Time variation in the chemical and isotopic composition of fumarolic gases at Hakone volcano Japan

*Takeshi Ohba[1], Muga Yaguchi[2], Kana NISHINO[1], Nozomi Numanami[1], Yasushi DAITA[3], Urumu Tsunogai[4], Masanori Ito[4], Chiho Sukigara[4]

1. Department of chemistry, School of Science, Tokia University, 2. Meteorological Research Institute, JMA, 3. Kanagawa Environmental Research Center, 4. Nagoya University Graduate School of Environmental Studies

A geochemical observation method that analyzes substances released from magma and hydrothermal systems such as volcanic gas, hot spring water, volcanic ash, etc. is a potentially effective means for predicting steam eruption and elucidating the structure of hydrothermal system. In Hakone volcano, an earthquake swarm began in late April 2015, and a small steam explosion occurred at the end of June. Prior to the earthquake swarm, the stable isotopic ratio of H2O in the volcanic gas declined and fluctuations in the CO2/H20 ratio synchronized with the increase and decrease in the number of earthquakes were observed. Analyzing the volcanic ash released at the end of June 2015 and using the constituent mineral species and the Cl/S ratio of the component adhered on ash surface, it was presumed that the source depth of the volcanic ash was shallower than about 350-500m. Hakone volcano repeats earthquake swarm and the associated volcanic gas anomalies every few years, and it is expected that means to predict the transition of earthquake swarm can be established by ongoing volcanic gas geochemical observation.

We collected and analyzed monthly fumarolic gases T and S, respectively, that are releasing naturally in Owakudani and Kamiyuba, which are geothermal zones developed in the central volcanic cone of Hakone volcano, and obtained the following results. The CO2/H2S ratio of T reached its maximum value around October 2017, and then showed a tendency to gradually decrease toward to January 2019. At T, a similar tendency was also observed for He/CH4 ratio. The CO2/H2S ratio of S remained nearly constant from February 2018 to February 2019, but decreased once in November 2018. The He/CH4 ratio of S showed a declining trend in 2018 like T, but the rate of decline was slower than T. CO2 and He are derived from magma that degas, H2S and CH4 are derived from hydrothermal system. Therefore the declining trend of CO2/H2S ratio and He/CH4 ratio observed in 2018 indicates that the flux of magmatic gas to shallow hydrothermal system was decreasing. The cause of the decreasing trend may be due to the development of the sealing zone surrounding the magma. The declining trend of the CO2/H2S ratio and the He/CH4 ratio in 2018 looks to disappear in 2019. The CO2/H2S ratio of T and S rose slightly from January 2019 to February. Corresponding to the rise, a minor swarm earthquake was observed on Hakone volcano on January 24, 2019 (based on Hot Springs Research Institute of Kanagawa prefecture HP). The N2/He ratio of T and S remained low from 2018 to 2019, but T was exceptionally high in January 2019. N2 is a component derived from the atmosphere, and an increase in N2 in T indicates that the fluid pressure in the shallow part hydrothermal system decreased and a part of atmospheric contamination occurred. The apparent equilibrium temperature (AETD) can be calculated by combining the hydrogen isotope ratios of H2O and H2 contained in T and S. A decline phenomenon preceding the earthquake swarm were observed in 2014 and 2017. From early 2018 to the October, AETD is declining especially for S. The decrease may be a preceding sign of earthquake swarm.

