The formation process of spring water at Kusatsu-Shirane volcano Japan based on the chemical composition of cations

Atsushi Shimizu[1]; Takeshi Ohba[1]

[1] Volcanic Fluid Research Center, Tokyo Institute of Technology

1. Introduction

Among the chemical composition of acidic spring water in volcanic hydrothermal systems, anions such as chloride and sulfate are provided by a degassing magma. Whereas cations in the water are provided by country rocks, and those compositions are affected by the rock composition and subsequent formation of secondary minerals.

In this study, we analyzed chemical composition of the acidic lake water in Yugama crater located on Kusatsu-Shirane volcano, four hot spring waters distributed on the eastern side of the volcano (Kusatsu-Yubatake, Bandaikou, Kagusa Spring and Johfu Spring) and four spring waters on the western side (Manza-Yubatake, Okumanza Spring, Karabuki Spring and Shakunage Spring), in order to investigate the formation process of spring water mainly considering the chemical composition of cations.

2. Result

The temperature of sampled springs was 25 to 95 deg. C. Except Shakunage Spring, the waters were strongly acidic, the pH of which was 1.3 to 3.0. The concentration of cations such as Na, Mg, Al, Fe, Ca were 1 to 300 ppm. The concentrations of SiO2 are 100 to 400 ppm, the variation of which was less than that of above cations.

3. Discussion

The concentration of cations dissolved in thermal water could be decreased by the formation of secondary minerals. We estimate the mass of rock which reacted with thermal water assuming that the Mg concentration in spring water had been hardly affected by formation secondary minerals. We calculated Saturation Index (SI) to verify the formation of secondary minerals such as Pyrite, Alunite, Gypsum and Silica

i) Yugama, Kagusa Spring

It was estimated that the Mg concentration was equivalent if 10 and 45g of rock was dissolved in 1 kg water at Yugama and Kagusa Spring, respectively. Although the estimated amount of rock was different, the cationic abundance pattern of both waters were identical to the composition of rock except Si. The SI value for Quartz was almost zero at 150 and 200 deg. C for Yugama lake water and Kagusa spring water, suggesting a deposition of quartz at the above temperatures or an incomplete dissolution of Si in rock, in other word, SiO_2 was left as a mineral in altered rock.

ii) Kusatsu - Yubatake, Johfu Spring

We estimated 20 and 45 g of rock is necessary in 1 kg water at Kusatsu-Yubatake and Johfu Spring, respectively. The Fe/Mg and Al/Mg ratio was lower than the ratio of country rock, which is consistent to the saturation in those spring waters in terms of Pyrite and Alunite. The SI values for Pyrite was almost zero at 100 and 150 deg. C for Kusatsu-Yubatake water and Johfu spring water, suggesting the deposition of Pyrite and Alunite at the above temperatures.

iii) Manza-Yubatake, Okumanza Spring

We estimated 30 and 8 g of rock is necessary in 1kg water at Manza-Yubatake and Okumanza Spring, respectively. The Fe/Mg, Al/Mg and Ca/Mg ratio was lower than the ratio of country rock, which is consistent to the supersaturation in terms of Pyrite, Alunite and Gypsum.

iv) Bandaikou, Karabuki Spring

We estimated 50 and 150 g of rock is necessary in 1kg water at Bandaikou and Karabuki Spring, respectively.

Alunite and Quartz was almost saturated at 200 deg. C for Bandaikou and Karabuki spring water, respectively. The Fe/Mg and Ca/Mg ratio of those spring water is less than the ratio of country rock. However, the waters are undersaturated in terms of Pyrite and Gypsum. The decreased Fe/Mg and Ca/Mg ratios could be due to the low ratio in the country rock for those spring water.