The temperature of hydrothermal system beneath of Owakudani in Hakone Volcano

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A small phreatic eruption occurred at Owakudani fumarole area in Hakone Volcano in 2015 and formed new craterlets and dozens of fumaroles (Mannen et al., 2018). The inflation of volcanic edifice was detected by GNSS observations since mid-March 2019 and the number of volcanic earthquakes were increased on May 18, which show increased volcanic activity. Then the JMA raised Hakone's volcanic alert level from 1 to 2, and it lasted until October 10, 2019.
The sharp increase in chemical composition ratio such as CO_2/H_2O and CO_2/CH_4 of fumarolic gases sampled from Owakudani were observed before 2015 phreatic eruptions, indicating addition of magmatic components to the hydrothermal system (Ohba et al., 2019). The 3-D resistivity structure of Owakudani inferred from AMT survey detected the high resistivity body just beneath Owakudani, and it was interpreted to be gas-rich hydrothermal system (Seki, 2019). We collected fumarolic gases within the Owakudani in order to reveal the hydrothermal system by estimation of the temperature of hydrothermal system and contribution of magmatic components to hydrothermal system.
We collected fumarolic gases formed after 2015 phreatic eruptions three times since July 2018, and measured chemical and isotopic compositions. The fumarolic gases sampled June 2019 during highly volcanic activities showed higher SO_2/H_2S and CO_2/H_2O than the other times fumarolic gases, which indicated addition of magmatic components, while isotopic ratio of water did not show large change among them. The sulfur isotopic ratio of H_2S and SO_2 were -4.9 to -2.4 per mill and +11.20 to +17.0 per mill, respectively, and they has not significantly changed. The isotopic equilibrium temperature calculated from sulfur isotopes were from 206 ºC to 258 ºC. Assuming that presence of saturated steam at temperature between 200 ºC and 260 ºC beneath Owakudani and conservation enthalpy to the surface, we calculated that it changed to superheated steam around 160 ºC at surface. This temperature was coincident with upper limit temperature of fumarolic gases observed in Owakudani. The constituent minerals measured for the boring core samples from one of the steaming wells called No. 52 by the XRD analysis showed that illite was detected instead of smectite at depth of 380 m to 440 m, and it indicated that the temperature of this region was higher than 200 ºC (Mannen et al., 2019). Therefore, we concluded that the hydrothermal system of Owakudani constantly keeps between 200 ºC and 260 ºC.

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