Estimation of H2O content in frontal arc basalt using melt inclusions hosted by Ca-rich plagioclase

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Quantifying H_2O content of island arc basalt, especially that of island arc tholeiite at volcanic front, is fundamental in understanding generation and differentiation of magma at island arc settings. Origin of Ca-rich plagioclase, which is commonly observed in island arc tholeiite, have been attributed to crystallization of hydrous and/or Ca-rich basalt. In this study, melt inclusions from Izu-Oshima volcano were analyzed to constrain H_2O content and chemical composition of island arc tholeiite that crystallized Ca-rich plagioclase.

The studied melt inclusions were mostly hosted by plagioclase taken from the summit eruption of basaltic scoriae of the Izu-Oshima 1986 eruption. In order to obtain less differentiated melt inclusions, melt inclusions hosted by olivine and plagioclase in the scoriae of the Older Oshima Group (˜10,000 y.B.P.) were also studied.

Composition of plagioclase ranges from An_{83}-An_{95}. The melt inclusions show wide range of composition suggesting that the melt inclusions represent various stages of crystallization differentiation at Izu-Oshima volcano. Ca/Na ratios of plagioclase-hosted melt inclusions without overgrowth correction range from 2.2-3.4, which are comparable with compositions of aphyric lava and denies exotic origin of Ca-rich plagioclase. H_2O content of the melt inclusions ranges from 0.2-2.4 wt.%.

In this study, Ca/Na partition coefficient between plagioclase and hydrous basaltic melt was also developed empirically as a function of temperature, pressure, Al/Si molar ratio of the melt, and H_2O content in melt based on melting experiments in the literatures and present study. Applying the developed plagioclase-melt equilibria to the host plagioclase-melt inclusion pairs, dissolution of variable H_2O content ranging from 3-6 wt.% H2O in melt is required, which is more than the analytical H_2O content (0.2-2.4 wt.%). The lower H_2O content of the analyzed melt inclusions is probably due to the leak of volatiles through the host crystal during decompression, eruption and quench, and variation in estimated H_2O content in melt at the time of crystallization of plagioclase (3-6 wt.%) is probably due to polybaric crystallization from H_2O-saturated melt.