

On the volcanic gas of Kirishima Iwoyama, Japan

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INTRODUCTION

At Mt. Kirishima Iwoyama Japan, the volcanic activity is becoming active, such as fumaroles appeared in the vicinity of the summit in Dec. 2015 and volcanic tremor occurs. In this research, from Dec. 2015 to Jan. 2018, fumarolic gases were repeatedly collected and analyzed. We consider the relationship between the variation of chemical composition and stable isotopic ratio of these samples and the volcanic activity.

SAMPLING OF FUMAROLIC GAS

Fumarolic gases a, b, c were collected at three places near the summit of Mt. Kirishima Iwoyama. The location of fumarole a is the place where fumarolic gas first appeared in Dec. 2015, fumarole b is located about 40 m south of fumarole a. The fumarole c is about 200 m away from the fumarole a in the south-southwest direction. The outlet temperature of the fumaroles was all close to the boiling point of water and the discharge pressure of fumarolic gas was low.

RESULTS AND DISCUSSIONS

The CO₂/H₂O ratio peaked once around May 2016 and then decreased until September 2017, but turned to rise in Oct. 2017. The ratio rose until Nov. 2017 and declined again in Jan. 2018. In the CO₂/H₂S ratio, similar fluctuations were observed as the CO₂/H₂O ratio. The CO₂/CH₄ and He/CH₄ ratios had relatively small fluctuations from Feb. 2016 to Sep. 2017, but after that it rose with large fluctuations. The apparent equilibrium temperature (AET) calculated from the concentrations of SO₂, H₂S, H₂ and H₂O contained in fumarolic gas was 232C in Dec. 2015, but it increased to 313C in Feb. 2016. Although it was stable thereafter, it rose sharply to about 500C in May 2017. At this time the fumarolic gas discharge was also vigorous. However, in Sep. 2017 AET fell to around 300C and stable thereafter. From Oct. 2017 the discharge of fumarolic gas decreased as well. Hydrogen and oxygen isotopic ratios of H₂O contained in the fumarole gradually increased from Feb. 2016 to May 2017 and then stabilized.

The He and CO₂ contained in the fumaroles are components of degassing magma origin and H₂S and CH₄ are classified as components formed in the hydrothermal system. Therefore, the rise of CO₂/H₂S, He/CH₄ and CO₂/CH₄ which are the ratios of these gases shows that the contribution of magmatic fluid is dominant in hydrothermal system, corresponding to the activation of the volcanic activity. Actually at Kirishima Iwoyama this correspondence relation has been established and these ratios show high values in cooperation between Dec. 2015 and Feb. 2016, when volcanic earthquakes occurred frequently. Similarly, in response to the increased volcanic earthquakes since Aug. 2017, CO₂/H₂S, He/CH₄ and CO₂/CH₄ are thought to cooperatively rise from Sep. to Oct. 2017. However, from Nov. 2017 to Jan.

2018, the coordination seen among these ratios was broken. Namely, although the CO₂/H₂S decreased, the He/CH₄ and CO₂/CH₄ ratio increased. There is a difference in reactivity in the gas components contained in the fumarolic gas. For example, H₂ is the most variable component affected by underground conditions close to the ground (temperature, redox potential). As for H₂S, the natural sulfur in the fumaroles is formed by precipitation of the sulfur component. The concentration of the sulfur component in fumarolic gas may change near the ground surface. On the other hand, CO₂ and CH₄ are relatively unchangeable components, and He is never lost in the course of traveling underground due to noble gases. From these facts, He/CH₄ and CO₂/CH₄, which are the ratios of components hard to change, are considered to reflect the relatively deep underground environment. Therefore, the temperature in the shallow part of the subsurface was stable from Nov. 2017 to Jan. 2018, on the other hand, it is interpreted that the magmatic fluid became dominant in the deep part of the hydrothermal system.

Keywords: Kirishima Iwoyama, Volcanic gas, Chemical composition