

Forecasting Volcanic Eruption of Sakurajima Volcano Based on Magma Intrusion Rate

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In order to find an empirical event branch logic from abnormal phenomena to following volcanic activity for forecasting scale and type of eruption, the magma intrusion rate prior to eruptions of Sakurajima volcano is examined using ground deformation mostly from observation data and partially based on legends, for eruptions after the 20th century: the 1914 eruption starting with plinian eruption followed by effusion of lava, the 1946 eruptions with lava effusion, eruptions at the summit crater of Minamidake during the period from 1955 to 2005, and vulcanian eruptions at Showa crater east of the summit from 2006 to 2017. Prior to the 1914 eruption, it is estimated that the magma intrusion rate attained a level of approximately $10^8 \text{ m}^3/\text{day}$ and was on the order of $10^6 \text{ m}^3/\text{day}$ during the effusion of lava in the 1946 eruption. During the eruptive period of Minamidake summit crater, three types of eruption occurred: vulcanian eruption, strombolian/lava fountain and continuous emission of volcanic ash. In cases of intrusion of magma forming a new conduit, the intrusion rate immediately before the 1914 eruption exceeded $10^8 \text{ m}^3/\text{day}$, but only $10^6 \text{ m}^3/\text{day}$ in the dyke-forming event of August 15, 2015. Magma intrusion rate into a pre-existing conduit prior to eruptions at Minamidake summit crater are ordered as follows: vulcanian eruption (1×10^5 to $8 \times 10^5 \text{ m}^3/\text{day}$) > continuous emission of volcanic ash (approximately $1 \times 10^5 \text{ m}^3/\text{day}$) > strombolian/lava fountain (0.2×10^5 to $2 \times 10^5 \text{ m}^3/\text{day}$). The magma intrusion rate prior to vulcanian eruptions at Showa crater is smaller (approximately $10^4 \text{ m}^3/\text{day}$) than for eruptions at Minamidake summit crater. However, the rate reached an order of $10^5 \text{ m}^3/\text{day}$ prior to lava fountain on August 22, 2017. Magma intrusion rates well correspond to the scale and type of eruption. In the case of magma intrusion under detection, the change of volcanic gas and increase in the heat discharge rate are available for the empirical event branch logic.

Keywords: magma intrusion rate, Sakurajima, volcanic earthquake, vulcanian eruption, strombolian eruption, plinian eruption