Behavior of Arsenic and Mercury related to hydrothermal activities in Kirishima, Satsuma Iwojima, and Yamagawa, Kyushu Japan

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Arsenic and mercury behave in similar manners during migration from the deep to the surface of the Earth with magmatic and associating hydrothermal activities. In this study, we sampled total 57 hydrothermal and local meteoric waters from Kirishima, Satsuma-Iwojima and Yamagawa in November 2017 to December 2018 to trace the migration processes of arsenic and mercury related to the volcanic and its associating hydrothermal activities. We analyzed concentrations of major components, arsenic and mercury and hydrogen and oxygen isotope ratios.
The highest temperature of hydrothermal water, which was taken from the craters phreatically exploded in the April 2018, was 94.5 ˚C and the pH was 0.8-1.7. The maximum concentrations of chloride ion and sulfate ion were 300 mM and 190 mM, and the positively linear relationship between these two components indicated the simple mixing of acidic hydrothermal fluid and local meteoric water. In many high temperature hydrothermal waters, $\delta^{2}H$ and $\delta^{18}O$ were in the range of magmatic water, -25 to -5‰ and +4 to +9 ‰. Total arsenic concentration in the hydrothermal waters was 1210-4640 μg/l, which had a positively linear relationship with sulfate ion concentration. Dissolved and suspended total mercury concentrations in hydrothermal waters were 0.5-85 ng/l and 0.5-826 ng/l, respectively. Since highly mercury concentrated hydrothermal water also contained high arsenic, these were derived from the same magmatic fluid. Chloride and sulfate ion concentrations of hot spring waters derived from fumarole in Kirishima and Kurinodake were < 0.2 mM and 26 mM at the maximum. Total arsenic concentration was 0.58-24 μg/l, and total suspended mercury concentration was 1980 ng/l at the maximum. Hot spring waters in Satsuma Iwojima and Yamakawa,contained high total arsenic concentration when the seawater directly infiltrated and the highest concentration was 2500 μg/l for the one of hot spring water in Satsuma Iwojima. In these areas, the highest total dissolved mercury concentration was 177 ng/l for a hot spring water with pH of 1.4 in Satuma Iwojima. Both arsenic and mercury are rising up from the deep with magmatic fluid. However, the two elements may behave differently along the migration path; mercury moves preferentially with vapor and removed from the water during flowing path on the surface, while arsenic preferentially behaves with hydrothermal water and remains as a dissolved phase in the surface water.

Keywords: magmatic fluids, Iwo-yama, phreatic eruption, hydrogen and oxygen isotope ratios of water

