Fragmentation and hybridization of magma inferred from essential materials in Aso-4 pyroclastics, SW Japan

Michiaki Imaizumi[1]; Yoshihiro Sawada[2]

[1] Fac. Sci. & Engin., Shimane Univ.; [2] Geoscience, Shimane Univ

[How do catastrophic eruptions and magma mixing take place?] are important questions in volcanology. In this paper we present a key to solve these problems, using the huge Aso-4 pyroclastic eruption as an example. Our work is based on geology, petrography, and mineral and glass chemistry of essential materials (pumice and fiamme).

The results are summarized as follows:

1. A 42m drillcore section of Aso-4 pyroclastic flow deposits contains pumice clasts with differing chemical compositions, and also banded pumice clasts. The pyroclastic flow deposit is welded in its lower part and non-welded in the upper part. The bottom third is densely welded and contains abundant fiammes. The pumices and fiammes contain phenocrysts of plagioclase, common hornblende, orthopyroxene, clinopyroxene and Fe-Ti oxides. These phases also occur as inclusions of the phenocrysts, as do glass and apatite. Dark brown pumices contain many more mafic phenocrysts than do grey-brown pumices. Mg-values [100xMg/(Mg+Fe)] of phenocrysts of common hornblende, orthopyroxene, clinopyroxene are 61-75, 61-77 and 66-79, respectively. A corundum grain (about 30um) was also found in pumice.

2. Ranges of major element abundances in bulk pumices and fiammes are: SiO2=62-71 wt%, Al2O3=16-19 wt%, TiO2=0.5-0.8wt%, total Fe2O3=2.3-5.7 wt%, MgO=0.5-1.7 wt%, CaO=1.6-4.5 wt%, Na2O=3.5-3.9 wt%, and K2O=2.6-4.7 wt%.

3.There are four differing occurrences and compositions of glass in fiammes, pumices and inclusions. 3-1) Groundmass glass with fine layers of differing compositions, 5-100um wide and more than a few mm long. SiO2 contents are 67-82 wt%, with systematic variation of the other major elements. 3-2) Groundmass glass containing spheres 20-40um in diameter. These spheres are half-filled with glass, and the other half is void. Si, Al and Na contents are higher than those of surrounding glass. 3-3) Host fiammes with small-scale lenticular vesicular glasses. Bubbles in the glass lenses are a few to 20um in size. SiO2 content of the small-scale glass lenses is around 73 wt%, similar to surrounding matrix glasses. 3-4) Glass inclusions in phenocrysts. These have SiO2 contents of 62-80 wt%, but concentrations are influenced by the host phenocrysts.

Kaneko et al. (2007) proposed a stratified magma chamber model for the Aso-4 pyroclastic eruptions, consisting of mafic, hybrid and felsic layers from bottom to top. Our results show that the magma composition of Aso-4 pyroclastic eruptions is variable, supporting Kaneko et al.'s model. Two interpretations from the results of 3) are proposed: (A) erupted magma involved and elongated previously solidified glass with different compositions existing in the conduit or basement, and (B) magma was injected into magma of different compositions, and vesiculation, fragmentation and hybridization the occurred. Model (A) does not explain the features described in 3-1), especially the presence of many thin layers (a few ten um order) with differing compositions. We conclude that input of mafic magma into felsic magma plays an important role in huge catastrophic pyroclastic eruptions, and vesiculation and fragmentation caused by input of different magmas also play an important role for magma hybridization.