

Thermal activities around Shirane pyroclastic cone, Kusatsu-Shirane volcano

*Akihiko Terada¹

1. Volcanic Fluid Research Center, Tokyo Institute of Technology

Phreatic eruptions have repeatedly occurred at Shirane pyroclastic cone, Kusatsu-Shirane volcano, over the last 130 years. Shirane pyroclastic cone exhibits thermal features such as hot crater lakes and steaming grounds. The most active hot crater lake, Yugama, contains extremely low pH water resulting from subaqueous fumarolic activities. On the northern slope of Shirane pyroclastic cone, vigorous steaming grounds emit volcanic gas which is mainly composed by H₂O, CO₂ and H₂S with a temperature of around 100 degree Celsius. MT surveys have revealed that a low resistive layer exists beneath Shirane pyroclastic cone. The layer may act as an impermeable layer enabling to store volcanic fluids supplied from depth. According to precise geophysical observations, hypocenters of micro earthquakes are located around undersurface of the impermeable layer. Sources of Long-period events, ground deformations and magnetizations are determined around the impermeable layer, meaning hydrothermal reservoir exists under the impermeable layer.

Thermal manifestations of Shirane pyroclastic cone are likely caused by fluid leakages from the reservoir; I believe monitoring of thermal activities are useful to evaluate activities of the hydrothermal reservoir. To estimate heat flux from vigorous steaming grounds, precise measurements of spacial distributions of ground surface temperatures are necessary. Using an infrared thermography, aerial infrared surveys have been repeatedly carried out since 2012. Most of these observation were done in the nighttime because even slight anomalies in ground surface temperature can be detected.

Intense earthquake swarms have occurred at shallow depth of the Shirane pyroclastic cone since March 2014, accompanied by ground deformations, changes in geomagnetic field and chemical concentrations of volcanic gas. A location of the pressure source is determined by network of our tilt meters at 550 m depth from Yugama crater lake, corresponding to the location of hydrothermal reservoir. We consider that increases in heat-discharge rates observed in 2015 and 2016 mean fluid leakages from the reservoir.

On the southeast slope of Shirane pyroclastic cone, no anomalies of ground surface temperatures were detected by the aerial infrared surveys while phreatic explosions occurred between 1927 and 1942 in this region. Fumaroles with a temperature of 148 degree Celsius emitted volcanic gas containing SO₂ and HCl in the early 1960s in the region. We believe that such intensive explosions developed permeable zone in the cap rock layer beneath the Shirane pyroclastic cone, as a result, high temperature volcanic gas emitted from here exclusively.

I find a stream which hot water springs out from the streambed. We collect water sample and measure flow rate systematically in order to estimate temperature, enthalpy, pH, concentrations of anions and stable isotope rates of hydrogen, oxygen and sulfur. Furthermore, Volcanic Fluid Research Center (VFRC), Tokyo Institute of Technology, has dug a monitoring well at 700 m east from the center of Yugama crater lake in 2016. At the depth of 50 m, VFRC finds a hot water vein with a temperature of 31 degree Celsius. Inserting a slender bottle to the well VFRC can easily collect water sample from 50 m depth. In addition to the thermometer installed in 2016, VFRC plans to install sensors of water level, pH and electrical conductivity in the well. These physical and chemical features of water in the southeast slope of Shirane

pyroclastic cone enable us to discuss signs of magmatic high temperature volcanic gas leakage from the hydrothermal reservoir.

Keywords: Kusatsu-Shirane Volcano, Hydrothermal system, Fumaroles, Monitoring well, Infrared thermography