The phreatic eruption on 23 January 2018 at Mt. Moto-Shirane of Kusatsu-Shirane volcano, Japan: geophysical observations and implications

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Kusatsu-Shirane volcano has experienced repeated historic phreatic eruptions, and is well known as one of the most active volcanoes in Japan (Ossaka et al, 1980; Ohba et al., 2008; Terada and Hashimoto, 2017). Historic eruptions have only occurred at around the Shirane pyroclastic cone. However, recent geodetic surveys have revealed pressure sources around the northern part of the Moto-Shirane pyroclastic cones (Terada et al., 2011; Terada et al., 2014). On 23 January 2018, the phreatic eruption occurred at the Kagami-ike-kita pyroclastic cone which is the northernmost end of the Moto-Shirane pyroclastic cones, spraying volcanic ejecta including volcanic bombs result in the death of a skier. In this study, we summarize the volcanic activities of Moto-Shirane pyroclastic cones based on geophysical observations and discuss ground deformations associated with the eruption on 23 January 2018.

The Moto-Shirane pyroclastic cones did not exhibit thermal features including fumarolic activities nor hyperacidic lakes around their craters, in contrast to the Shirane pyroclastic cone. The cones were naturally covered by vegetation, and ski slopes were built on the northern slopes of the Kagami-ike-kita pyroclastic cone. It was believed that the latest eruption event of the Moto-Shirane pyroclastic cone is the emission of the Sessho lava flow in 3 ka (Hayakawa and Yui, 1989). Recent geological investigations have shown that explosive phreatic, phreatomagmatic and Vulcanian eruptions occurred repeatedly at the Moto-Shirane pyroclastic cones from approximately 5 - 1.5 ka (Yoshimoto et al., 2013; Nigorigawa et al., 2014; Kametani et al., 2015).

Kusatsu-Shirane Volcano Observatory, Tokyo Institute of Technology has deployed three borehole-type tiltmeters JTS-33 and two ground installation-type tiltmeters 701-2A in the area within 1 km from the center of Yugama crater lake of Shirane pyroclastic cone. In addition, six seismometers and four GNSSs have been operated in order to detect even slight changes in underground pressure around Yugama crater lake, but the Moto-Shirane pyroclastic cones have been outside of our observation network.

At 10:00 (UT +9) on 23 January 2018, our tiltmeter network detected a ground deformation, indicating an increase in pressure at the source around the northern part of the Moto-Shirane pyroclastic cone (Terada et al., 2014). The inflation rate accelerated with time, followed by a rapid deflation from 10:02:10. At 10:02:13, significant infrasound was recorded at KSRH station, 1.1 km from new fissure zone, indicating phreatic eruption started at around 10:02:10. Assuming a crack (Okada, 1992) located beneath new fissure zone formed during the eruption on 23 January 2018, an increase and decrease in volume were estimated to be 0.42 and 0.3 million cubic meters, respectively. We believe most of such volume changes are caused by gas phase because total mass of ejecta is much smaller than that of volume changes.

Although seismicity around the Moto-Shirane pyroclastic cones slightly increased prior to the eruptions,

clear precursors of the eruption are not found on the basis of preliminary surveys of observed data. At Moto-Shirane pyroclastic cones, an aerial infrared survey was carried out on 5 November 2017, 79 days before the eruption. As a result, no temperature anomalies were found. The observation was done in the nighttime because even slight anomalies in ground surface temperature can be detected.

Keywords: Phreatic eruption, Kusatsu-Shirane volcano, Moto-Shirane pyroclastic cones, Kagami-ike-kita pyroclastic cone, Eruption on 23 January 2018

