

## High-frequency sampling of a volcanic hot spring water discharged from Bengara thermal spring of Tokachidake volcano, Japan

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Temporal changes in chemistry of volcanic hot spring waters can be good indicators for monitoring volcanic activity. Long-term repetitive sampling and subsequent chemical analysis of the spring water samples have successfully captured changes corresponding to volcanic activity for qualitative tracking (e.g., Fischer et al., 1997; Martin-Del Pozzo et al., 2002; Sano et al., 2015; Takahashi et al., 2015, 2019). However, in order to allow quantitative tracking of volcanic activity, high-frequency sampling is essential. To achieve unprecedentedly high sampling rate, Ono et al. (2020) developed a field auto-sampling tool based on a commercially available XY plotter, named GOFAT, for high-frequency sampling of volcanic hot spring waters. Through high-frequency samplings using the GOFAT, Ono et al. (2020) successfully detected short-term positive  $\text{SO}_4$  peaks triggered by rainfall at a hot spring discharged from Hakone volcano, Japan, and suggested the importance of the high-frequency samplings even during quiescent periods of volcanic activity.

Tokachidake volcano is an active volcano in central Hokkaido, Japan. Two major spa areas, Fukiage and Tokachidake spa areas, are located on the western and southwestern flanks of the volcano, respectively. Based on long-term geochemical data of the hot spring waters since 1986, Takahashi et al. (2015, 2019) revealed that a NaCl-type magmatic fluid with high Cl concentration and temperature (approximately 20,000 mg/L and 280°C, respectively) was supplied to the spring waters discharged from the Fukiage spa area corresponding to volcanic activity. Takahashi et al. (2019) also pointed out that some of volcanic earthquake events around Tokachidake volcano were related to migration of the NaCl-type magmatic fluid based on a good correlation between changes in the Cl concentration and seismic activity since 2009.

In this study, for detailed tracking of changes in chemical compositions of a volcanic hot spring water discharged from Bengara thermal spring belonged to the Fukiage spa area, an automatic sampling using the GOFAT was carried out at the Bengara thermal spring from July 12, 2019. The spring water samples were taken every 12 hours except for samplings at 3-hourly intervals between October 17 and November 11, 2019.

Through the high-frequency samplings at the Bengara thermal spring, we detected increases in major cation and anion concentrations of the hot spring water from the end of October 2019 to the beginning of November 2019, when the number of volcanic earthquakes increased temporarily. In addition, a transition of the  $\text{Cl}/\text{SO}_4$  molar ratio from monotonous decrease to a constant value at this timing may suggest that supply of the NaCl-type magmatic fluid into the spring water increased temporarily related to the volcanic earthquakes.

Keywords: Volcanic hot spring waters, High-frequency sampling, Automatic sampling, XY plotter, Tokachidake volcano