Seismic observation for an anomalous activity of shallow low frequency events mixed with normal earthquakes at Hakodate

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In this presentation, we report the regional dense seismic observation targeting an anomalous shallow seismic activity consists of both normal earthquakes and low frequency events (LFEs) at near Hakodate, Hokkaido, Japan.
Shallow (<10 km) LFEs have been reported to occur (Noguchi et al., 2018) near Hakodate (A on Fig. 1), which were detected by the AS-net, regional high-sensitive seismic network installed and operated by the Association for the Development of Earthquake Prediction (ADEP). Moreover, normal crustal earthquakes occur quite closely to these LFEs. It is commonly considered that LFEs occur at a depth of 15–40 km, deeper than the depth threshold where normal non-volcanic earthquakes occur. This curious seismic activity near Hakodate conflicts with such common knowledge. Following this report, Nakajima and Hasegawa (2019) reexamined almost a million of shallow crustal earthquakes in Japan to detect another similar shallow activity of LFEs.
It has also been suggested, but not clarified that LFEs can be induced by crustal fluid (water or magma). Additionally, it is known that crustal fluids can also be related to activities of normal crustal earthquakes including destructive ones. It is necessary to investigate the shallow activity near Hakodate in detail to confirm these hypotheses. Particularly, we need to derive highly accurate hypocenter locations and source mechanisms for these events. The density of the existing seismic networks, including AS-net in this region, is not enough for this purpose because the targeted events are too small (M<2).
In order to investigate this shallow seismic activity, ADEP and Hirosaki University started a dense seismic observation around this activity in October 2018 using short-period seismometers. Fourteen stations are operating as of February 2020 (Fig. 1). We intend to install more stations than would normally be required to cover this area in order to compensate for the artificial noise since this activity occurs near the habitation area. We are also targeting another deep LFEs activity occurring 5~10 km to the east of the shallow seismic activity mentioned above (B on Fig. 1). Different from the shallow activity, this deeper LFEs activity is quite similar to the other deep LFEs activities frequently seen in NE Japan. We used Lennartz LD-3lite, three-components seismometers with the natural frequency of 1 Hz. Solar power and/or battery provide power to the sensor and recorder. Data recorded at five distant stations are transmitted via a cell-phone network in real-time. It is expected that real-time data acquisition will make it easier to detect changes in the seismic activities and enable us to accelerate the processing time of our analysis.
According to the JMA catalog, four LFEs and two normal earthquakes have occurred at the shallow target area since the beginning of our observation till the end of 2019. This shallow seismic activity has not been relatively active for decades. When we derive enough event data, we plan to start a highly accurate hypocenter determination procedure using a template matching method. Because of our dense observations, we will be able to detect smaller events compared to the JMA catalog. We also compare the recorded waves of targeting events to the events in the other region. Similar analyses also will be applied to the event data for deep LFEs activity. Based on the results of these analyses, we aim to clarify the detail and mechanism of this anomalous seismic activity near Hakodate.

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References

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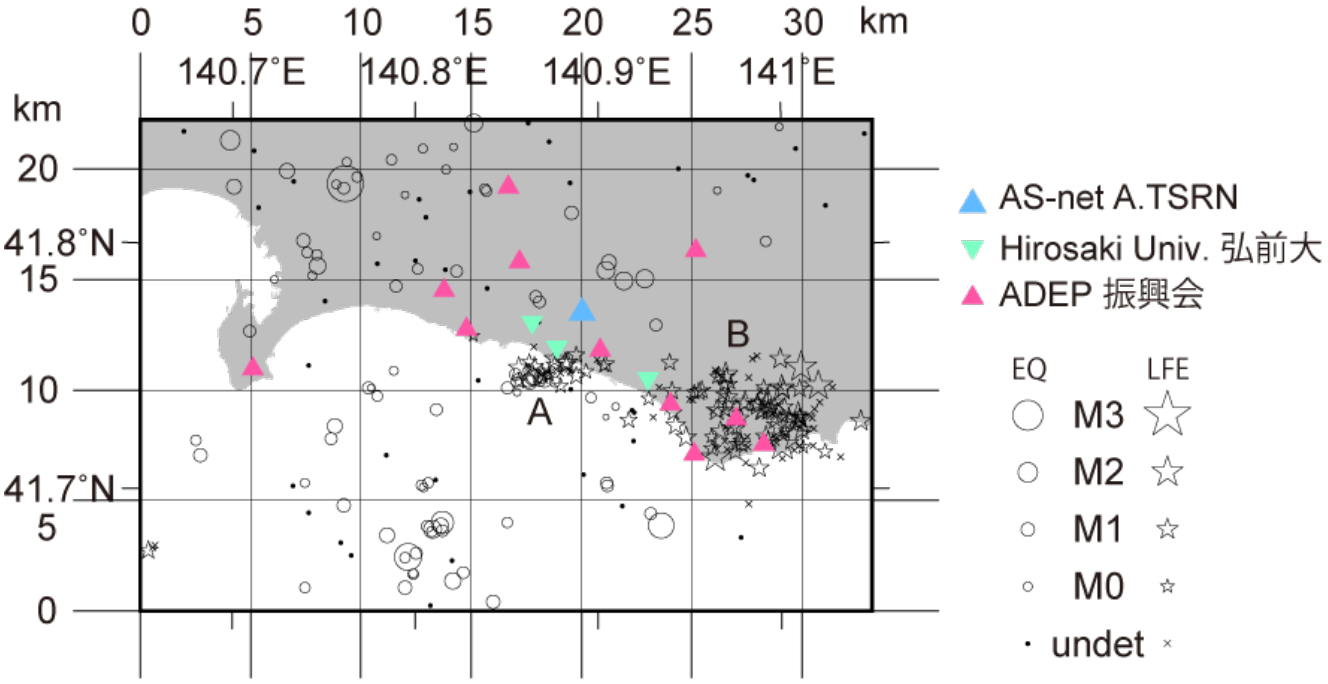

Fig. 1. Distribution of hypocenters and seismic stations around Hakodate.

