Silisic magma reservoirs beneath Fuji Volcano, Japan, constrained from interstitial melt in gabbroic xenoliths

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Gabbroic xenoliths in the deposits of the 1707 eruption of Fuji volcano, Japan, sometimes include interstitial glass filling the space between euhedral mineral grains. These melt-beating gabbros are thought to be fragments of a crystal mush constituting a magma reservoir beneath Fuji volcano. In this study, chemical compositions of interstitial glasses and co-existing minerals in the gabbroic xenoliths are analyzed, and based on the results, pre-eruptive magmatic conditions and processes in the crystal mush are investigated.

The analyzed gabbro samples are classified into two groups, Goup-A and B, based on the interstitial glass compositions. In Group-A gabbros, interstitial glasses are rhyolitic (SiO_2~72.7-77.6wt.%) and homogeneous in each sample. On the other hand, chemical compositions of interstitial glasses in Group-B gabbros vary significantly from basaltic andesitic to dacitic (SiO_2~54.5-74.5wt.%) in each sample. Volume fraction of melt + bubble is higher in Group-A gabbros (23.8-35.2vol.%) than Group-B gabbros (0.8-14.8vol.%). In Group-A gabbros, composition of the interstitial glass coincides with that of the most SiO_2-rich plagioclase-hosted melt inclusions, suggesting that the interstitial melt of Group-A (melt A) is a residual melt of crystallization. In contrast, in Group-B gabbros, plagioclase-hosted melt inclusions are more silicic than the interstitial glasses. In addition, banded flow structure composed of chemically distinct glasses are found in interstitial glasses of Group-B gabbros. These suggested that permeable flow and mixing of chemically distinct melts occurred in Group-B crystal mush. Furthermore, Group-B gabbros are subdivided into two types, Group-B1 and B2; as SiO_2 content of interstitial glass increases, Al_2O_3 content decreases and increases in Group-B1 and B2 gabbros, respectively. These two compositional trends were formed by mixing between the same mafic end-member melt and two distinct silicic end-member melts. The melt-A is the silicic end-member melt in Group-B1 gabbros. In contrast, silicic end-member melt in Group-B2 gabbros is a dacite melt with a SiO_2 content of ~68.0wt.% (melt B). The results suggest that at least three end-member melts of rhyolitic, dacitic and mafic compositions exist in the crystal mush beneath Fuji volcano. Based on Fe-Ti oxide thermometry and plagioclase-melt thermohygrometry, the equilibrium temperatures and H_2O contents are estimated to be ~823℃ and ~7.4wt.% for the melt-A and ~863℃ and ~8.6wt.% for the melt-B, respectively. The estimated H_2O contents correspond to the H_2O-saturated depths of ~8.5km and ~13.5km for the melt-A and B, respectively. The estimated depths coincide with that of the low seismic velocity zone where low frequency earthquakes occur beneath Fuji volcano, suggesting the seismic activity may be related to crystal mush processes.

Keywords: Fuji Volcano, gabbro, interstitial melt, crystal mush, xenolith

