

Ground deformation caused by an accumulation of hydrothermal water beneath hot crater lake at Kusatsu-Shirane volcano

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Kusatsu-Shirane volcano is one of the most active volcanoes in Japan in terms of persistent heat-release of approximately 150 MW. Mt. Shirane which is one of the pyroclastic cone contains a hot crater lake, locally referred to as Yugama, showing interesting variations of water temperature and chemical concentrations. These thermal activities are caused by subsurface circulations of hydrothermal water; however, a detailed understanding of the hydrothermal system including localities of heat source and ascent routes has not yet been clearly established.

At Shirane pyroclastic cone, three continuous bore-hole type tilt meters and seismometers are installed by Volcanic Fluid Research Center, Tokyo Institute of Technology. In addition them three seismic stations are deployed on the ground surface. All of stations are located within 1 km from the center of Yugama crater lake.

Intense earthquake swarms have been detected at shallow depth around Shirane pyroclastic cone since March 2014, accompanied by a ground deformation, changes in geomagnetic field and chemical concentration of volcanic gas. Records of tilt meters include fluctuations caused by earth tidal effect, atmospheric pressure and co-seismic variation as well as seasonal long-term changes. To estimate these non-volcanic variations in tilt meters, we apply a code of BAYTAP-G (Tamura et al., 1991) to past records of tilt observed during calm period. As a result, our tilt meters reveal that a single inflation source is formed at shallow depth of Yugama crater lake. Applying the Mogi model we find the inflation source at a depth of only 500 meters from the bottom of Yugama crater lake. A total volume change of the inflation source during the period from March 2014 to January 2015 is estimated to be 84,000 cubic meters.

3D magnetotelluric surveys revealed that bell-shaped low-resistivity region underlays beneath Yugama crater lake (Ogawa et al., personal comm.). Chemical analyses of samples obtained from bore-holes suggest the low resistive layer is composed by highly altered materials such as clay which acts as an impermeable layer. The pressure source obtained in this study is located just beneath the low resistivity layer. We consider that accumulation of hydrothermal water is controlled by such subsurface structure.

Keywords: Kusatsu-Shirane volcano, ground deformation, tilt meter, hydrothermal system, cap rock