Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SVC49-04 Room:102B Time:May 25 15:00-15:15

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

OHBA, Takeshi[1*] ; AOKI, Ryou[1] ; SHIGEMURA, Taisei[1] ; SAGO, Masakazu[1] ; DAITA, Yasushi[2] ; CHENG, Lin[3] ; IKEYA, Kosuke[3] ; TSUNOGAI, Urumu[3]

[1]Dep. Chem. School Sci. Tokai Univ., [2]Hot Spring Res. Inst. Kanagawa Pref., [3]Grad. School Environ. Studies Nagoya Univ.

The driving force of eruption is the degassing of magma or the explosion of hydrothermal reservoir. The volcanic gas contains the component originating in the degassing magma or the hydrothermal reservoir. Therefore, the volcanic gas is essentially important object for the understanding of eruption and the eruptive prediction.

Although no historical eruption was recorded at Mt Hakone, the swarm of volcanic earthquakes has been observed several times. For example, in 2001 the swarm of volcanic earthquakes was observed with the deformation of volcanic body suggesting a pressure source the depth of which was estimated to be 7km (Daita et al, 2009). In parallel to the swarm of earthquakes, the steam pressure in the borehole located in the geothermal area of Owakudani significantly increased.

Sampling and analysis of fumarolic gas

The Owakudani geothermal area is developed on Mt Kamiyama, one of the central cones of Hakone caldera. The fumarolic gases have been sampled and analyzed at two outlets in Owakudani geothermal area almost every month since May 2013 to Jan 2015. One fumarolic gas (T) is located near the parking for sightseeing people of Owakudani geothermal area. Another fumarolic gas (S) is located on the north flank of Mt Kamiyama, 500m far from the fumarole T. The temperature of gas at the outlets was about 96C, which is close to the boiling temperature of the altitude of the fumaroles. The fumarole T associates the discharge of hot spring water. The fumarolic gas was sampled in the evacuated glass bottle containing 20ml of 5M KOH solution. For the determination of SO2/H2S ratio, KIO3-KI solution was reacted with fumarolic gas at the sampling site. For the sampling of condensed water of gas, a double glass tube was used for cooler. The solution in the evacuated glass bottle was analyzed along the method by Ozawa (1968) to determine the amount of H2O, CO2, total S (=H2S + SO2) and R-gas. The R-gas was analyzed by GC with Ar and He carrier gases to determine the relative concentration of He, H2, O2, N2, CH4 and Ar. The isotopic ratio of condensed water was determined by use of an IR-laser cavity ring down analyzer (Picarro). The isotopic ratio of H2 in R-gas was determined by use of the continuous flow system combining a mass spectrometer (Thermo Fischer Scientific Delta V).

Result and Discussion

The both fumarolic gases, T and S was composed by mainly H2O vapor the relative concentration is about 98%. The secondary dominant component was CO2, the concentration was 1 to 2%. The T and S fumarolic gases contained H2S of 0.2 to 0.4% and 0.04 to 0.05%, respectively. The CO2/H2O ratio of T decreased in May 2013 until Oct 2013, then stable until Sep 2014. In Oct 2014, a small increase was observed in the ratio. A similar change was observed in the S fumarole. In Oct 2014, about 50 of earthquakes occurred at Mt Hakone, the number of which was higher than the preceding months. The increase of CO2/H2O ratio in Oct 2014 looks to be correlated with the occurrence of earthquakes. The change in CO2/H2S was almost similar the change in CO2/H2O ratio for both T and S fumaroles. An interesting change was found in the He/H2O ratio of T fumarole. The ratio increased in Sep 2014, which is one month before the increase in CO2/H2O ratio. The increased He/H2O ratio decreased in Oct 2014, which looks like a precursor of the change in CO2/H2O ratio and also the swarm of earthquakes. For the estimation of hydrothermal reservoir temperature, the apparent equilibrium temperature (AET) was calculated between H2O and H2 assuming the exchange of D between those species. The AET was high as 140C in May 2013 at T fumarole. The AET deceased quickly down to 100C. A small increase was observed in Dec 2013 and Aug 2014. The AET of S fumarole was almost stable, showing a gradual increase from 92C in May 2013 to 104C in Aug 2014. The AET seems to be useful for the estimation of reservoir temperature.

Keywords: Hakone, Volcanic gas, Chemical composition, Volcanic earthquake, CO2, He