Determination on the stable isotopic compositions of water vapor in volcanic plumes

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The fumarolic H_2O occupied more than 80% of volatiles ejected from volcanic fumaroles (volcanic gases). The origin of fumarolic H_2O is either magma (magmatic water) or groundwater (meteoric water). Because of the significant differences in the isotopic ratios (δ D and δ^{18}O) of H_2O between magmatic water and meteoric water, we can differentiate the origins of fumarolic H_2O (magmatic water or meteoric water), if we can determine the isotopic ratios of fumarolic H_2O from those in volcanic plumes during a volcanic eruption. This is extremely useful to clarify the mechanism of each volcanic eruption, magmatic eruption and phreatic eruption.

In this study, we developed a new system to determine the isotopic ratios of H_2O in volcanic plumes by using Cavity Ring-Down Spectroscopic system (CRDS) and applied for the measurements on the plume samples. The samples of a volcanic plume were taken around high temperature (> 700 ˚C) fumaroles in Satsuma-Iwojima volcano. We collected around 15 samples of the volcanic plume into pre-evacuated glass bottles (ca. 500 ml), while changing the distances from a fumarole. Besides, we also collected the fumarolic H_2O through condensation using a cold trap. The isotopic ratios (δ D and δ^{18}O) of plume H_2O showed strong linear correlation (R^2 = 0.75 and 0.78, respectively) with the reciprocal of H_2O concentration. The δ D and δ^{18}O values of the fumarole H_2O estimated from the linear relationships were −16.2 ±10.5 ‰and +4.0 ±1.9 ‰, respectively. Because the values coincided well with those of fumarolic H_2O collected directly at the fumarole (−22.9 ±1.2 ‰and +7.8 ±0.4 ‰, respectively), we concluded that we can apply the present method to determine the stable isotopic ratios of fumarolic H_2O remotely using plume H_2O, and to clarify the mechanisms of each volcanic eruption.
This study was supported by MEXT Scientific Research Program grants "Integrated Program for Next Generation Volcano Research and Human Resource Development ".

Keywords: volcanic gases, stable isotopic compositions, Cavity Ring-Down Spectroscopy