Precursors to the eruption at Kuchinoerabujima volcano and decision making of evacuation

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On August 3, 2014 and May 29, 2015, eruptions occurred at the Shindake summit crater of Kuchinoerabujima Volcano, which is located in the Ryukyu Islands in southwestern Japan. The Japan Meteorological Agency upgraded the Volcanic Alert Level (VAL) to 3 (restricted zone within 2 km from the summit) after the 2014 eruption and to 5 (evacuation) after the 2015 eruption. The possibility of implementing early warnings for eruptions and forecasting the area most likely to suffer damage from volcanic eruptions was examined based on monitoring data and the disaster areas of historic eruptions. A long-term process spanning 15 years and a relatively short-term process that could have been implemented immediately before the onset of the 2014 eruption were identified. The seismicity, which mostly represented extremely shallow (less than 0.5 km) volcano-tectonic earthquakes beneath the summit crater, increased from July to December 1999. After the first increase in seismicity, several repeated bursts of seismicity occurred. Repeated ground inflation events around the crater detected by continuous GNSS were associated with the increase in seismicity. Increases in the activity were also accompanied by increases in geothermal and fumarolic activity. An alert zone of 1 or 2 km (VAL 2 or 3) from Shindake crater was established immediately after three bursts of volcanic earthquakes occurred during the precursory period of the 2014 eruption. However, there were no definite indications to trigger an upgrade to the VAL before the 2014 eruption because the relatively high volcanic activity had been stable and the precursory tilt change began only a short time before the eruption. The phenomena prior to the 2015 eruption were more intense than those prior to the 2014 eruption, as demonstrated by the seismicity, which included a felt earthquake six days before the eruption; the larger ground deformation; the higher rate of discharge of SO_2 gas; and the higher temperature. Among these precursors, the felt earthquake could be considered an appropriate indication to trigger an upgrade of the VAL from 3 to 5 for evacuation because felt earthquakes suddenly increase the seismic energy, whereas other parameters showed gradual progress. In historical cases, a few felt earthquakes were reported prior to the eruptions in 1931 and 1966. The felt earthquake before the 2015 eruption was induced by the accumulation of other eruption-related parameters, such as an increase in the SO_2

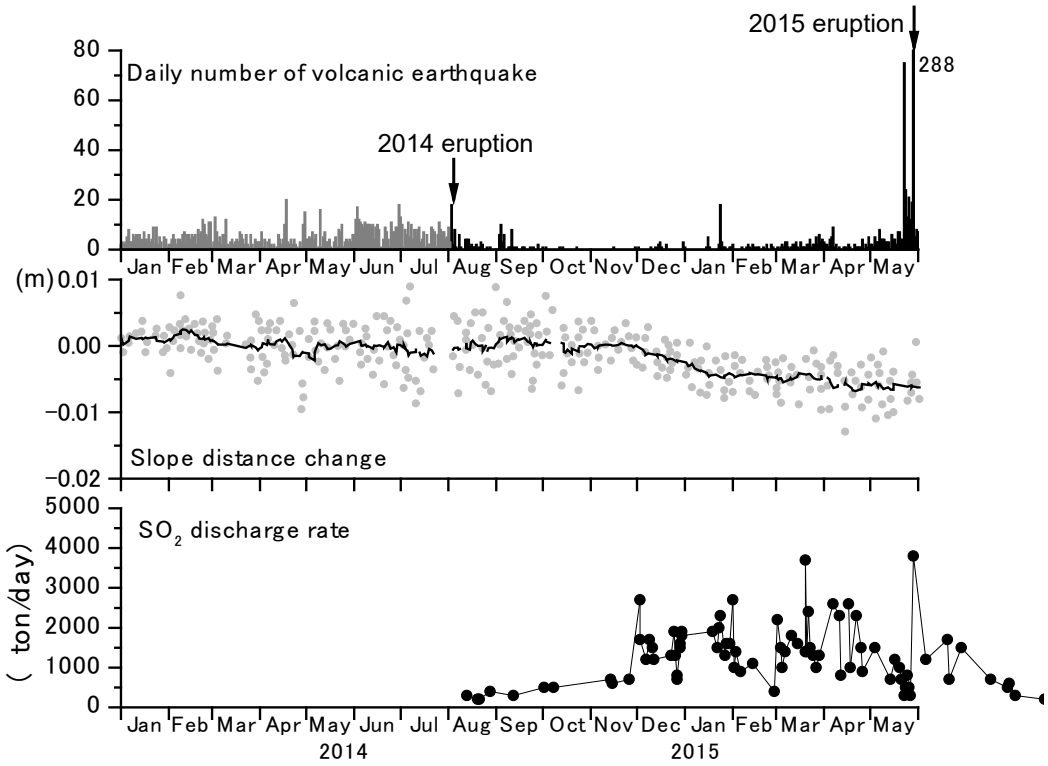

Fig. 1 Daily numbers of volcanic earthquakes (top), change in the slope distance (middle), and the discharge rate of SO2 gas (bottom) during the period from January 1, 2014, to May 31, 2015. The daily numbers were obtained by JMA. The slope distance was measured between station KG1in Kuchinoerabujima, and GEONET station Kamiyaku2 (960727) in Yakushima. The SO2 discharge rate was measured using the differential optical absorption spectroscopy (DOAS) traverse method on the volcano or by boat (Mori et al., 2017).

discharge rate, the inflation of the volcano, and the appearance of volcanic glow at the summit. Decreases in the seismicity, SO_2 gas discharge rate, and geothermal activity led to an initial reduction of the alert zone radius to less than 2.5 km in October 2015, and a further reduction to less than 2 km (VAL 3) was later implemented based on the deflation around the summit area in June 2016.

Main References

Mori, T., Morita, M., Iguchi, M., Fukuoka Regional Headquarters, 2017, Sulfur dioxide flux monitoring using a public ferry after the 2014 eruption of Kuchinoerabujima Volcano, Japan, Jour. Nat. Disast. Sci., Vol. 38, 105-118.