Origin of composition correlation between plagioclase phenocryst and groundmass in basalt lava of Aogashima Volcano

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If volcanic rocks from one arc have common petrologic and petrographic features, they may reflect the essential process controlling the arc volcanism. The Izu arc is a volcanic island arc related to the subduction of the pacific plate beneath the Philippine Sea plate. Volcanic rocks from frontal volcanoes of the Izu arc show characteristic features. The most remarkable feature is the strong Fe-enrichment in the whole-rock compositional trend, which is often used to define a tholeiitic trend (Miyashiro, 1974). At the same time, some rocks from the Izu arc volcanoes contain abundant plagioclase phenocrysts that are not in equilibrium with their groundmass. These two features are probably closely related with each other. It is, therefore, important to clarify the origin of plagioclase phenocrysts to understand the characteristic tholeiitic trend. In this study, correlation between MgO content of plagioclase and FeO*/MgO of its groundmass, one of key observation to understand the origin of plagioclase is critically examined

The volcanic rocks from Aogashima Volcano in the Izu arc contain abundant (~40vol %) calcic plagioclase phenocrysts. Their anorthite (An) content ranges from 70 to 97 at the core, but the cores are mostly not in equilibrium with their groundmass. From extensive BEI observation and EPMA analysis, it is clarified that the zoning pattern of An contents in each plagioclase phenocryst is very complicated, suggesting repeated stages of growth and/or dissolution. On the contrary, the MgO content in plagioclase for the same An contents shows a negative correlation with the FeO*/MgO of its groundmass. Samples with lower FeO*/MgO groundmass contain plagioclase phenocrysts with higher MgO content. Both tight and diffuse negative correlations between MgO and An for plagioclase phenocrysts are noticed. The correlation between the MgO content and groundmass FeO*/MgO suggests a genetic link between the groundmass melt and plagioclase phenocrysts, although they are not in equilibrium in terms of Ca-Na partitioning. The strong correlation between MgO and An# of plagioclase phenocrysts, on the contrary, may suggest that rapid diffusion of MgO in plagioclase promote effective exchange of MgO with the groundmass melt resulting in strong control on the MgO contents by An. This is because partition coefficient of MgO between plagioclase and melt depend on An-contents of plagioclase (Blundy and Wood, 1994). Because several basalts show a diffuse MgO-An# correlation, these effects of diffusion must be evaluated.

Aiming at this assessment which does not suggest rapid MgO exchange with groundmass melt, annealing experiments of plagioclase were carried out. Plagioclase phenocrysts in two samples from Aogashima Volcano were chosen for the experiments; 10302 with strongly correlated and 244 with weak and scattered correlate. Plagioclase with 125-250um in size were heated on the Pt mesh at condition of 1330 C for 120h. The fO2 was buffered at NNO by CO2 and H2O gas mixture. The results show that the FeO* content in each plagioclase grains shows parabolic zoning, which is attributable to absorption by Pt mesh. The MgO content varies complementarily to the FeO* content, suggesting fairly rapid diffusion of MgO as measured by LaTourrette and Wasserburg (1998).

The experiments show that diffusional exchange of MgO between plagioclase and melt is expected to be quite effective, and samples with tight correlation between MgO and An contents may be explained by long residence with the groundmass melt. The fact that even samples with weak MgO-An# correlation show a good correlation between the MgO contents in plagioclase and groundmass FeO*/MgO suggests that the plagioclase phenocrysts and groundmass may have been genetically linked before the exchange of MgO with groundmass melt modified the MgO content in most of plagioclase phenocrysts.