Evolution of the magma plumbing system in Niijima volcano, Izu islands

Kana Yoshiki[1]; # Michihiko Nakamura[1]; Yuki Suzuki[1]; Takeyoshi Yoshida[2]; Yoshitaka Nagahashi[3]

[1] Inst. Mineral. Petrol. Econ. Geol., Tohoku Univ.; [2] Inst.Min.Petr.Econ.Geol., Tohoku Univ.; [3] Fukushima Univ.

The Niijima volcano locates at the northern tip of Izu-Mariana arc. More than twelve rhyolitic, one or two andesitic, and one basaltic monogenetic volcano compose the main volcanic edifice. The latest eruption occurred in A.D. 886 and present-day formed Mukaiyama lava dome. In this study, we have carried out a petrological study on the rhyolitic eruptive materials in order to understand the magma feeding system of the Niijima volcano.

Rock samples were collected from eight rhyolitic volcanoes formed in the last 50,000 years (Setoyama (ST), Ooiso (OI), Jina-kayama (JN), Akasakimine (AZ), Miyatukayama (MT), Niijimayama (NJ), Attiyama (AT), and Mukaiyama (MY)). The assemblages and solid-solution compositions of ferromagnesian phenocryst in these lavas systematically change with eruption sequence; cummingtonite (˜AZ; Cum-magma), cummingotnite + biotite (˜NJ; Cum+Bt-magma) and biotite (Bt-magma). However, two lines of evidences show that these magmas do not represent a simple fractionation series.

Firstly, two district trends and / or compositional gaps were observed between Cum- magma (77.5˜75 wt.% SiO2) and Bt-magma (79˜78 wt.% SiO2) for whole rock composition. Mass balance calculation and Rayleigh crystal fractionation modeling cannot explain the difference in composition between Cum- and Bt- magmas.

Secondly, the petrographic and geochemical characteristics observed in Cum+Bt-magma, such as wide range of Mg# of Cum and Bt, wide range of core An content of plagioclase (Pl) covering those in the Cum- and Bt- magmas, Mg/Mn ratio of magnetite(Mt) , and reverse zoning only of low-An-core Pl suggest that Cum+Bt-magma was formed by mixing between Cum- and Bt- magmas. Cum+Bt-magma may have had a considerable residence times prior to eruption after the mixing, because Fe-Ti oxide phenocrysts do not have prominent reverse zoning. Whole rock compositions of Cum+Bt-magma show linear trends between Cum- and Bt- magmas in some SiO2-variation diagrams. These observations support the mixing origin of Cum+ Bt-magma.

The major and trace elements compatible for plagioclase (Ca, Na, Al, Sr and Ba) show remarkable gaps between Cum- and Bt-magmas, which suggests that fractionation of plagioclase in the Cum- and Bt-magmas occurred under different PH2O. Reaction relation between Cum and Bt, as suggested by Evans and Ghiorso (1995), cannot related the two magmas directly, although the gap in Y and Nb concentration is favorable to the reaction relation model.

A cummingtonite crystal having thick Bt reaction rim was found in NJ (Cum+Bt-magma). The relic Cum is richer in Al2O3 than regular cum phenocrysts, suggesting that the reaction relation has proceeded in greater depth than crystallization of present phenocrysts. Given this findings, I propose a two-level magma chamber model as follows which best explains the eruption sequence, whole rock and mineral composition variation of the two magmas. In a deeper cooling magma chamber, fractional crystallization of a parental magma occurred from proto-Cum-magma to proto-Bt-magma via reaction relation involving cumulate cummingtonite crystals. The present Cum- and Bt- magmas were formed by fractional crystallization from aphyric rhyolite magmas segregated from proto-Cum- and then proto-Bt- magmas, respectively, in shallow-level discrete magma chambers with different PH2O.