Characteristics and transition of erupted magma in large-scale silicic pyroclastic eruptions of Asama volcano

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Explosive eruptions that disperse an enormous amount of pyroclasts are generally driven by silicic magma and often cause devastative hazards such as large pyroclastic flows. Thus, it is important to understand the characteristics of silicic magma and its temporal changes in a series of eruptive events.
At Asama volcano, large silicic pyroclastic eruptions occurred ca.16,000 years ago and produced three main pyroclastic units: the Itahana yellow (YP) fallout pumice, the 1st Komoro pyroclastic flow deposit, and then the Kusatsu or Tsumagoi (YPk) fallout pumice. The volumes of these eruptions have been estimated to be 1.28 DRE km^3, 1.58 DRE km^3, and 1.52 DRE km^3, respectively. The series of eruptions is known as the largest eruptive activity in the history of the Asama volcano. Despite the importance of unraveling the eruptive processes, however, the eruptions are not investigated enough excepting tephra distribution, ages, and whole rock compositions of the pyroclasts. In this study, we investigate the physical and chemical properties of pyroclasts, characterize the erupted magma, and discuss its transition through the series of eruptions.
We divided the YP fallout pumice, the 1st Komoro pyroclastic flow, and YPk fallout pumice into several subunits and analyzed the physical and chemical properties of pumice. The average apparent density of pumice in the subunits of the YP fallout pumice is 0.47-0.49 g/cm^3, which is significantly lower than 0.70-0.83 g/cm^3 of the YPk fallout pumice. In terms of petrology, pyroclasts in every main unit include phenocrysts of plagioclase, orthopyroxene, clinopyroxene, magnetite, and ilmenite. A small amount of olivine and quartz also come in the 1st Komoro pyroclastic flow.
Both core and rim of the plagioclase phenocrysts have a peak of An50. Additionally, An mol% of the plagioclase cores range from An40-90, which is a much broader composition than An40-60 of their rims. Mafic parts of the banded pumice in the 1st Komoro pyroclastic flow include many small phenocrysts around An70. Mg# of two pyroxene phenocrysts in every main unit has two peaks of Mg#67 and Mg#75, regardless of the core or rim. YP fallout pumice has the least number of clinopyroxene, making a subtle peak of Mg#75.
The temperature and pressure in the magma reservoir were estimated with two pyroxenes thermobarometer and magnetite-ilmenite thermometer using the chemical compositions of coexisting or nearby phenocrysts. The magma reservoir temperatures obtained from the YP and YPk fallout pumice are ca. 860-870℃, which is near ca. 880-890℃ estimated for the 1st Komoro pyroclastic flow. As a result of the two pyroxenes thermobarometer, moreover, the magma reservoir pressures of the three main units range ca. 4.0-6.0 kbar.
Using the plagioclase chemical compositions, melt inclusion compositions, and magma reservoir temperature and pressure, we analyzed the water content of the main units with two hygrometers. The results have a gap of 0.5 wt.% in the two hygrometers. The YP and YPk fall pumice show 4.0-5.5 wt.%, whereas the 1st Komoro pyroclastic flow shows 3.5-5.0 wt.%.
The three main units have almost the same phenocryst types, their chemical compositions, magma reservoir temperature and pressure, and water content, indicating that the characteristics of erupted magma had been constant through the series of eruptions. Takahashi et al. (2008) found two trends in the whole rock composition of the main units and considered that the eruptions have been driven by several magma systems. Considering this idea, our results imply that the multiple magma systems had been under almost constant conditions in the chemical composition of phenocrysts, temperature, and pressure. On

the other hand, interestingly, the apparent densities are significantly different between the YP and the YPk fallout pumice. This difference may not reflect the change of the magma reservoir conditions but of another process such as magma ascent in the conduit.

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