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噴火前の地殻変動から推定した地下の圧力源挙動のパラメトリックインバージョン Parametric inversion of volumetric variations of two subsurface pressure sources from pre-eruptive ground deformation

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We numerically developed a parametric inversion scheme to infer a time-dependent magma accumulation process in the magma plumbing system beneath an active Showa Crater of Sakurajima Volcano (Japan). Our objective is to find what would be dominant geophysical parameters in the accumulation process before eruption. Geodetic observations showed that a periodic inflation and deflation events had lasted 30 hours before an explosive eruption on April 9, 2009. Our model consists of two reservoirs, one shallower filled mainly with gas and the other deeper filled with magma, connected by a volcanic conduit as inferred from the past geophysical observations. A pressure difference between the two reservoirs forces the magma to move from the deeper up to the shallower reservoir. We assumed a constant rate of magma supply to the deeper reservoir as an input to the magma plumbing system. In a cylindrical volcanic conduit, a viscous multiphase magma flow is simulated by either Hagen-Poiseuille or permeable flow with the effects of the relative motion of gas in magma, the exsolution of volatiles in melt, the crystallization of microlites in groundmass, the change in height of magma head, etc. As a result of the parametric inversion of the observed volumetric variations, we found the observed event before the eruption could be reproduced not by the Hagen-Poiseuille model but by the permeable model. We also found that the radius of the volcanic conduit, the bulk modulus of the deeper reservoir, and the gas permeability, and the initial gas volume fraction in the conduit are the key parameters to reproduce the observed volumetric variation. Among these parameters, our sensitivity analysis indicates that the initial height of magma head and the temperature reservoir would have much less influence on the volumetric variations of the reservoirs than the key parameters. We propose our parametric inversion as one of quantitative simulation methods that could be applied to the future eruptive events not only at Sakurajima Volcano but for the other volcanoes.

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