Secular change in the chemical composition of lake water within Yugama crater at Kusatsu-Shirane volcano

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Kusatsu-Shirane volcano is an active volcano consisting of three pyroclastic cones, Mt. Shirane, Mt. Ainomine, and Mt. Motoshirane, counting from the north. Although a phreatic eruption occurred at Mt. Motoshirane in 2018, most of the recorded eruptions have occurred at around Yugama crater of Shirane pyroclastic cone [1]. The last eruption at Yugama crater was five phreatic eruptions during the 1982-83 active period, but after the last eruption, abnormal phenomena such as frequent earthquakes and tremors or discoloration of the lake surface in 1989-91 and small ejection of lake water within Yugama crater in 1996, have been still observed. The chemical composition of the lake water within the Yugama crater has been analyzed since the 1940s. Ohba et al. [2] discussed in detail about the relationship between the chemical composition of lake water at Yugama and volcanic activity, and a magma degassing model using the analytical data until 2005.

Abnormal phenomena have been observed also in recent years, such as frequent earthquakes accompanied by crustal deformation in 2014. There was no eruption in 2014, but pH drop and significant increase of Cl and SO_4 have been observed after the 2014 period. A similar change in past observations is the pH drop with Cl increase that occurred after the 1989-1991 activity period, and the change at that time was thought to be attributed to the efficient extraction of HCl from the solidifying magma by water vapor derived from deep intruded groundwater. Since a good correlation was observed between the H^+ and Cl concentrations before and after the 2014 period, the water quality change in this period was also attributed to the HCl supply due to the contact between the groundwater-derived steam and the solidifying magma, as in the 1989-91 period.

We also focus on the Mg/Cl ratio of lake water as one of the indicators of volcanic activity. Among these components, Mg is derived from the volcanic rocks of the Kusatsu-Shirane volcano [2]. Therefore, if the HCl-rich acidic fluid comes into contact with the hot rocks and water-rock interaction is promoted, the Mg contents of rock will be leached and supplied to the lake water, and the Mg/Cl ratio is expected to increase. In fact, during the 1982-83 period when five eruptions occurred around the Yugama crater, and around 1996 when the small ejection occurred within the Yugama crater, the Mg/Cl ratio of the lake water increased clearly; the active water-rock interaction in the magma-hydrothermal system seems to play an important role in the eruption or similar activity [2]. In recent years, a slight increase in the Mg/Cl ratio has been observed since the autumn of 2019, and these analytical results have been provided to the Coordinating Committee for Prediction of Volcanic Eruptions. In this presentation, we report on the chemical composition of lake water within Yugama crater in recent years and discuss the factors of the change and the correspondence with volcanic activity.

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