

A small phreatic eruption on the south rim of lo-yama crater in the Kirishima volcano group, southern Kyushu: Understanding multi-volcanism

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Fumarolic activity restarted on December 14, 2015 at the south rim of lo-yama crater. Based on ¹⁴C dating, it is assumed that the last magmatic activity comprised the vulcanian eruptions that produced lo-yama lava between the 16th and 17th centuries. Tajima et al. (2014) proposed that the last eruption was a phreatic eruption at the lo-yama east crater in 1769, based on a geological survey and historical records. Tajima et al. (2013) found that three distinct eruptions from three other volcanoes, Ebino-kogen, Shinmoedake, and Miike, in the Kirishima volcano group yielded similar ¹⁴C ages. There is a need to clarify the reciprocal volcanic activity in one cluster of volcanoes such as the Kirishima volcano group.

Temperatures of the fumarolic activity on the south rim of lo-yama crater, termed the lo-yama fumarole area, have been observed since the 1950s by various researchers, such as the Geological Survey of Japan (1955) and Kagiya et al. (1979) (Funasaki et al., 2017). Fumarole temperatures were found to be 120–150 °C during the 1950s and 247 °C during the 1970s. However, fumarole temperatures decreased rapidly during the 1990s and fumaroles on lo-yama crater disappeared during the late 2000s.

Fumarolic activity restarted in December 2015. The thermal anomaly area of the lo-yama fumaroles exhibited a gradual increase in activity during 2016 (Tajima et al., 2017). In early 2017, this activity increased rapidly, and some fumarole vents (such as the loud fumarole vent H) and hot springs appeared from March to May. During this thermal anomaly expansion event, we observed a volcanic ash deposit from a very small vent named fumarole vent A from May 5th to 10th. We observed two thin layers in the ash deposit consisting of a lower coarse and an upper fine ash layer. This sequence indicated the opening of the first vent and the fragmentation of wall rock at the surface. Afterward, hydrothermal water was ejected from the vent and hydrothermal material dispersed towards the southwest and northeast. We captured this event using a Japan Meteorological Agency (JMA) web camera on April 26th. We observed a light gray thermal cloud from the south rim of lo-yama crater at 11:29 AM using web camera images. The thermal plume dispersed southwestward after the very small eruption. The thermal activity produced the ash layer reached about 200 m distance from fumarole vent A. We assumed that the volume of the ash fall was approximately 1 ton.

Hydrothermal activity continued after this small eruption. At fumarole vent H, temperatures of 128.0 °C and 134.2 °C were observed on June 4th and September 24th, respectively. Before the opening of the fumarole vents, every fumarole observed exhibited a temperature between 95.0 and 95.5 °C, as this is the boiling point of water at that elevation. In this time, underground hydrothermal water that had undergone boiling by volcanic gas leaked into the lo-yama fumarole area. After the fumarole-opening event, high-pressure hydrothermal water and volcanic gases spewed out from some fumarole vents in the lo-yama fumarole area.

After the 2011 Shinmoedake eruptions, many volcanogenic earthquakes occurred under Karakunidake,

beginning in October 2013. The Global Navigation Satellite System length near Io-yama increased from late 2013 to the middle of 2014 (JMA, 2014). These results indicate that residual magma from the 2011 Shinmoedake eruption blocked the Shinmoedake passage after the eruptions. The magma so moved toward the Io-yama. The volcanic gas from this magma may have singed from the hydrothermal system under Io-yama from August 2014. Pronounced hydrothermal events at a distant location after magma intrusion are sometimes observed. Examples of such events include the Nishi-Iwate activity after magma intrusion into the Iwate volcano (Ueki and Miura, 2001; Doi, 2000) and the Nishiyama hydrothermal activity after the cryptodome intrusion into the Usu volcano (Saba et al., 2007; Terada, 2008).

Keywords: Kirishima volcano group, Ioyama, small eruption