

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

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### Introduction

Mt Hakone having the caldera structure is an active volcano located on the western end of Kanagawa prefecture. At the central region of caldera, several volcanic cones are located. On the flank of cones, geothermal areas have been developed. The magmatic activity, which formed the cones, started 50 Ka (Kuno, 1972). The activity is estimated to have continued until 3 Ka (Kobayashi et al., 1997). At the last eruption, the western flank collapsed at one of the central cones, resulting in the formation of dammed Lake Ashi (Ooki and Hakamada, 1975).

At Mt Hakone, volcanic earthquakes have been observed frequently, although no historical eruption is known. Especially in 2001, the occurrence of volcanic earthquake was intense. The seismic activity was accompanied with an inflation of body at the central cones. The inflation was interpreted to be brought by a pressure source at 7 km of depth (Daita et al., 2009).

### Sampling of fumarolic gas

We sampled fumarolic gas at two sites since May 2013 at Owakudani geothermal area developed on the central cones. One of the sites is located 200m far from the Owakudani car parking in the direction of southeast. At the site we had sampled fumarolic gas in previous study. We call the fumarole as the regular fumarole. Another fumarole is located 500m far from Owakudani car parking in the direction of north. The fumarole has been generated recently. Before the generation, the area was forest. Now many large stout trees were killed by the geothermal effect. We call the fumarole as the new fumarole. Both of the fumarolic gases were sampled in the evacuated Giggenbach bottle containing 20 ml of 5M KOH solution.

### Result

The main component of the regular and new fumarole was water vapor (H<sub>2</sub>O). The molar percentage of H<sub>2</sub>O was about 98% for the both fumaroles. Both of the gas contain CO<sub>2</sub> gas as the major component next to H<sub>2</sub>O, the percentage was about 1 to 2%. The regular fumarolic gas contained H<sub>2</sub>S as much as 0.2 to 0.4%. The H<sub>2</sub>S concentration in the new fumarolic gas was only 0.036 to 0.050%, about 1/10 to the regular fumarolic gas.

The CO<sub>2</sub>/H<sub>2</sub>S molar ratio indicated a time variation, a monotonic decrease since May 2013 to Oct 2013. Daita (2013) reported a similar trend based on the observation with detecting tubes. Daita (2013) found an abrupt increase in the CO<sub>2</sub>/H<sub>2</sub>S molar ratio on Jan 2013. The increased ratio had been kept until April then decreased gradually toward Oct 2013. According to the seismic observation by Hot Springs Research Institute of Kanagawa Prefecture, volcanic earthquakes occurred frequently in Jan and Feb 2013. We suppose the change in the CO<sub>2</sub>/H<sub>2</sub>S ratio has been synchronized with the occurrence of volcanic earthquakes.

Keywords: Fumarolic gas, CO<sub>2</sub>, Volcanic activity, Hydrothermal system