

## Hydration processes of volcanic glass under the super-critical condition

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### (1) Introduction

In a volcanic eruption processes, behavior of the volatile phase released from magma is one of a primary factor to determine magma pressure in the eruption. At high temperature and pressure, super-critical water interact with rocks and minerals surrounding magma, such as leaching, alteration and precipitation in dissipation processes. Kinetics of interactions between rocks and super-critical fluid with excess pressure is a fundamental clue to hydrothermal processes in the early stage of the volcanic eruptions. In this study, hydration experiments of a volcanic glass under the super-critical conditions are carried out to elucidate initial processes of hydrothermal alteration.

Starting material of the experiments is obsidian collected from Haneyama welded tuff, Oguni, Kumamoto prefecture. Cubes with 3mm in dimension are cut from obsidian. An obsidian cube is washed and sealed in silver capsule distilled water. Experimental conditions are as follows; starting material:water ratio; 1:1, temperature; 400-550 C, pressure; 25-75 MPa, run duration; 24-168 hours. Run products are cut and observed by SEM and micro-FTIR.

### (2) Hydration processes of volcanic glass

Hydrated layers were found in shallow part of the all run products. The hydrated layer is observed with darker density of the layer in backscattered electron imaging than that of central region. The thickness of hydrated layer is approximately proportional to square root of run durations. Therefore, diffusion of water is considered to be rate-determining process of growth of hydrated layers.

Micro FT-IR measurements of selected run products were carried out to analyze depth profile of water content and determine distribution of water species. Molecular H<sub>2</sub>O, OH and total H<sub>2</sub>O concentration profiles indicated that a surface layer of the run products are saturated with molecular H<sub>2</sub>O and OH, respectively. A boundary between hydrated layer and unhydrated central area was observed at the maximum point of total H<sub>2</sub>O concentration gradient.

Apparent diffusion coefficients of H<sub>2</sub>O strongly controlled by saturated surface layer were estimated from the thickness of hydrated layers observed by BEI. Calculated diffusion coefficients were 10e-11~13 m<sup>2</sup>/sec, and these values were larger in one or two orders than that observed dehydration processes of rhyolitic glass by Zhang et al (1991). Activation energy calculated from temperature dependency of the diffusion coefficient was 69+/-11 kJ/mol. It is possible that super-critical water intruding into volcanic glass has high apparent diffusion coefficient by their higher activity than that of water in the rhyolitic glass under the dehydration processes.

Hydration of silicate glass is expressed as H<sub>2</sub>O molecule + O (glass) = 2(OH). Concentration ratios of H<sub>2</sub>O molecule and OH were calculated as dissociation coefficients to express relationship between these two water species under diffusion. Dissociation coefficients were constant from surface of the run products to the maximum point of total H<sub>2</sub>O concentration gradient. Then, the dissociation coefficients decrease and finally increase to the unhydrated region. Decrease of dissociation coefficients indicates that apparent diffusion rate of H<sub>2</sub>O molecule is higher than that of OH. Furthermore, it is suggested that the intrusion rate of H<sub>2</sub>O molecule to network structure of volcanic glass is faster than dissociation rate of H<sub>2</sub>O molecule to OH, that reaction breaks Si-O-Si network and bonds as Si-OH. It is possible that the diffusion processes of super-critical water into volcanic glass were faster than the simple diffusion controlled by concentration gradient of water, because high pressure of water makes intrusion of H<sub>2</sub>O molecule into the structure of volcanic glass.