

Water isotope analysis to estimate possible aquifer structure around the crater of molten sulfur eruption at Shiretokoiozan Volcano, JAPAN

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Shiretokoiozan Volcano, located in the middle part of the Shiretoko Peninsula in Hokkaido JAPAN is known for a large amount of molten sulfur eruption. Four eruptions have been documented since the 19th century. In the last eruption of 1936, 116,523 tons of molten sulfur was expelled at Crater I on the northwestern mountain flank, and the molten sulfur flowed into Kamuiwakka Creek.

Shiretokoiozan is the only volcano that expelled such a huge amount of molten sulfur in the world. Elucidation of the eruption mechanism is of academic interest. Before this study, we found that high self-potential area, which indicates a volcanically active area located to the eastern uphill of Crater I. By DC resistivity survey, we found a hot spring aquifer around the crater (Yamamoto et al., 2017). The generation of molten sulfur is relevant to the existence of water and volcanic gas. At the 1936 eruption, molten sulfur and hot spring water were expelled intermittently (Watanabe and Shimotomai, 1937). At the crater lake, Ooyunuma, in another volcano at Niseko Hokkaido, molten sulfur is generated on the bottom of the hot water where volcanic gas is coming up. Takano and Watanuki (1990) discussed the molten sulfur generated in Yugama Crater at Kusatsu-Shirane Volcano in the chemical reaction between hydrogen sulfide and sulfur dioxide discharged from the subaqueous fumaroles on the bottom of the lake. Based on the evidence acquired in those previous research, we proposed the underground structure model as shown in Fig. 1.

Then we have questions:

1. Do those hot springs at the Kamuiwakka Creek and Crater I have a common aquifer? In other words, those hot springs are connected by the aquifer?
2. Is magma-sourced water supplied at the eastern area from Crater I, where SP values are higher than the surrounding area?
3. Is the stream water at the Iwo Creek located to the east of Crater I supplied to the aquifer of Crater I or hot springs in the Kamuiwakka Creek?

The purpose of our study is to find out the relationship between hot springs on the volcano and the aquifer and how magmatic gas is supplied as a part of the mechanism of molten sulfur eruption.

In our study, we collected hot spring water samples at the Kamuiwakka Creek, Crater I, and creek water samples in surrounding creeks and springs and measured water isotope ratios and dominant dissolved ion concentrations.

As shown in Fig. 2, the data of creek water and spring water in the vicinity of the research field, except for both the Iwo creek water and snow-melted water at Iwo Creek, are plotted along the meteoric line. On the other hand, the data of hot spring water at the Kamuiwakka Creek and Crater I deviate from the meteoric line.

We drew an approximate line by the data of hot spring water (Fig.2). The approximate line goes to the vicinity of meteoric water data and it implies that the hot spring water was originated from meteoric water. On the other hand, the data of magmatic water at Kuju-Iwozan Volcano (Mizutani et al 1986) composed mainly of andesite as Shiretokoiozan is on the extended line. Hot spring water data are plotted between the magmatic water and meteoric water. Based on those fact, we estimate that the hot spring water is generated by the mixture of magmatic water coming into the ground water. In our previous Self-Potential survey we had found a heat anomaly area where SP values are higher than surrounding area shown to the right of Crater I in Fig. 1. And the heat anomaly area includes Crater I where molten sulfur was expelled. Based on the result, we interpret that magmatic water vapor comes up to the aquifer and mixed with the ground water in this area.

Obtained conclusions are as follows:

- Magma water is included in the hot spring water at Kamuiwakka Creek and Crater I. In other words, the hot spring water has been heated by magma water.
- The aquifer of both the Kamuiwakka Creek and Crater I are connected. In other words, those waters have the same source.
- The water in the Iwo Creek is not the source of the hot spring water at the Kamuiwakka Creek nor Crater I.

Keywords: Molten sulfur eruption, water isotope analysis, Shiretokoiozan Volcano, Kamuiwakka Creek, Aquifer

Figure 1

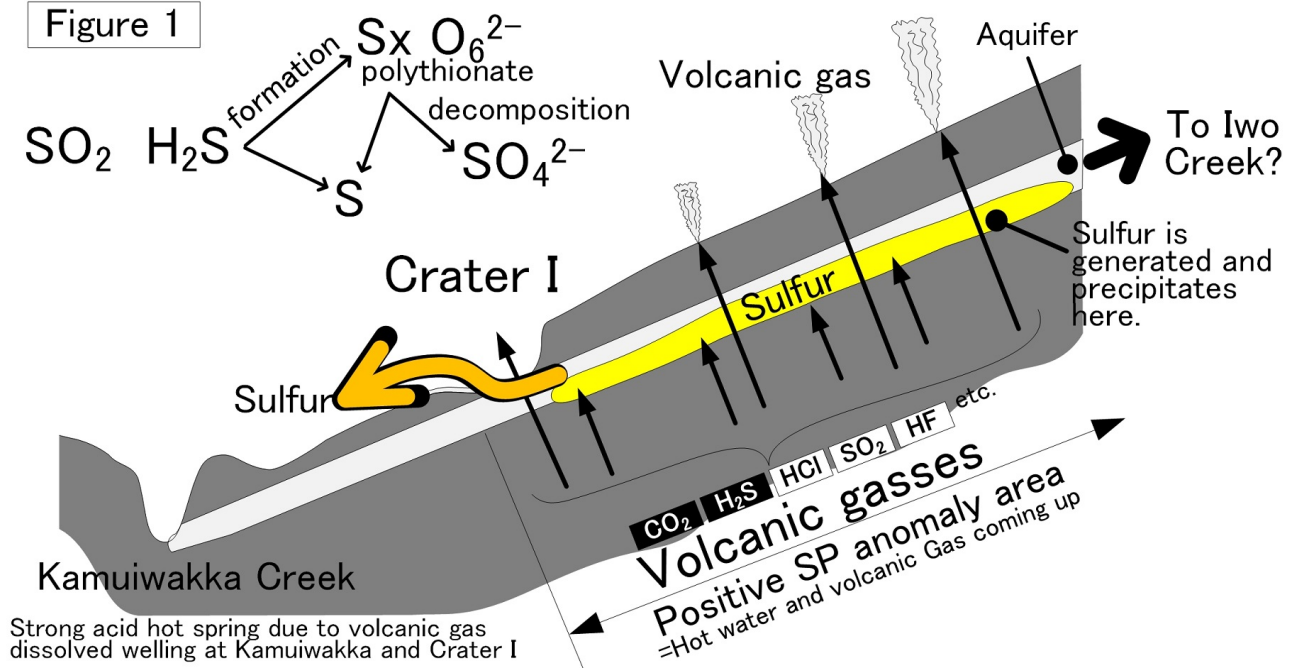


Figure 2

Water isotopic ratio of hot spring and creek water in Shiretokoiozan Volcano

Red circles ● : Hot spring water, Blue triangles ▲ : Creek water or snow, Red square ■ : Magma water

