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組織解析から見る北海道白滝，十勝石沢黒曜石溶岩のマグマ上昇過程
Magma ascent process inferred from textural analysis in Tokachi-Ishizawa obsidian lava, northern Hokkaido, Japan

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Formation process of obsidian is poorly understood, while it is thought that gas loss (outgassing) plays an important role. Glass formation needs the high-effective supercooling resulted from a high ascent and decompression rates. However the high-effective supercooling increases magma viscosity, so the rapid ascending process of such a highly viscous magma is an enigma. In this study, we conducted textural and chemical analyses for Tokachi-Ishizawa (TI) obsidian lava, one of Shirataki rhyolite lava, Hokkaido, northern part of Japan, in order to elucidate the magma ascent and outgassing process, and obtain clues to solve the problem.

In Shirataki rhyolite lava area there are monogenetic volcanoes composed of 10 obsidian lava flow units, which were erupted at 2.2Ma. Rhyolite lava area with well-exposed outcrops allow us to observe the internal structure of obsidian lava flow. The stratigraphic sequence of TI lava 50 m in height is a brecciated perlite layer, obsidian layer (7m), banded obsidian layer, and rhyolite layer from the bottom. It is uncertain that brecciated perlite layer is essential. In this study, we define the obsidian and rhyolite based on the difference in appearance of specimen and rock texture, especially crystallinity. Rhyolite has perlitic cracks on glass, and contain the crystalline materials (i.e. spherulite and lithophysae). Banded obsidian layer which is located at the boundary between the obsidian and rhyolite layer, is composed of fine layer of obsidian and rhyolite. Volume fraction of the crystalline materials in rhyolite layer is up to 40 vol.%.

Obsidian in TI lava is almost aphyric, composed of glass (>98 % in volume), rare plagioclase phenocrysts, plagioclase microlites, magnetite microphenocrysts, oxide microlite, and rare biotite. The nanoscale crystals in obsidian glass are identified as plagioclase, based on transmission electron microscope (TEM) and field emission scanning electron microscopy (FE-SEM). This type of crystals forms microscopic layering structure in obsidian glass.

Chemical compositions of obsidian glass, plagioclase and magnetite were analyzed by electron microprobe (EPMA). Water content in obsidian glass was determined by Karl Fischer Titration (0.5-0.6 wt.%).

The maximum depth of magma chamber is estimated as $<$300MPa from the rhyolite-MELTS (Gualda et al., 2012) and petrographic characteristics. Magmatic temperature is calculated as T= 800-820 [deg C] from the plagioclase-melt geothermometer (Putirca, 2005). Magma viscosity is estimated as 4.9-8.7 [log Pa s] (Giordano et al., 2008).

We measured length, width and number of oxide microlite based on three-dimensional measuring method (Castro et al. 2003), and oxide microlite number density (N_v [/m^3]) was obtained. From N_v value of oxide microlite, 10^{13}-10^{14}, and glass chemical compositions, water exsolution rate and ascent rate are inferred as 10^{-8}-10^{-7} [wt.%/s], and 10^{-5}-10^{-4} [m/s] respectively (Toramaru et al., 2008). These results means that obsidian and rhyolite experienced the same degassing rate, that is, ascent rate. This provides a constraint on the formation process of obsidian.

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