occurred around the grid, and the cumulative number of detected events increases rapidly after the 2011 Tohoku earthquake. However, detected events include the VLFEs reported by Matsuzawa et al. (2015). Therefore, it is verified that VLFEs can be detected by this method. To exclude regular earthquakes from our detection, we investigated amplitude spectra and amplitudes of events, and discarded the events whose amplitudes of 1–2 Hz are larger than a fixed value. After this selection, the number of events decreases to about 1000, but a lot of misdetections occurred during the passage of teleseismic waveforms are contained. Therefore, further investigation is needed to construct the method of detecting VLFEs more comprehensively.

キーワード：浅部超低周波地震、スロー地震、マッチドフィルター法
Keywords: shallow very low frequency earthquake, slow earthquake, matched-filter technique

