

Characteristics of seismograms of VLFEs recorded by short period OBSs in the northern Japan Trench

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Various kind of slow earthquakes were found in several subduction zones [Obara and Kato, 2016]. Slow earthquakes are characterized by a wide spectrum of fault slip behaviors, and these events have been reported in both updip- and downdip-sides of the seismogenic zone. Here, we report on the Very Low Frequency Earthquakes (VLFE) occurred in the shallow part of the megathrust along the Japan Trench based on the near-field seafloor seismic observations.

Although slow earthquakes have not been recognized off the Pacific coast of Tohoku in the northern part of Japan, except for afterslips following large ($M > 7$) interplate earthquakes, slow slip events and tectonic tremor activities were identified by seafloor observations [e.g. Ito et al., 2013; 2015]. Recently VLFEs have been discovered by inspecting onshore broad-band seismograms during the period between 2005 and 2013 [Matsuzawa et al., 2015]. The VLFE activities were identified in the limited area along the Japan Trench and tend to occur successively in a short time period. In this study, we try to detect the VLFEs along the Japan Trench based on the short-period ocean bottom seismograms deployed near to the epicenter locations estimated by the previous study and to find out characteristics of the short-period signals radiated from the VLFEs.

We used the five short-period ocean bottom seismograms (SP-OBS) deployed near the hypocenter of the VLFEs identified in 2011 in the northern Japan Trench. We inspected horizontal component records of 4.5 Hz geophones around the origin times of the VLFEs previously estimated. On the seismograms, we found evident arrivals of wave-trains with gradual increase in amplitudes around the expected S-wave arrival times. The observed amplitudes show systematic dependence on the arrival times and seem to obey a simple distance decay. These observations strongly suggest that the S-waves radiated from the VLFEs are recorded on the SP-OBS records.

The characteristic of frequency contents of the VLFE signals was studied by comparing power spectral density functions of the VLFEs and those of ordinary earthquakes closely located to the VLFEs. The observed VLFE signals have significant power up to ~ 8 Hz, well above noise level. However the signal powers are much smaller than those of the ordinary earthquake of the similar size indicating significant deficiencies of higher frequency components. VLFE signals in this high frequency range have never described based on the onshore observations obtained far away from the epicenters, but nearfield seismograms can help to study their natures.

Based on the revealed characteristic of the spectrum of VLFE, we detected 35 candidates of VLFEs by visual inspection of horizontal-component velocity spectrograms of the OBSs for their operation periods, six months. Some of these newly identified VLFEs successively occurred with short time intervals showing a swarm-like behavior. This characteristic is similar to the VLFE activity in the Nankai [Sugioka et al.,

2012]. Our results imply that there are number of unidentified VLFs in the northern off-Tohoku regions.

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