Remote temperature sensing of active fumaroles using hydrogen isotopes of molecular hydrogen in volcanic plumes: Temporal variation in the temperature of fumaroles in Aso volcano

Urumu Tsunogai[1], Daisuke D Komatsu[1], Fumiko Nakagawa[2]

[1]Nagoya University, Japan, [2]Hokkaido University, Japan

E-mail: urumu@nagoya-u.jp

In high-temperature volcanic fumaroles (>400℃), the isotopic composition (δD value) of molecular hydrogen (H_2) reaches equilibrium with that of the fumarolic H_2O under the outlet temperature so that the δD value of fumarolic H_2 is a function of fumarolic temperature. Combining this temperature-dependent variation in δD value of fumarolic H_2 with our high-sensitivity mass spectrometric technique which enable us to deduce the δD value of fumarolic H_2 from trace H_2 in the volcanic plume, we can determine the temperature at volcanic fumaroles remotely. We have applied this methodology (HIReTS: Remote Temperature Sensing using Hydrogen Isotopes) to the volcanic plume emitted from the Crater 1 of Mt. Naka-dake, Aso volcano (Japan), where direct measurement on fumaroles was impractical. The average H_2 concentration of the plume samples (n=12) taken at the crater rim was 1.2 ppm (from 0.54 ppm to 2.3 ppm), while that taken apparently outside the volcanic plume was 0.53 ppm. We estimated that the δD value of the fumarolic H_2 to be –172$\pm$16‰and the outlet temperature to be 868$\pm$97℃ during the first observation in Nov. 2010. While the temperature was much higher than the highest temperature of the fumarolic area determined remotely using a dedicated IR thermometer (ca. 300℃), we concluded that our temperature was a reasonable and reliable estimate of the outlet temperature. Besides, subsequent periodic observations on the same crater using HIReTS revealed ca. 80 ℃ increase in the temperature that was not detected by the IR thermometer. The HIReTS is the reliable method to determine temporal variations in fumarolic temperature remotely.