

## Long-term change in the concentration of arsenic in Manza hot springs accompanying volcanic activities of Kusatsu-Shirane volcano

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The long-term change in arsenic concentration during 1967 and 2006 was investigated for the three hot springs, Manza-Yubatake, Okumanza and Manza-Karabuki, in the Manza hot spring area located in the western foot of Kusatsu-Shirane volcano, Gunma, Japan. The water chemistries of Manza-Yubatake and Okumanza hot springs are characterized by high concentration of dissolved hydrogen sulfide. While the Manza-Karabuki hot spring is spouting out with fumarolic gas containing hydrogen sulfide, its water dissolves very little hydrogen sulfide because of its high water temperature (near boiling point). In this presentation, we discuss the long-term changes in water chemistry of the Manza hot springs with the main focus on the concentration of arsenic, and their correlation with the volcanic activity of Kusatsu-Shirane volcano.

Manza-Karabuki water shows the highest concentration of arsenic of the three, with the maximum concentration of 21 mg/L in 1981. The arsenic content in Manza-Karabuki has fluctuated nearly equimolecularly with that of iron through the period of our investigation. This suggests that the major origin of the dissolved arsenic in this hot spring is arsenopyrite lying under the ground around there. Contrary to this, the arsenic concentrations in Manza-Yubatake and Okumanza waters are about 100 times lower than in Manza-Karabuki. The low concentration in these two hot springs probably results from the low solubility of the sulfide minerals in waters with high hydrogen sulfide content, which are the origin of dissolved arsenic.

Besides the above, the contents of arsenic in all three hot springs have been decreasing as a whole since 1969, the first year of our research. However the content had increased temporarily during the period of high volcanic activity of Kusatsu-Shirane volcano (between mid 1970s and mid 1980s). This period is characterized by the phreatic eruptions observed in 1976, 1982 and 1983 at the summit of Kusatsu-Shirane volcano. Especially, the content of arsenic in Manza-Yubatake seems to have fluctuated in harmony with volcanic activity. The fluctuation of the arsenic content in the Manza-Yubatake water accords with those of sodium and chloride ions. This suggests dissolved arsenic in the hot spring waters in this area is also supplied as volatiles accompanying the geothermal fluids, because the chloride ion in hot spring water is commonly originated from hydrogen chloride supplied as volcanic gas. Thus, there are two major mechanisms of supplying arsenic to the hot spring waters in the Manza area. One is the direct supply as the volatile in the geothermal fluids that originated from the volcanic activities of Kusatsu-Shirane volcano, and the other is the secondary supply via oxidation dissolution of arsenic-containing sulfide minerals which had been formerly deposited from such geothermal fluids.