Hydrothermal System of Atosanupuri Volcano: Modeling by Chemical Composition and Isotope Ratio of Fumarolic Gases

Noriyasu Taira[1]; Takeshi Ohba[2]; Michiko Ohwada[3]; Noritoshi Morikawa[4]; Kohei Kazahaya[5]

[1] V.F.R.C., Titech; [2] Volcanic Fluid Research Center, Tokyo Institute of Technology; [3] Inst. Geol. and Geoinfo., GSJ, AIST; [4] GSJ, AIST; [5] Geol. Surv. Japan, AIST

1. Introduction

In volcanic area, where fumaroles and hot springs are found, hydrothermal system is regularly developed. The high temperature gas from degassing magma undergoes complex processes on the way to the surface. For example, there are mixing with meteoric water at deeper part and shallower part, boiling, condensation, and so on. Atosanupuri volcano is situated at eastern part of Kutcharo caldera in eastern Hokkaido. It has high fumarolic activity and there are many hot springs at the periphery like Kawayu hot spring. Near this volcano, some fumaroles are found at Second Atosanupuri volcano, Ponpon-yama and Wakoto peninsula and so are hot springs.

The aim of this research is to make a model for the hydrothermal system of Atosanupuri volcano from these chemical composition, stable isotope ratio and noble gas composition.

2. Survey and Result

The samples were taken from nine observation points, four samples from Atosanupuri volcano (A), two samples from Second Atosanupuri volcano (S), one sample from Wakoto peninsula (W) and two samples from Ponpon-yama (P), on July 23-25, 2007. The temperature of fumarolic gases varies from 98.6 to 105C except one point, 85.0C, which has huge air contamination. At Atosanupuri volcano, it is 102-105C and it has high fumarolic activity. At the other points, they are 98.6-100C and they have low activity.

For chemical composition, fumarolic gases are mainly composed of CO_2 and H_2S and contain little HCl and SO_2. These could be classified into two types, CO_2-H_2S type and CO_2 type. In addition, composition of R-gases could also be classified into two types; N_2-H_2 type and N_2 type, and contain a little CH_4 and noble gases. On the other hand, stable isotope ratios of these gases are as follows in permil; dD=-120 to -58, d^{18}O=-17.6 to -6.5, d^{13}C=-7.2 to -3.9, d^{34}S=-5.6 to +2.6. The d^{13}C values at Atosanupuri are between -4.3 and -4.0 permil but at the other points, it varies widely. The trends of d^{34}S values are lighter at Atosanupuri and Second Atosanupuri and heavier at Wakoto and Ponpon-yama.

From the correlation among these results, all data points are plotted between meteoric water line (Mizota et al., 1994) and magmatic water. Then, R_H values, a factor which reflects redox condition properly (R_H=log(H_2/H_2O)), varies from -6.9 to -3.8 and it shows linear correlation with H_2S/He ratio. The R_H value increases with decreasing of H_2S/He ratio. However, CH_4/CO_2 ratio remains constant in any R_H values. In these plots, Atosanupuri and Second Atosanupuri have linear correlation but there are gaps with Wakoto peninsular and Ponpon-yama.

3. Discussion

From these results, fumarolic gases found at Atosanupuri and Second Atosanupuri are highly oxidized and have less CH_4, so it is said that they are highly affected by magmatic hydrothermal fluid. On the other hand, Wakoto and Ponpon-yama are far from each other but both gases are more reductive and contain more CH_4. It is typical of geothermal fluid. That model that two different types of fluid coexist is similar to the model proposed by Giggenbach (1987) at White Island. Then, Helium is typical of magma-originated gases and decrease in H_2S/He means the removal of H_2S resulting from movement of hydrothermal fluid. Therefore, from the correlation between RH and H_2S/He ratio, the change in redox condition of fluid arises from reaction of sulfur species.