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Magma plumbing system and ground deformation associated with the eruption at the Showa crater of Sakurajima in 2009

Soma Minami[1*], Masato Iguchi[2], Hitoshi Mikada[1], Tada-nori Goto[1], Junichi Takekawa[1]

[1]Grad. School of Eng., Kyoto Univ., [2]Disa. Prev. Res. Inst., Kyoto Univ.

Many qualitative studies have been conducted on the mechanism of a volcanic eruption from the analyses of volcanic ejecta and from geological interpretations. However, little is known about the quantitative evaluation of the mechanism in terms of magmatic flow. There are indeed some quantitative studies about the part of an eruptive system such as a volcanic flow, a crystallization differentiation in a magma reservoir etc., but very few to consider the system consisting of a magma reservoir and a volcanic conduit together.

Here, we studied the magma plumbing system inferred from the ground deformation associated with the eruption at the Showa crater of Sakurajima volcano. After the application of the Mogi's model to data in the past geodetic observations, the existence of two magma reservoirs has been inferred beneath the summit of volcano at depths of 4 km and 0.1 km, respectively. The change in the tilt and strain data in two underground tunnel sites observed 36 hours before an eruption in April 9, 2007, are analysed in terms of the behaviour of magma prior to the eruption. An about three-hours time lag in the inflation and the difference in the volumetric change were observed between the two reservoirs. We conducted a numerical simulation to investigate the magma plumbing system and to explain the time-lag in the inflation between the two reservoirs. Our model consists of shallow and deep magma reservoirs interconnected by a vertical conduit through which gas-liquid two-phase magma flows with phase change. Two conditions of a constant magma supply into the deeper and of a pressure threshold to initiate the ascent of magma to the shallower are given to the model. We confirmed that our hypothetical model could explain the time lag of the inflation. As a next step, we would like to describe the difference in the volumetric changes using our model.

Keywords: eruption, volcanic conduit, magma reservoir, sakurajima, ground deformation, numerical simulation