Probing magmatic processes just prior to historic eruptions at Sakurajima volcano: Toward understanding “magma pre-charge”

*Naoki Araya[1], Michihiko Nakamura[1], Satoshi Okumura[1]

1. Division of Earth and Planetary Materials Science, Department of Earth Science, Graduate School of Science, Tohoku UniversityUniversity

Based on the pressure at which volatiles within phenocryst-hosted melt inclusions and plagioclase rims were finally equilibrated, Araya et al. (2019, Scientific Reports) reported that the magma storage depths immediately prior to the historic Plinian eruptions at the Sakurajima volcano (AD 1471, 1779, 1914) were much shallower (0.9–3.2 km) than those of the present magma reservoirs beneath Aira Caldera (~10 km) and Sakurajima (~4–6 km). They proposed that the Plinian eruptions were fed from a thick shallow conduit pre-charged from the magma reservoirs. How this process, “magma pre-charge”, has occurred is poorly understood because the Sakurajima case is the first report. As magma pre-charge is assumed to have occurred at least a few tens of days before each eruption, probing magmatic processes just prior to the eruptions is a key to prepare for the possible future eruption.

Magnetite is a mineral suitable for investigating short-timescale pre-eruptive processes because of its fast element diffusion (i.e., high time resolution) compared to common phenocrystic silicates. We have analysed chemical compositions of more than 300 magnetite phenocrysts in pumices and lavas from the historic eruptions. The magnetite phenocrysts showed scarce zoning in each crystal (mostly within 1 Usp mol%), while their compositional range is wide (e.g., 27–45 Usp mol% for the 1914–1915 eruption). This indicates that the eruptions had initiated from a magma reservoir heterogeneous in at least either temperature, melt composition, or oxygen fugacity, and that this heterogeneity had not been perturbed prior to the eruptions. Therefore, widely accepted models for eruption trigger, such as new magma injection and overturn of stratified magma reservoir are not likely to apply to these historic Plinian eruptions.

Keywords: Sakurajima volcano, magnetite, diffusion

