Evolution of magma plumbing system between large pyroclastic eruption cycles in Aso volcano, Japan

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The purpose of this study is to clarify the evolution of magma plumbing system between large pyroclastic eruption cycles in Aso volcano, Japan.

In Aso volcano, four large pyroclastic eruptions, Aso-1, 2, 3 and 4, occurred in about 300, 150, 120 and 90 ka, respectively. Between these large eruptions, there are many small activities of silicic pyroclastic falls called Aso-2/1, 3/2 and 4/3. Ejecta by these small activities record the transition of the magma plumbing system from small activities into a next large pyroclastic eruption. In this study, we investigate petrological features of Aso-3/2 and Aso-4/3 in detail and compare them with Aso-2, 3 and 4.

Chemical analyses of volcanic glasses and phenocrysts in silicic ejecta of Aso-2, 3 and 4 were performed in order to compare with silicic ejecta of Aso-3/2 and 4/3. Systematical change of petrological features is clear. K_2O content and FeO*/MgO of volcanic glasses decrease in a given SiO_2 content with time. Compositions of Fe-Ti oxides indicate that oxidation states of magmas become higher with time.

Aso-3/2 deposits are divided into six units, U, O, P, Q, R and S, from the top (Ono et al., 1977). Compositional variation of these volcanic glasses (SiO_2 69-72 wt%) cannot be explained by single fractional crystallization. Aso-3/2 ejecta are divided into two groups on the basis of relationship between SiO_2 and K_2O contents: high K_2O content group (U, upper part of O, R, and S) and low K_2O content group (lower part of O, and P). These high and low K_2O content groups are similar to Aso-2 and Aso-3 on SiO_2-K_2O relationship, respectively. On the other hand, features of SiO_2-FeO*/MgO relationship and redox state estimated by Fe-Ti oxides in all the units of Aso-3/2 are similar to Aso-3.

Aso-4/3 deposits are divided into upper, middle and lower parts (Hoshizumi, 1990). Analyses of Units A, B, C and D in the upper part and Unit F in the middle part have been finished at present (the units are based on Ono et al., 1977). Compositional variation of these volcanic glasses (SiO_2 69-72 wt%) cannot be explained by single fractional crystallization, like Aso-3/2. Aso-4/3 ejecta are divided into two groups on the basis of SiO_2-K_2O relationship: high K_2O content group (lower part of F) and low K_2O content group (A-D and upper part of F). The former has similar features to Aso-2 on SiO_2-K_2O relationship and the latter has intermediate features between Aso-3 and 4. On the other hand, features on SiO_2-FeO*/MgO relationship and redox state estimated by Fe-Ti oxides in Units A to F are similar to Aso-4.

From these results, we can point out four common petrological characteristics for Aso-3/2 and Aso-4/3 in the following; (1) compositional variation cannot be explained by single fractional crystallization; (2) on SiO_2-K_2O relationship, compositions of volcanic glasses scatter within the compositional range of the ejecta of a next large eruption and before it; (3) features of SiO_2-FeO*/MgO relationship is similar to the next large eruption; (4) oxidation state of magmas is higher than the previous large eruption and similar to the next large eruption. The characteristic (2) probably shows compositional range of source materials. The characteristic (3) may be results of crust melting and fractional crystallization under a constant redox state throughout the stages of the small activities and the next large eruption as shown in (4).

We summarize the evolution of the magma plumbing system of Aso volcano as follows. After a large eruption, magmas from some different sources formed individual magma chambers under more highly oxidative environment. Subsequently, large-scale magma chamber was formed. The systematical expansion of compositional range of source materials to less K_2O content on SiO_2-K_2O relationship with time implies that magma forming processes (crust melting and crystallization) affect compositions of the source materials generating the subsequent magmas.