

Long-term changes in concentration of sulfur oxyanions dissolved in Yugama, an active crater lake of Kusatsu-Shirane volcano, Japan, since the 1960s

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Yugama is an active crater lake of Kusatsu-Shirane volcano, Japan, fed by volcanic fluids from subaqueous vents. Since the chemical composition of the lake water changes in response to volcanic activity, Yugama water is the critical target for geochemical monitoring of Kusatsu-Shirane volcano.

Sulfur species in Yugama water are mainly sulfate and polythionate ($S_nO_6^{2-}$, $n \geq 3$) ions and elemental sulfur. They are probably formed from H_2S and SO_2 , components of volcanic fluids fed to the lake water, through their complex redox reactions. Polythionates are often found in active crater lakes. In the case of Kusatsu-Shirane volcano, a drastic change in their concentration was observed in Yugama water during the eruptive activity in 1982 [1]. It has been pointed out that the variation in polythionates concentrations is helpful for volcanic activity and eruption prediction [2].

To determine dissolved sulfur species accurately, we performed chemical isolation of sulfate (SO_4) and thiosulfate (S_2O_3) in sample water with anion-exchange referring to the previous study [3]. After that, we determined the contents of sulfur in those fractions, respectively, by ICP-OES. The concentration of total polythionate ions ($T-S_nO_6$) can be estimated as a difference in total sulfur content in sample water determined by ICP-OES without any pretreatment ($T-SO_4$) and sulfur contents obtained from fractions after chemical isolation using anion exchange above.

We reanalyzed more than 140 preserved samples of Yugama water, then summarized the long-term concentration changes of sulfur species and other major dissolved components since the 1960s. By applying the new determination methods for sulfur species and analyzing an increased number of samples, this study allowed for a more detailed understanding of concentration fluctuation than was previously possible. The time-series data revealed that although sulfur species concentrations increase with every eruption or volcanic unrest, the $T-S_nO_6/T-SO_4$ concentration ratio does not change identically with other anions (e.g., Cl). These differences in variation may be due to the respective behaviors of ascending magmatic volatiles during periods of volcanic unrest.

Reference:

[1] Takano. (1987), Science, **235**, 4796.

[2] Takano et al. (1990), J. Volcanol. Geotherm. Res., **40**(1), 71-87.

[3] Druschel et al. (2003), Geochemical Transactions, **7**, 38-46.