

Geochemical characteristics and changes of thermal waters around Tokachidake volcano, Japan

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Tokachidake volcano, located in central Hokkaido, caused three magmatic eruptions (AD 1926, 1962 and 1988-89) in the 20th century. The seismic and thermal activities at the summit crater area have increased since AD 2010. We have continuously investigated thermal waters around the volcano since AD 1986 in order to understand the volcanic activity. Around the AD 1988-89 eruption, the chemical compositions and temperature of the thermal waters had obviously changed (Murayama et al., 1991). Therefore, we need to reveal the origin and changes of the thermal waters in order to forecast the future volcanic activity.

The thermal waters are discharged in the Nukkakushi crater (Ansei crater) and at its lower reaches, which is located at about 2 km southwest from the summit craters. Each thermal water is acidic with pH <3.2. At the time of AD 1986, all thermal waters were rich in sulfate ion but were scarce in chloride ion. In addition, anion content of the thermal waters decreases in proportion to the distance from the Nukkakushi crater. Therefore, the thermal waters derived from the Nukkakushi crater area flow, while mixing with groundwater, and are discharged at the lower reaches.

At the Fukiage hot spring area (1,000 m a.s.l.), the concentration of chloride and sodium ions in the thermal waters had abruptly increased since AD 1986. The increase of these chemical concentrations had continued until AD 1992, and the concentration of them had decreased since then. Accompanied with the chemical change, the temperature of the thermal waters had also increased more than 20 °C around the AD 1988-89 eruption. Such increase of the chemical compositions and temperature of the thermal waters had occurred related to the increase of the volcanic activity. Thus, these increases can be explained by mixing of highly dense NaCl type thermal water into shallow aquifer, and its mixing ratio changed with the volcanic activity. The chemical and thermal changes of the thermal waters have not occurred at the Okina hot spring (1,060 m a.s.l.). This indicates that the input of highly dense NaCl type thermal water has occurred at the lower reaches of the Okina hot spring.

Based on our investigations, the thermal waters in this area are formed by mixing of three end-members, sulfate ion rich thermal water, dense NaCl type thermal water and groundwater. The effect of the dense NaCl type thermal water is recognized only at the Fukiage hot spring area, and the mixing ratio changes according to the volcanic activity. The concentration of chloride and sodium ions in the thermal waters has begun to increase again since AD 2012. However, the increase is obviously small compared with that before the AD 1988-89 eruption, and the oxygen and hydrogen isotopic compositions of these thermal waters have not shown obvious change yet. Observations of the thermal waters will provide useful information to forecast the future volcanic activity in Tokachidake volcano, and hence we will continue the observations.

Keywords: Tokachidake volcano, thermal water, chemical composition, eruption forecasting