Temporal variation in volcanic ash texture during single vulcanian eruption at Sakurajima volcano, Japan, revealed by real-time collection of ash samples

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Vulcanian eruptions have been recognized as explosive emissions of volcanic gases and tephra in short duration and modeled as instantaneous bursts of pressurized gas chambers at the shallow part of the conduit. However, detailed observation of the eruption process reveals most vulcanian explosions consist of an intense explosion at the onset followed by continuous emission of volcanic gases and tephra for several minutes to several hours. To model vulcanian eruptions, it is important to consider the temporal evolution of their eruptive process, which is controlled by the structure of the vent-conduit system. Examination of the temporal variation in petrological character of the ejecta is crucial for understanding changes in the vent-conduit system because the ejecta carries a record of magma properties and eruptive processes as crystalline and vesicle textures and chemical composition. Previous studies have reported daily or inter-event variation in the eruptive processes of small eruptions including vulcanian and strombolian styleson the basis of petrological analysis of volcanic ash. However, durations of vulcanian eruptions are actually much shorter than the time resolution determined by these studies.

Here we discuss the progress of vulcanian eruptions with short duration on the basis of temporal variation of texture of volcanic ash from Sakurajima volcano, Japan. We performed the real-time collection of the falling ashes every 2-50 min and the collected ashes are petrologically analyzed. These ashes consist of juvenile particles, altered rock fragments, and fragments of crystals. The juvenile particles are subdivided into blocky, vesicular, and fluidal particles. Because the crystallinities of the vesicular and fluidal particles are smaller than those of the blocky particles, we termed the vesicular and fluidal particles as low-crystallinity particles (LCPs with 25-28 vol.% of plagioclase), and the blocky particles as high-crystallinity particles (HCPs with 28-35 vol.% of plagioclase). Analysis of temporal variation in ash texture revealed that the number ratio of LCP to HCP (LCP/HCP) was minimal in the deposits of initial eruption and increased with the progression of each eruption. The higher crystallinity of HCPs suggests crystallization under lower pressure (10-30 MPa) and longer duration than that of LCP magma (20-40 MPa). The temporal variation in LCP/HCP suggests that emission of less-viscous or vesicular magma under a dense cap increases with the progress a single vulcanian eruption. Such temporal variation in ash texture may correspond with the progress of the emission style of sudden, explosive to continuous during a vulcanian eruption.