Transition of magma plumbing system of Aso volcano as deduced from mineral and melt inclusion data

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Abstract

Aso volcano in Kyushu Island, SW Honshu arc, Japan has three contrasting stages of activities: i.e. (1) pre-caldera, (2) caldera-forming and (3) post-caldera stages. We attempt to evaluate the possibility of caldera-forming eruption from petrological and mineralogical data.

(1) Pre-caldera volcanism is represented by occurrence of lava flows and lava domes at Aso caldera walls or outside caldera. The peak activities are between 400 ka and 800 ka. (2) Caldera-forming stage is represented by four large-scale pyroclastic eruptions, called as Aso-1, Aso-2, Aso-3 and Aso-4 with K-Ar ages of 266 ka, 141 ka, 123 ka, and 89 ka, respectively. Large-scale pyroclastic eruptions were intervened by intra-caldera volcanism of lava flows and moderate explosive eruptions producing tephra. Precursory lava effusion event occurred before large-scale eruptions of Aso-1, Aso-2 and Aso-4. (3) Post-caldera volcanism is a collection of basaltic cones, lava flows and minor silicic explosive events to form central cone complex inside the caldera.

(1) Olivine and/or hornblende bearing andesite are dominant among pre-caldera lavas. (2) Pyroclastic flows contain abundant dacite pumice with or without hornblende phenocryst. Hornblende is a key mineral used to identify Aso-4 pumice. Some pyroclastic flow units contain basaltic scoria and banded pumice with olivine. Intra-caldera lavas and tephra are pyroxene andesite and hornblende dacite. (3) Post-caldera volcanic products are represented by medium-K olivine basalt, olivine basaltic andesite, and pyroxene andesite, high-K pyroxene dacite, and pyroxene rhyolite. Hornblende is rare among post-caldera products.

Melt inclusions (MIs) in plagioclase and pyroxenes, a proxy of fossil magma, show several different patterns of compositional variation. (2) Caldera-forming Aso-4 MIs show very narrow compositional range. The most voluminous unit, Oyatsu and Yame pumice contains MIs with two distinct compositional peaks, which might represent different layers of a stratified large magma reservoir. (3) Post-caldera silicic tephra (ACP4, 3, 2) contains MIs showing a narrow compositional range, whereas ACP1 shows a very scattered range. Early scoria and Holocene scoria show a straight mixing line.

In summary, we do not seem to observe the development of homogeneous silicic large magma reservoir in Holocene epoch of post-caldera stage as revealed by MIs.