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Zoning pattern analyses of plagioclase phenocrysts in Fuji-Jogan magma; constraints on pre-eruptive magma process

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Jogan eruption occurred at 864-866 at northwest flank in the largest historical eruption of Fuji Volcano. During the eruption, more than 1.3km3 of relatively homogeneous differentiated basaltic lava was effused. In addition, most of the lava was effused in the first two month of the eruption duration, indicating contribution of large magma reservoir. Our interest is in the pre-eruption processes in its magma reservoir.

Plagioclase composition sensitively depends on coexisting melt compositions, melt water content, temperature and pressure. In addition, compositional zonation is not significantly modified due to slow CaAl-NaSi diffusion in plagioclase. These characteristics allow us to decipher magma processes such as crystallization, magma mixing and eruption from compositional zonation of plagioclase phenocrysts. In this study, we focused on compositional zoning patterns of plagioclase phenocrysts in the Jogan basaltic rocks to decipher pre- eruption processes the magma experienced in its reservoir

In this study, plagioclase phenocrysts in two basaltic ejecta, Nagaoyama lava and Nagaoyama scoria, are investigated. BSE images were acquired for 187 and 87 plagioclase phenocrysts in Nagaoyama lava and Nagaoyama scoria, respectively, by using SEM at Michibayashi lab., Shizuoka University. We classified plagioclase phenocrysts into five groups based on gray scale intensity zoning patterns. In addition, chemical analyses were done for representative grains by using EPMA (JEOL 8800R) at Earthquake Research institute, University of Tokyo.

Comparison of BSE image and compositional map indicates that An content [=Ca/(Ca+Na]] is responsible for gray scale intensity in BSE images. Plagioclase phenocrysts in Jogan basalt are classified into the following five groups; (A) normally zoned grains with An-rich homogeneous core, (B) grains showing narrow, strong reverse zoning at boundary between An-poor core and normally zoned rim, (C) oscillatory zoned grains, (D) grains with irregular zoning pattern, and (E) homogeneous grains. Type D and E grains are rare and Type B grains are most abundant. We cannot find grain with reverse zoned rim. Core of type A grain shows An content higher than that observed in any part of type-B grain. Wavy boundary and alignment of melt inclusions are observed at core-rim boundary in type B plagioclase.

Monotonous crystal growth explains normal zonation shown in Type A phenocrysts. Magma mixing is required to explain zoning pattern in type B grains; An-poor homogeneous plagioclase was once melted by magma mixing and then overgrown with An-rich composition to form Type B phenocrysts. Textures observed at core-rim boundary is consistent with this interpretation. Repeated magma mixing and crystallization formed type-C grains. Presence of oscillatory zoned plagioclase indicates that magma replenishment, crystallization, crystal fractionation and eruption have been repeated in this magma reservoir. With considering high effusion rate of basaltic magma in the 864-866 eruption, the reservoir was one of main long-lived ones in Fuji Volcano. Normal zoned rim parts observed in most of plagioclase phenocrysts were interpreted to form during eruption because no discontinuity in zoning pattern is observed in this parts. In type B plagioclase, the rim part is neighboring with reverse zoned part formed by magma mixing, suggesting that eruption occurred right after magma mixing.

Keywords: Fuji volcano, plagioclase, Compositional zoning, magma chamber, Jogan eruption