Crust fusion model for the generation of magmas from Aso volcano

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Post-caldera activity of Aso volcano (for 9ka) is characterized by the dispersed extrusions of lavas showing a wide compositional variation (Ono and Watanabe, 1985).

This activity contrasts with preceding caldera-forming large plinian eruptions, and cast an interesting problem of finding contrasting magmatic generation models for caldera-forming and post-caldera activities for Aso volcano.

Major element data show five compositional groups in the post-caldera products that also correspond to different petrographical characteristics. 1. bt-opx-cpx rhyolite, 2. opx-cpx dacite, 3. aphylic opx-cpx andesite, 4. porphyritic opx-cpx andesite, 5. ol-opx-cpx basalt, basaltic andesite.

In Harker and other diagrams, no continuous differentiation trends are found between these five groups. Trace element spidargrams (normalized by n-MORB values) of post-caldera rhyolite, dacites, andesites, and basalts show nearly identical shapes. This shows that compositions of source materials of all post-caldera products are similar. No difference in such patterns are found between post-caldera products and caldera-forming pyroclastic products; thus the magma feeding system for Aso volcano has supplied magmas derived from the similar source. Petrographical data indicate that mineral assemblage of discrete phenocrysts and glomero-porphyritic phenocrysts are similar in all lavas. Mingling textures, irregular shaped plagioclases and enclosed glass parts are well observed in rhyolites, dacites, and andesites. Almost all phenocrysts are not euhedral. Mineral composition data analyzed by SEM-EDS indicate that all phenocryst-sized pyroxenes are in disequilibrium with host rock. Temperatures estimated by pyroxene thermometers are in narrow range, from 950 to 1100 degree regardless of compositions of lavas. Petrographical data as well as compositional variation observed for Aso magmas suggest neither continuous differentiation of magmas in the static chamber nor magmas originating from source materials with different compositions.

When Fe-Mg exchange reactions between melt and Fe-Mg phases are considered, early all phenocryst-sized pyroxenes are probably xenocrysts. Thus all estimated temperatures may not show pre-eruptive temperatures of magma. Petrographical observations indicate magma mixing or mingling.

We suggest a crustal partial melting model to explain all petrographical data as well as compositional variation of post-caldera lavas, because when different degree of partial melting of gabbroic crust is employed a wide compositional variation of extruding magmas.

According to the thermal model of Takahashi (1986), magmas formed away from the heat source are rhyolitic, whereas those formed closer to the source are more basic. The center of Aso caldera shows the largest negative gravity anomaly (Ono and Watanabe, 1985), and probably corresponds with the center of pre-existing magma reservoir or heat source. Distribution of basalt, andesite, dacite and rhyolite lavas in present Aso seems to fit with model of Takahashi (1986). We interpret that mingling textures, irregular shaped minerals, and glomero-porphyritic minerals seem to be remnants of partial melting processes.

Crustal partial melting seems to be the controlling process to form the compositional variations for post-caldera lavas.