

## Possible very micro low-frequency earthquakes in the Showa-Shinzan lava dome in the Usu volcanic region captured by dense seismic campaign

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The Showa-Shinzan lava dome has a unique evolution history grown from a wheat field to an altitude of about 400 m with several eruptions in 1943-1945. To understand its evolution process from shear-wave velocity structure, we deployed 22 short-period seismometers on and around the lava dome from May 9-10 to Jun 6-8, 2018 (Takeo et al. 2019 SSJ meeting) and recorded three-component seismograms at 200 sps. We here report local events near the summit that unexpectedly recorded by this observation.

We first used vertical-component seismograms filtered at a frequency higher than 2 Hz, and manually detected 56 events whose signals are visible at most of the stations on the lava dome. Some events can be recognized at the nearest JMA permanent station located at the southeast of the lava dome. The signal cannot be seen at other permanent stations. Smaller events, visible only at several stations on the dome, were frequently observed for a rate of about 1.5 per hour.

We then picked the first arrival for each event and each station from the envelope function, the moving average of RMS at a frequency higher than 5 Hz with a time window of 0.05 s. The first arrival time is defined at the time when the envelope amplitude becomes 10% of the maximum envelope amplitude. When the maximum-amplitude time and the arrival time differ more than 0.1s, the pick was rejected. After the trial hypocenter determination with various assumed homogeneous velocities in a range of 0.5-5 km/s, we found that the velocity of about 2 km/s is needed to reduce the misfit between picked and theoretical arrival times. This result indicates that the recorded signals are not acoustic waves like the firework signal from the Lake Toya-ko, but are P-waves from seismic events.

We finally determined the hypocenters of 37 events by only analyzing events with more than 10 first arrival measurements. The assumed velocity structure is homogeneous with a P-wave velocity of 2.0 km/s. Most of the events are located near the summit within the lava dome at altitudes of 250-350 m. Some events are located at the east of the summit at altitudes higher than 400 m in the air, indicating the insufficient quality of arrival-time picking and/or the assumed velocity structure. The roughly estimated magnitudes based on the JMA equation are between -3 and -2.5.

Although the validation is still ongoing, the durations of signals indicate that the events are not regular earthquakes but low-frequency earthquakes. The distribution of arrival times further indicates that the hypocenter is not a unique location. Preliminary calculation by the template matching method with one template event shows smaller events are occurring almost constantly. The activity may be thus related to the fumarolic activity continuing near the summit, or the contraction of the dome. To understand its activity and its meaning to the volcanic activity, relocation and template matching analyses are needed in the future.

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