

## Diffusive kinetic isotope fractionation of water in silicate glasses

KURODA, Minami<sup>1\*</sup>; YAMAMOTO, Daiki<sup>1</sup>; TACHIBANA, Shogo<sup>1</sup>; NAKAMURA, Michihiko<sup>2</sup>; OKUMURA, Satoshi<sup>2</sup>; ASAKI, Miho<sup>2</sup>; ISHIBASHI, Atsuko<sup>1</sup>; SAKAMOTO, Naoya<sup>1</sup>; YURIMOTO, Hisayoshi<sup>1</sup>

<sup>1</sup>Department of Natural History Science, Hokkaido University, <sup>2</sup>Department of Earth Science, Tohoku University

Oversaturation of dissolved volatiles in an ascending magma leads to bubble nucleation and growth, which depend on volatile solubility and diffusivity, and drives explosive volcanic eruptions in the Earth. It is thus important to clarify the behaviors of volatiles in silicate melts in understanding the mechanism and dynamics of volcanic eruptions.

Hydrogen isotopes record the degassing processes of hydrous magmas due to isotopic fractionation between dissolved and exsolved water. The degree of hydrogen isotopic fractionation is correlated with the water content in natural volcanic rock samples; Deuterium is more deficient in water-poor samples, and the degree of D-deficiency increases as the water content decreases. This trend has been interpreted to reflect the transition of degassing model from that in a closed-system to in an open-system. However, these two extreme degassing schemes do not take the diffusive transport of water in magmas into account, which should be included in a realistic degassing model, because the timescale of diffusion is not necessarily negligibly small compared to that of degassing during magma ascent. Moreover, diffusion of water in silicate melts may cause kinetic isotope fractionation between silicate melt and explosive fluid phases because H<sub>2</sub>O is likely to diffuse faster than HDO, of which effect can be overprinted in the D/H ratios of natural samples. The hydrogen isotopic fractionation during water diffusion in silicate melts, however, has not yet been fully determined. In order to determine the isotopic fractionation factor of hydrogen due to water diffusion in silicate melts, we performed diffusion experiments of water in SiO<sub>2</sub> and synthetic rhyolite glasses in a D-enriched system (H/D=10, 5 and 1).

The experiments were performed for SiO<sub>2</sub> and rhyolite glasses at 850 °C and water pressure of 50 bar in sealed silica tubes and at 650 °C and water pressure of 500 and 1000 bar in a hydrothermal furnace developed at Tohoku University. Concentration profiles of H and D in run products were measured with the ion microprobe (Cameca ims-6f at Hokkaido University) to evaluate diffusion coefficients of water (including H<sub>2</sub>O and HDO) in glasses. The obtained diffusivity (a diffusion coefficient divided by a water content) in SiO<sub>2</sub> glass at 650 and 850 °C were consistent with the values reported in previous studies (Davis and Tomozawa, 1995; Berger and Tomozawa, 2003). The D/H ratios along the diffusion profile were also analyzed for SiO<sub>2</sub> glasses with the ion microprobe. The D/H ratio first decreases, but apparently increases along the profile. The decrease of D/H ratio may imply the kinetic isotope fractionation during diffusion. However, the increase of D/H ratio cannot be explained simply by diffusion and may reflect the change of instrumental mass fractionation with water content (Hauri et al., 2006), which should be precisely determined to correct the profile of hydrogen isotopic ratio.

Keywords: eruption dynamics, silicate glass, water, diffusion, hydrogen isotope, isotopic fractionation