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Chemical variation of phenocrysts and their inclusions, and origin of volatile components in the Aira felsic magma

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The following points will be presented: 1. vertical variations of phenocrysts and their inclusions, based on stratigraphy of the Osumi pumice fall deposit; 2. CNS variation of sedimentary contact metamorphic rocks from the Shimanto basement and xenoliths in the Osumi pumice fall deposit; 3. discussion of the cause of the catastrophic eruption.

1. 1) Two cycles of variation of minimum SiO_2 contents of glass inclusions are recognized in the pumice fall sequence. SiO_2 contents of the lower layer of the sequence range from 78 wt% to 75 wt%, whereas those of the upper layer are 78 wt% to 75 wt%. This trend is consistent with the vertical variation of bulk pumice chemistry reported by Tsukui and Aramaki (1990).

2) S contents in glass inclusions are also high in the upper part of each layer, at 900 ppm and 1200 ppm, respectively.

3) The upper part of the pumice fall sequence exhibits abnormal characteristics, namely: (a) although maximum Mg/(Mg+Fe) values of orthopyroxene phenocrysts in other layers are less than 0.53, those in the upper part of the layer range up to 0.57; (b) ratios of quartz and plagioclase with glass inclusions to those without such inclusions are very high, up to 40% of total felsic phenocrysts, compared with 30% in the other horizons. Glass inclusions containing fluid or bubbles are also dominant (about 50%), whereas those in the other layers are about 20%. (c) F and S contents in the glass inclusions are very high, up to 1.4 wt% and 1200 ppm, respectively.

4) Ratios of phenocrysts with glass inclusions to those without inclusions differ layer by layer. The following general tendency is recognized: glass inclusions are most dominant in orthopyroxene phenocrysts (20 - 60% ; average about 40%); subordinate in plagioclase phenocrysts (20-50%; average 30%); and scarcest in quartz phenocrysts (17 to 45%; average 25%).

Sawada et al. (2007) argued that the volatile components in the Aira felsic magma were mainly derived from surrounding Shimanto Belt sedimentary rock basement, based on D13C=-24 to -31 per mil; high concentrations of F and S in glass inclusions; the presence of F-apatite, pyrite, corundum and carbonaceous matter with high B contents as inclusions in phenocrysts; and background of geology and petrology. C and S concentrations in Shimanto pelites show the following tendency with increasing thermal metamorphism: C contents change little from low grade metamorphic rocks to cordierite hornfels (about 0.90 to 0.80 wt%), but decrease abruptly in migmatite (0.10 wt%). In contrast, sulfur concentrations decrease sharply from the lower grade rocks through cordierite hornfels to migmatites (0.45 wt%, 0.15 wt%, to 0.02 wt%, respectively). The volume of volatile components derived from the Shimanto metasediments added to the Aira felsic magma can be estimated based on maximum sulfur contents in glass inclusions and the varying concentrations with increasing metamorphic grade. The volatile components from sedimentary rocks only one- quarter of the volume of the Aira felsic magma are required to produce the maximum sulfur concentration in the magma.

The felsic magma supplying the Aira pyroclastics interacted strongly with surrounding Shimanto Belt sedimentary rocks during magma stoping and subsequent storage in the magma reservoir. This occurred without or with minor contribution of siliceous melt from sedimentary rocks, based on the isotopic composition of pumice of 87Sr/86Sr=0.706 and DNd= -5.62 to -4.10 (Arakawa et al., 1998). Although concentrations of the volatile components in glass inclusions in the upper part are greater than those in the lower part, some glass inclusions in the lower part are vesiculated. This suggests that the lower part of the magma reservoir was also oversaturated with respect to volatiles. The felsic magma was thus oversaturated in volatiles in both the upper and lower parts of the magma reservoir. Magma bumping and catastrophic eruptions then took place.