

# Origin of long-duration of deep low-frequency earthquakes and activity of shallow low-frequency earthquakes beneath northeastern Japan

\*Masahiro Kosuga<sup>1</sup>, Taichi Haruyama<sup>1</sup>, Yuki Matsuno<sup>2</sup>, Iori Narita<sup>2</sup>, Takuto Maeda<sup>1</sup>

1. Graduate School of Science and Technology, Hirosaki University, 2. Faculty of Science and Technology, Hirosaki University

We investigated the origin of long duration of deep low-frequency (DLF) earthquakes and the activity of shallow low-frequency (SLF) earthquakes beneath northeastern Japan. Source mechanism of DLF events has attracted attention because the events are anomalous with very low predominant frequencies and with a very deep hypocentral location, suggesting a possible link to a magma transport system. Previous studies have shown that the source mechanisms are variable, double couple, CLVD, and single force, among the events. However, the other aspect of the characteristics of DLF events, long duration of the seismic signal, has not been well studied. We firstly searched for typical DLF events with low frequency and long duration. Then we evaluated the frequency content by employing frequency index (FI) defined by the logarithm of the amplitude ratio of spectra between high- low-frequency ranges. We specify specified the range as 2–4 Hz and 10–20 Hz for low- and high-frequency ranges, respectively. These ranges correspond to the predominant frequencies of DLF and shallow ordinary earthquakes. We specified determined the location of typical DLF events based on the FI and duration measurements. For the case of Hijiori in Yamagata prefecture, long-lasting (> 10 s) monochromatic vibration is was in phase among the stations, which suggests that the source effect is the origin of extended coda is a source origin rather than some path effects. Spectrogram of this event shows no hint of overtones expected from a resonance mechanism. We next numerically simulated seismograms from several source models by the OpenSWPC code for seismic wave propagation in 2D/3D media. Simulation indicates that the resonance of seismic waves in a low-velocity body could produce monochromatic vibration, but under an exceptional condition of the size and physical properties of the resonant body, and restricted location of the initial source that trigger the resonance. We are conducting the following simulation for a moving source through multiple channels of the fluid transport system.

Event detection using FI is effective for SLF earthquakes that have no low-frequency flag in the JMA earthquake catalog. We searched for the SLF events in the Hakkoda area in Aomori prefecture and the Hakodate area in southern Hokkaido. SLF events in Hakkoda exhibit a cylindrical distribution beneath the Odake volcano in a depth range from the surface to about 5 km, clearly separated from the distribution of VT earthquakes around the volcano. Since the activity of SLF events are restricted in time when the expansion of volcanic body was suggested by GNSS observation, the SLF activity probably related to a magmatic activity of the volcano. In Hakodate area, the SLF earthquakes are located apart from the active volcano, Esan, and with focal depths shallower than 10 km. We confirmed the depth of several SLF earthquakes by adding travel time data from our two temporary seismic stations just above the SLF sources. Thus, the SLF events in this area are collocated with ordinary high-frequency events. Investigation of the generation mechanism of SLF earthquakes in the brittle regime is also important to comparably understand the mechanism of DLF earthquakes in the ductile regime.

Keywords: low-frequency earthquakes, Frequency Index, duration

