Hydrothermal circulation system beneath crater lake at Aso volcano, Japan

Akihiko Terada[1]; Takeshi Hashimoto[2]; Tsuneomi Kagiyama[3]; Hisashi Sasaki[4]

[1] AVL, Kyoto Univ.; [2] Inst. Seismol. Volcanol., Hokkaido Univ.; [3] Graduate School of Science, Kyoto University; [4] Kokusai Kogyo Co., Ltd.

The water level and temperature of crater lakes on some volcanoes sometimes show interesting changes with time in relation to variations of volcanic activity (Hurst et al., 1991). Based on an analysis including chemistry, seismicity and heat-material budgets, some crater lakes such as Poas volcano (Rowe et al., 1992), Kusatsu-Shirane volcano (Ohba, et al., 1994) are considered constituent parts of a hydrothermal system. A laboratory experiment is applied to water level change of Waimangu geothermal field, suggesting a hydrothermal instability (Vandemeulebrouck et al., 2005).

Nakadake in Aso caldera is one of the most active volcanoes in Japan from which a large amount of volcanic gas including 300-1000 $*10^3$ kg/day of SO_2 (Monthly report by JMA) is constantly emitted. The crater of Nakadake has a hot crater lake, locally called Yudamari, of over 200 meters in diameter with some fumaroles on its crater wall. In August 2007 seismicity of Aso volcano increased and red hot glows associated with high temperature gas emissions started at the fumaroles (Monthly report by JMA).

At Yudamari, we can see that substantial changes of water level and temperature were related to volcanic activities, as in the case of Poas (Brown et al., 1989; Rowe et al., 1992). Preceding an active period, the water level rapidly declines. The disappearance of lake water is followed by a red hot crater bottom or wall, then a phreatic to phreatomagmatic and strombolian eruption sequence over several months. Returning to the calm period of volcanic activity, the lake reforms. The lake temperature is maintained at much higher level than ambient through most of the calm period (Ohsawa et al., 2003). These significant changes of the crater lake are probably caused by changes of volcanic fluid input to the crater bottom from depth.

In this study, to monitor the water volume changes as accurately as possible, we used a high-resolution Digital Surface Model (DSM) that has detailed digital elevation data for topography. Using a high-resolution commercial digital camera, we monitored the water volume changes since July 2006. Combining these two with temperature measurements by using an IR thermal imaging apparatus, we revealed the slight but consistent changes of heat flow through Yudamari. During the observations, changes in the volcanic activities around Yudamari were also confirmed from other geophysical observations. We investigate the correlation between these phenomena and show how monitoring of a crater lake is useful for detection of subtle changes of geothermal activities beneath it.