Petrological constraints on magma plumbing system beneath Izu-Oshima volcano

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[Introduction]
During the past 1,500 years, Izu-Oshima volcano, a frontal-arc volcano in the Izu arc, has experienced 12 major eruptions with an average interval of 100 to 150 years. Among them, three eruptions during 50 years in the 9th century could be linked to a huge earthquake and/or regional tectonics at that time. Since the 19th century, smaller scale eruptions have been occurring with an average interval of 30 to 40 years. Thirty years have passed since the last eruptions in 1986~1987; therefore, the next eruption may be coming soon. However, we are not sure whether it might be triggered by an aftereffect of the huge earthquake on March 11th, 2011. Here, we review the magma plumbing system beneath Izu-Oshima volcano based on petrological studies, which will be useful for volcanologists to deal with the next eruption.
[Geochemical variation of volcanic rocks]
Two endmember trends, referred to here as a higher-Al/Si trend and a lower-Al/Si trend, can be distinguished among the aphyric volcanic rocks, which represent the liquids of Izu-Oshima volcano. The liquids are bracketed by these two endmember trends, and thus may be mixtures of the two endmembers or may have been derived under intermediate conditions between those responsible for these two endmembers. An experimental study by Hamada and Fujii (2008) suggests that the higher-Al/Si and lower-Al/Si trends can be reproduced by upper crustal crystallization differentiation of high-Mg basalt under moderately hydrous (~3 wt% H_2O) and almost dry conditions, respectively.
[Hydrous melting experiments]
Island arc low-K tholeiite magma is characterized by the presence of Ca-rich plagioclase (An≥90), with a Ca-poor rim (~An75). Hydrous melting experiments on two volcanic rocks from Izu-Oshima volcano, MA43 and MA44 (MgO~5 wt%), were conducted to constrain the origin of Ca-rich plagioclase (Hamada and Fujii, 2007). MA43 and MA44 represent less differentiated liquid compositions in the higher-Al/Si and lower-Al/Si trends, respectively. The hydrous melting experiments were conducted at 250 MPa using an internally-heated pressure vessel. In the melting experiments on MA43, plagioclase crystallized as the liquidus phase at all H_2O content (1~6 wt% H_2O) and the crystallization temperature of plagioclase was linearly suppressed, and anorthite content of the plagioclase increased from ~An80 under nearly dry conditions to An≥90 with ~6 wt% H_2O. In the melting experiments on MA44, plagioclase crystallized as the liquidus phase under low-H_2O (≤2 wt%) conditions, but augite replaced plagioclase as the liquidus phase with more H_2O in melt. Anorthite content of plagioclase increased from about An70 under nearly dry conditions to An80 with ~4 wt% H_2O. Increases in anorthite content of plagioclase crystallized from the MA44 melt were suppressed compared with plagioclase crystallized from the MA43 melt. In short, Ca-rich plagioclase (An≥90) can be crystallized from melts on the higher-Al/Si trend with ≥3 wt% H_2O, but cannot be crystallized from melts on the lower-Al/Si trend with any H_2O. The Ca-poor rim (~An75) cannot be crystallized from melts on the higher-Al/Si trend, but can be crystallized from melts on the lower-Al/Si trend.
[Summary]
Geochemical variations in the liquids from Izu-Oshima volcano are bracketed by two endmember trends, the higher-Al/Si and the lower-Al/Si trends. The origins of these trends can be explained by crystallization differentiation under moderately hydrous conditions (~3 wt% H_2O) and almost dry

conditions, respectively. We propose that polybaric crystallization of H_2O-saturated melts, at a depth range between the ~4-km-deep magma chamber (~3 wt% H_2O) and near the surface level (nearly dry), proceeds beneath Izu-Oshima volcano.

Keywords: Izu-Oshima volcano, Magma plumbing system, Experimental petrology

