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Morphology of microlite -projections of plagioclase microlite-

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At Tokachi-Ishizawa (TI) rhyolite lava, Shirataki, Hokkaido, northern part of Japan, the interior structure transition can be observed, from the outer obsidian layer to the inner rhyolite layer. Thus TI lava is an appropriate target field for correlating textural characteristics with lava interior structure. In order to obtain insights into the magma ascent and outgassing process of viscous magma, we have analyzed oxide microlites of TI rhyolite lava, suggesting that dominant outgassing process is ductile permeable development (Sano et al.,2013 JpGU meeting). However, we have not examined the morphology of microlite. Morphology of crystal is considered to reflect the effective undercooling of the melt and provide the constraint for ascent process and water exsolution processes. In this study, we focused on the morphology of microlites, especially projections of plagioclase microlites. The projections mean localized growth of crystal from plagioclase surface.

In Shirataki, aphyric rhyolite lavas erupted ca. 2.2Ma and composed of 10 flow units. The TI lava is about 50 m in height and stratigraphic sequences from the bottom are a obsidian layer region, a boundary bounded region of obsidian and rhyolite, and rhyolite layer region. The obsidian layer region consists of a single vesicle-free obsidian about 7 m high. The rhyolite layer region consists of rhyolite layers with variable vesicularity, crystallinity and characteristic scales in layer thickness. The boundary banded region, which is located between the obsidian and rhyolite regions, consists of thin obsidian ($<$10mm in width) and rhyolite. In this study, we define the obsidian and rhyolite based on the differences in appearance of hand specimens and rock texture. Rhyolite has perlitic cracks in the glass and contains some amounts of crystalline materials, namely, spherulite and lithophysae. In boundary banded region, the fraction of obsidian decreases toward rhyolite layer region.

From the examination by scanning electron microscope (SEM) for thin sections from obsidian layer region, boundary banded region and rhyolite layer region, we found the projection texture in all samples. We measured projection length and number density (Nv) of plagioclase microlites for obsidian and rhyolite layer regions. The measurement results show that plagioclase microlites in obsidian and rhyolite layer regions indicate the similar number density. Nv for obsidian layer region is $1.8\times10^{11} - 3.5\times10^{11}$ [/m^3] and $8.2\times10^{10} - 3.0\times10^{11}$ [/m^3] for rhyolite layer region, respectively. However, the length of projection is remarkably different between two regions. The mean values are 2.3 μm in obsidian layer region, and 8.7 μm in rhyolite layer region. The transition of mean length can be observed in boundary layer region.

Since the difference of projection length reflects the growth rate (G [m/s]) and growth time (t [s]) according to the theory of crystal growth (Keith and Padden, 1963; Lofgren, 1971; Rao, 2002), we can estimate the degree of effective undercooling at the formation time of projections. Under the assumption that G is constant for the time, the length of projection can be given by Gdt. Assuming the constant growth rate and growth time, the difference in projection lengths indicate that in growth rate, namely, the undercooling. Using experimental values for growth rate and undercooling, it is found that the rhyolite layer region experiences higher undercooling than obsidian layer region by $30 - 70$ K. The projection can be formed after the nucleation of plagioclase microlite, which indicate the similar number density in obsidian and rhyolite layer region. Thus projections reflect the different undercooling after the nucleation of microlites. Based on the quantitative analysis of crystal morphology of microlites, we can obtain the insights into the magma ascent process that rhyolite layer region experienced higher undercooling than obsidian layer region.

Keywords: textural analysis, obsidian, rhyolite, lava, Shirataki