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Anti-fractionation of andesite magmas from Daisen volcano

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INTRODUCTION

Tsukui (1985) studied chemical compositions of phenocrysts in the member of the Upper tephra Group (the last 150000 years) of Daisen volcano in detail. He showed that magmatic temperatures estimated by the Fe-Ti oxide geothermometer change cyclically and go back and forth from 850 to 950C, 2.5 times during 150000 years. In the meantime, although Daisen volcano has previously been considered to consist of only dacites, olivine tholeiites at the western foot of Daisen volcano, which have typical arc trace element signatures, must now be interpreted to be members of the Daisen volcanic suite (Tamura et al., 2000). Daisen volcano is a volcanic complex, consisting of clustered and overlapping lava domes and associated lava flows and pyroclastic flows. Most peaks are dacitic and andesitic in composition. Here we propose that petrological features of many aphyric andesites and porphyritic dacite lavas of Daisen volcano during the last 1 million years can be caused by anti-fractionation, which indicate remelting of protolith and repeated heating events. Basalt magmas would be intruded into the base of Daisen volcano before dacite and andesite eruptions, thereby causing remelting and remobilization.

ANDESITE AND DACITE LAVAS OF DAISEN VOLCANO

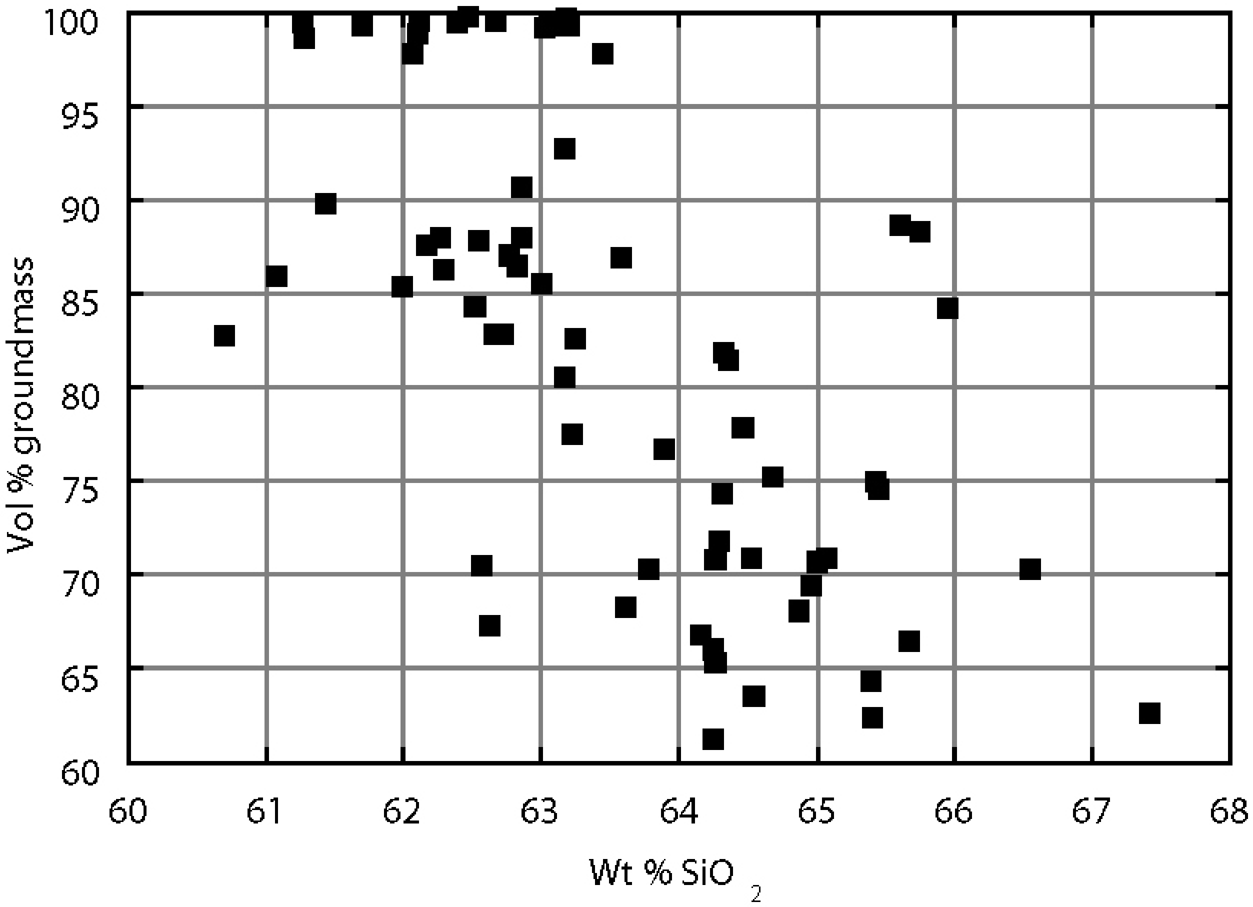
Major and trace elements of lavas were determined by XRF at the Ocean Research Institute, University of Tokyo. Instrumental neutron activation analysis was carried out with the Kyoto University reactor and at the RadioIsotope Centre, Kanazawa University. Microprobe analyses were carried out at Kanazawa University and IFREE. 87Sr/86Sr and 143Nd/144Nd ratios were determined with thermal ionization mass spectrometer at Niigata University. Aphyric andesite and porphyritic dacite lavas from Daisen volcano have similar 87Sr/86Sr (0.7045-0.7052) and 143Nd/144Nd (0.5127~0.5128). The eruption ages of the aphyric andesites lie within those of the porphyritic dacites(Tsukui et al, 1985). These lines of evidence suggest that aphyric andesites are also members of Daisen volcanic suite. The volcanism of Daisen volcano is, however, strictly bimodal, having a compositional gap between 52 and 60 wt. % SiO2.

Aphyric andesites (100-97 vol. % groundmass) have SiO2 contents ranging from 61-63.5 wt. %. Highly porphyritic rocks (75-60 vol. % groundmass) are biotite-bearing orthopyroxene hornblende dacite having 64-68 wt. % SiO2. Rocks which have intermediate vol. % groundmass (85-65 %) are clinopyroxene orthopyroxene andesite and dacite.

The highly-porphyritic dacite has the same mineral assemblage with tephras studied by Tsukui (1985), which would have the similar magmatic temperatures (850-950 C). Many orthopyroxene phenocrysts from most two-pyroxene bearing lava flows have overgrowth rims (up to 50 um) with high Ca content, a feature consistent with crystallization from higher temperature magma than the core. Generally, temperatures of 800-900 C are obtained from the cores, whereas 1000-1100 C are indicated for the rims. Many orthopyroxene phenocrysts do not show normally zoned patterns in terms of Mg#. The zoning patterns of Wo and Mg#, however, do not necessarily correlate with each other.

Texture of phenocrysts and vol. % phenocrysts are related to each other. Phenocrysts of hornblende and plagioclase in highly porphyritic dacites are mostly unaltered, clear and euhedral. On the other hand, phenocryst-poor rocks are characterised by opacite, by which hornblendes are pseudomorphed, and resorbed plagioclases. Clinopyroxene phenocrysts, which are relatively, minor in volume, if any, seems to appear after hornblendes are completely pseudomorphed by opacite.

We suggest that a two stage process, involving mid-crustal solidification of calc-alkaline magmas followed by partial melting related to reheating by subjacent, basaltic magmas, would generate melt and magmatic trends and zoning patterns of phenocrysts in the Daisen volcano.



Plots of vol % groundmass against wt % SiO_2 . Mode (vol %) of phenocrysts based on 4000-5000 points counts. Melt fraction (vol % groundmass) increases as SiO_2 decreases.