

Changes in the contents of sulfur species in Yugama, an active crater lake of Kusatsu-Shirane volcano, connected with its recent volcanic activity

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The Kusatsu-Shirane volcano is one of the most famous active volcanoes in Japan. Yugama, an active crater lake located on the pyroclastic cone of the volcano, is filled with high acidity water due to the injection of hydrothermal fluids from subaqueous fumaroles. Yugama has been the center of recent volcanic activity. We have been monitoring the water chemistry of Yugama over the past five decades.

The volcano has been in an active period since the late 2000s, and the activity has increased further since March 2014. In 2014, an earthquake swarm was observed around Yugama crater with inflation at shallow depth beneath Yugama. The concentrations of chloride ion and dissolved sulfur species in the Yugama water started increasing sharply in September 2014, immediately after the end of the earthquake swarm. We estimated the total amount of polythionate ions in the Yugama water as the difference between the sulfate ion content determined by ion chromatography and total sulfur content determined by ICP-OES. Our analytical results reveal that polythionate ions, which had not been observed for few years, have appeared with remarkable amounts in the Yugama water in September 2014, and their total amount has drastically increased to 3000 mg/L on a sulfate basis within seven months. Resultantly, more than a half amount of dissolved sulfur in Yugama has existed as polythionate species since mid-2015. This high proportion of polythionate species to the total sulfur species in Yugama is comparable to that observed in the 1970s before the 1982-1983 phreatic eruptions at Yugama. The changes in ORP in the Yugama water in and after 2014 suggest that increasing of SO₂/H₂S ratio in the volcanic gasses from the subaqueous fumaroles induce a production of polythionate species. The chemistry of polythionates in the Yugama water may be more complex than we thought.

Keywords: Kusatsu-Shirane volcano, Yugama, crater lake, subaqueous fumarole, polythionate, sulfur oxyanion