Shallow low-frequency tremor activity off Erimo, Hokkaido from 2006 to 2007 revealed from pop-up type ocean bottom seismometers

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The shallow part of the plate boundary around the Kuril and Japan Trench junction, off Erimo, Hokkaido, is known as the place where slow earthquakes are comparatively active along the Japan island arc. In this region, VLFEs (Very Low Frequency Earthquakes) have been observed since the 2003 Tokachi-Oki Earthquake (Asano et al., 2008). On the other hand, LFTs (Low Frequency Tremors) were firstly discovered in 2016 based on the inspection of the seismograms obtained by the Seafloor observation network for earthquakes and tsunamis along Japan Trench (S-net) (Tanaka et al., 2019; Nishikawa et al., 2019). One of the important discoveries by the S-net is that the LFT activity off Erimo usually precede the VLFE activity by 0.5–4 days (Tanaka et al., 2019). The correlation between the LFTs and VLFEs persistence of the VLFEs activity before and after the 2011 Tohoku-oki Earthquake (Asano et al., 2008; Tanaka et al., 2019), it is expected that the LFT activity would exist before the S-net deployment and before the occurrence of the 2011 Tohoku-oki earthquake off Erimo region. This study aims to clarify the LFT activity in the region by analyzing the OBS records obtained in the development from 2006 to 2007.

In this study, we detect LFTs from the records of 42 pop-up type ocean bottom seismometers from October 25, 2006 to June 5, 2007. For detection of seismic events and determination of their hypocenters, we use the envelope correlation method (Ide, 2010). We defined an event as an earthquake if a maximum cross-correlation (CC) value exceeds 0.6 for more than 10 station-pairs. Then, we determined its hypocenter by using lag-times maximizing the CCs at the station pairs, as arrival time difference of S-waves from the source. For discrimination of LFTs from other type of events, we selected events with duration larger than 20 sec and of magnitude less than 3 as LFTs. After the first screening, we excluded the events having large epicenter errors and large time residuals. As a result, 989 LFTs were identified out of 10,445 events firstly detected. The detected LFTs were distributed at a certain distance from the trench axis and the LFTs with focal depth errors less than 10 km are distributed near the plate boundary.

During the analysis period, we found three major LFTs activities with VLFEs activities. During the first period (2006/11/12–19), the LFTs activity showed migration towards northeast by 16–23 km/day though detectivity of LFTs may be degraded by the pronounced aftershocks following the middle Kuril Trench earthquake on November 15, 2006. The LFTs during the second period (2007/3/15–19) also migrated but was directed towards southwest by 25–30 km/day. On the other hand, the last activity occurred in the narrower area than others and converged just one day on May 10, 2007, and the migration like previous periods was not recognized.

We found that every LFT swarm activity preceded the known VLFEs (Asano et al., 2008). The VLFEs detected 0.5–4.5 days after the onset of the LFTs swarm occasion. Similar relationship between the LFT and the VLFEs is reported for the current activities in the region (Tanaka et al., 2019). The locations of the swarm almost coincide with the LFT distribution located by the S-net data (Nishikawa et al., 2019). These common points between the LFT/VLFE activities at present and in 2006-2007 indicate that the shallow plate boundary off Erimo does not change in their behavior in terms of the slow-slip activity through the period containing the 2011 Tohoku-oki earthquake happened.

Keywords: Shallow low-frequency tremor, Ocean bottom seismometer, Kuril Trench