Petrological features of Aso-3 gigantic pyroclastic-eruption cycle deposits at Aso Volcano, SW Japan

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At Aso volcano, four gigantic pyroclastic-eruption cycles occurred from 300 ka to 90 ka. The third gigantic eruption-cycle from the oldest, Aso-3 (120 ka), is the second largest (total volume is 100km3). Ono et al. (1977) divided pyroclastic deposits of Aso-3 into four subunits, Aso-3W, 3A, 3B, and 3C in eruption order. Lithologies of all the subunits are not homogeneous. In some subunits, pyroclastic deposit from a single flow unit consists of some kinds of essential blocks with different petrographical features such as the modal amount of phenocrysts. In order to understand kinds of the magmas of Aso-3 eruption and the features of the magma chamber, we investigated the occurrence and petrological features of subunits of Aso-3 in detail and carried out whole-rock chemical analyses of essential blocks.

We show the occurrence of the subunits of Aso-3 in the northern and eastern areas of Aso volcano in the following.

1) Aso-3W pumice fall deposits: Plinian fall deposits that consist of aphyric dacitic pumices.

2) Aso-3A pumice flow deposits: non-welded dacitic pumice flow deposits that consist of aphyric pumices and aphyric banded pumices. Fraction of banded pumices is 10% in the northern flank, while not in the eastern flank.

3) Aso-3B scoria flow deposits: Andesitic scoria flow deposits. This subunit is the most voluminous in Aso-3. The upper and lower parts are non-welded, and the middle part is densely welded. In the lower part, deposits consist of aphyric scoria, obsidian blocks, aphyric banded pumices, and aphyric pumices. In the upper part, they consist of aphyric scoria, obsidian blocks, and porphyritic scoria.

4) Aso-3C scoria flow deposits: Basaltic-andesitic scoria flow deposits that consist of porphyritic scoria.

Phenocrysts of all the essential blocks are plagioclase, orthopyroxene, clinopyroxene, Fe-Ti oxide minerals, and apatite. The modal amounts of phenocrysts in the aphyric blocks of 3A and 3B are less than 5%, and those in porphyritic blocks of 3B and 3C are about 20%.

We analyzed whole-rock compositions using XRF in Fuji Tokoha University. The results of the analyses suggest that the essential blocks of Aso-3 are from three distinct magmas. We refer to them as 3A group (SiO2 about 68%), 3B group (63%), and 3C group (52~59%). The essential blocks of 3A group are aphyric pumices in 3A and 3B. Those of 3B group are black parts in aphyric banded pumices in 3A and 3B, aphyric scoria in 3B, and obsidian blocks in 3B. Those of 3C group are porphyritic scoria in 3B and 3C.

3A deposit contains the blocks of 3B group, and 3B deposit contains the block of 3C group. These suggest that Aso-3 activity is the eruption from a 3-layered magma chamber where magmas increase in silica from bottom to top, and that the magmas in the stratified magma chamber were tapped from the top with mechanical mixing at the boundaries of the magmas.

We test if the compositional variation of the magmas of Aso-3 can be explained by fractional crystallization on the basis of mass balance. Whole-rock compositions of 3A group can be explained by fractionation of several percent of crystals, plagioclase, orthopyroxene, clinopyroxene, magnetite, and ilmenite from the 3B group magma. The origin of 3B group can be explained by the same manner from the 3C group magma with the highest silica. On the other hand, the compositional variation in 3C group cannot be explained by simple fractionation but requires complicated processes that subtraction of plagioclase and orthopyroxene and addition of clinopyroxene occur simultaneously. Now we carry on the isotope analyses to investigate if the relationships that can be explained by fractional crystallization are consistent with the isotope data and how an external material such as the crust melt contributed.