Observation campaign of seismic activity and geochemistry of hot spring waters at western flank of Kusatsu-Shirane volcano, Japan

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Mt. Kusatsu-Shirane is an active volcano situated in the central Japan. Micro earthquake swarms and ground deformation have repeatedly occurred around the top of volcano since 2014. In January 2018, small phreatic eruption resulted in a dead. The Takayama district in the western flank of Kusatsu-Shirane volcano experienced earthquake swarm accompanied by rumblings from September to December in 2018. GNSS observation indicates a deep pressure source around Takayama area. Thermal manifestation such as hot springs occur along a fault in this area.

To reveal a magma-hydrothermal system associated with volcanic activity of Kusatsu-Shirane volcano, we have deployed seismic and GNSS stations around Takayama area. Assuming a seismic velocity structure, we find hypocenters of earthquake swarms are located beneath the Mt. Misawa, 12 km west of the top of Kusatsu-Shirane volcano. Hypocenters' depth are located around 4 km below the sea level, which does not show marked changes in its depth. During the earthquake swarm at Takayama area in 2018, no ground deformation was observed by our GNSSs.

Mt. Misawa is not a volcano, on the other hand, there are hot springs around Mt. Misawa. Most of hot spring waters are obtained from wells at depth between 100 –200m from ground surface. We have investigated geochemistry and isotope geochemistry of these hot spring waters since 2018, as a result, we found chemical compositions of hot spring waters at Takayama area much differ from that at Kusatsu -Shira volcano such as Yugama, hyper-acidic crater lake, and Kusatsu Spa. The hydrogen and oxygen isotopic ratios of the hot spring waters correspond to the representative values of the local meteoric water around this area. The composition are enriched in Na, Ca, Cl and SO4 ion, which are comparable to seawater. Stable isotopes of $d^{34}S$ of SO_4 show a degree of scattering, indicating disproportionation in a hydrothermal system.

Hypocenters at Takayama area are 12 km far from the top of Kusatsu-Shirane volcano. There are no emissions of acidic fumarolic gas and hot spring waters in this area. On the other hand, we found an increase in chemical concentration of the hot spring nearby Mt. Misawa which corresponds to the area of earthquake swarm's hypocenters. We believe that an increase in the pressure source beneath Takayama area associates with formation of hot spring waters in this area

Keywords: hot spring, fossil seawater, Kusatsu-Shirane volcano, Takayama village, hydrothermal system

