The eruption of Kusatsu-Shirane volcano on 23 January, 2018, observed by V-net of the NIED

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Kusatsu-Shirane volcano is known as a particular field of volcano hydrothermal system consisting of the Yugama crater lake and a plenty of hot springs. On 23 January, 2018, an eruption occurred near the summit of Motoshirane, where is about 2 km apart from the Yugama lake. Although some swarms of VT earthquakes and ground inflation events have been reported near the Yugama lake (Terada et al., 2011), no considerable volcanic activities were reported at Motoshirane area. To understand the volcanic system, it is important to understand the dynamics of this eruption. The National Research Institute for Earth Science and Disaster Resilience (NIED) operated three permanent stations (V-net) at Kusatsu-Shirane volcano. Each station has a borehole short period seismometer and tiltmeter (ABS-143, Mitsutoyo), a broadband seismometer (Trillium 240, Nanometrics), and a microbarometer (F-401, Yokogawa). We report the data obtained by the V-net accompanying the eruption.

The eruption signal begins with a tremor on seismograms at 9:59 (JST) on 23 January, which has a duration of 2 minutes. Second wave group (SWG) with a large amplitude follows at 10:02 with a duration with 10 seconds. We see the tremor is consisting of seismic signals of 0.5–2.5 Hz and 2.5–20 Hz. The SWG has a peak frequency of 1.2 Hz. It is interesting that the SWG has no considerable signals at the high frequency band (2.5–20 Hz) of the tremor.

Accompanying the tremor, borehole tiltmeters detect an inflation of the flank of Motoshirane. The tilt change vector at each station roughly points to the summit of Motoshirane. The ground inflation turns to deflation associated with the excitation of the SWG on seismograms.

An microbarogram at KSHV, the closest station to the summit of Motoshirane, shows slight pressure change accompanying the SWG. Assuming the sound source is locate at the summit of Motoshirane (Kagamiike crater), arrival time difference of observed seismic and infrasound signals at KSHV can roughly be explained with possible seismic and infrasound wave velocity and horizontal distance between the source and KSHV. However, since the S/N ratio is not sufficient for the infrasound signal, more detail analyses are needed to determine the infrasound signals accompanying the eruption.

The characteristics of broadband seismic data are described below. Since considerable background noise of 0.2 Hz is recorded on the broadband seismogram, we focus on the signals within a band of 0.01–0.1 Hz. As the tremor signals appear, considerable very-long period (0.02–0.05 Hz) signals are also recorded broadband seismograms. Subsequently, a pulse (VLP pulse) with a large amplitude and a peak frequency of 0.07 Hz follows. From band-pass waveforms with an acausal filter, we see that that excitation of the VLP pulse is simultaneous with amplitude decreasing of the tremor. No considerable very-long period signals are seen accompanying the SWG. We investigate particle motions of these very-long period signals to examine the source location. Since no considerable amplitude difference is seen from each component of the coda of an earthquake at Alaska (M 7.9) on 23 January, we regard the site effect on the very-long period signals is negligible. Horizontal particle motions of the signals (0.02–0.05 Hz) accompanying the tremor show a straight movement along with each station and the summit of Motoshirane. From vertical cross sections, we see the seismic wave propagates from the beneath the summit, which has an elevation about 2000 m. At KSNV, where is the elevation is about 845 m, the incident angle of the very-long period signals is almost horizontal. Therefore, it suggests the source depth of the very-long period signals is located about 1 km beneath the surface. Particle motions of the VLP pulse shows a complex behavior, that makes difficult to estimate the source location. More detail analyses are needed to examine the source location and mechanism of the VLP pulse.

Keywords: Kusatsu-Shirane volcano, volcanic eruption