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Hydrokinetic modeling of magma plumbing system beneath Showa crater of Sakurajima volcano, southwestern Japan

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We numerically simulated hydrokinetic magma supplies in the magma plumbing system beneath an active Showa crater of Sakurajima volcano to find dominant geophysical parameters in the magma accumulating process before an explosive eruption on April 9, 2009. Geodetic observations revealed that a periodic inflation and deflation event had lasted 30 hours before the eruption. Our model consists of shallower gas and deeper magma reservoirs connected by a cylindrical volcanic conduit that had been suggested by 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 and a viscous multiphase magma flow, i.e., crystalized materials, melt, and gas, in the volcanic conduit. The effects of the lateral escape of gas from the conduit, the vesiculation of volatiles in the magma, and the relative motion between gas and solid-liquid are taken into account in the simulation. Our simulations prove that the time-dependent inflation and deflation sequences of the two subsurface reservoirs could be reproduced and that the key parameters such as the radius of the conduit, the magma supply rate and the compressibility of the deep reservoir could be constrained through a least-square error criterion.

Keywords: hydrokinetic simulation, magma plumbing system, transient ground deformation, Sakurajima volcano