Relationship between volcanic activity and chemical and isotopic compositions of thermal waters in Tokachidake volcano, Japan

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Tokachidake volcano is one of the most active volcanoes in Japan, and three magmatic eruptions (AD 1926, 1962 and 1988-89) occurred in the 20th century. We have investigated chemical and isotopic compositions of thermal waters in Tokachidake volcano. Recently, as the volcano tends to be active, we discuss the relationship between the volcanic activity and these compositions of thermal waters.

Bengara hot spring (BHS), Hakuginso hot spring (HHS), Fukiage hot spring (FHS) and Okina hot spring (OHS) are located at the western flank of the volcano, about 3 km from the summit craters. The chemical compositions of BHS, FHS and OHS and those of HHS have been continually measured since AD 1986 and 1992, respectively. The temperature of thermal waters of BHS, HHS and FHS ranges from 48 to 56 ℃, whereas that of OHS is about 25 ℃. These thermal waters are acidic with the pH ranging from 2.5 to 3.0.

These thermal waters have various dissolved species. Here we show the Cl/SO_4 ratio. The ratio of these thermal waters was about 0.2 in AD 1986. Since then the ratio had abruptly increased, and the ratio of BHS and FHS was about 2.9 and 3.9, respectively, at the time of the AD 1988-89 eruption. The increase of the ratio had continued until AD 1992, whereas then the ratio had gradually decreased to 0.6 until AD 2010. Temporal change of the chemical compositions of HHS shows similar to that of BHS and FHS, and the ratio had decreased until AD 2010. However, temporal change of the ratio of these three thermal waters has changed to nearly constant or weak increase since AD 2010. In addition, these thermal waters have shown obvious increase of the ratio since June 2012, and the ratio reached about 1.0. In all thermal waters, there is no remarkable temporal variation of SO_4^{2-} concentration, and hence we can consider that temporal change of the Cl/SO_4 ratio has been caused by change of Cl^- concentration.

In addition to the chemical compositions, the oxygen and hydrogen isotopic compositions of these thermal waters have been investigated since AD 2011. All samples collected before July 2012 show nearly the same isotopic compositions as meteoric waters, ranging from $d^{18}O$=-13.6 to -12.1 per mil. In contrast, thermal waters of BHS and HHS, which were collected after October 2012, show heavy oxygen isotopic composition compared with meteoric waters, ranging from $d^{18}O$=-10.9 to -9.8 per mil.

The increase of the Cl/SO_4 ratio and shift of the oxygen isotopic composition toward heavier value could indicate that volcanic gas is supplied into thermal waters more than before. Observations of chemical and isotopic compositions of thermal waters are important for evaluating the future volcanic activity.