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# Shallow seismic activity containing both low-frequency events and normal earthquakes observed by a local seismic network

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We observed a shallow (H<10 km) seismic activity containing both low frequency events (LFE) and regular earthquakes using a dense local seismic observation network installed recently at northeastern Japan.

Significant recurring activities of deep (H>20 km) LFE have been monitored carefully around several subduction zones including Japan. Additionally, activities of shallow and deep LFE are also reported worldwide occurring beneath several potentially damaging active volcanoes. Deep (H>15 km) LFEs have also been observed to occur in inland areas not associated with active volcanoes or volcanism.

The shallow seismic activity we observed was located on the Tsugaru Channel, between the Hokkaido and Honshu Islands of Japan. We installed a local seismic network consisting of 36 stations, called AS-net, in 2013 and 2014 and are monitoring shallow and deep seismic activities in the region. AS-net improved both the earthquake detection capability and the accuracy of hypocenter determination around this region significantly. The shallow activity of earthquakes and LFEs was observed at just ∼2 km south of an AS-net station. The seismic record at the station revealed that the depth of this seismic activity was shallower than 10 km. From 2014 to 2017, 23 earthquakes and 19 or more LFEs were detected. Both earthquakes and LFEs swarmed individually and intermittently. Magnitudes of all events were less than two. Both types of events seemed to occur in the vicinity of one and other however this is not clear because of the limit of the accuracy of the hypocenter location. At ∼10 km eastward of this activity, we observed another activity of deep (15∼35 km) LFEs in an area without volcanos.

Above this curious shallow seismic activity, Yamagata et al. (1989) pointed out the existence of a volcano based on their research about tephra layers over Hokkaido. They estimated that a tephra layer on tens of thousands of years ago could be from Zenigame Caldera, a depression (1∼2 km in diameter) at seafloor of Tsugaru Channel. Because it is under the sea, it is not easy to survey, and no other studies about this potential volcano have been reported.

In Japan, opposite to deep LFEs, shallow LFEs are only monitored around potentially damaging volcanoes. Outside of such regions, the presence of shallow LFE is not clear. Shallow LFE activity and its mechanism as well as its relation to volcanoes should be clarified. By doing so, we will be able to locate potential volcanic activity by monitoring shallow LFEs; even underwater. Additionally, we have recently started to install several temporal seismic observation stations in the area surrounding this seismic activity to investigate it in detail.

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