Modeling of magnetic structure of Taal Volcano, Philippines

Makoto Harada[1]; Yoichi Sasai[2]; Yoshikazu Tanaka[3]; Julio P. Sabit[4]; Juan M. Cordon Jr.[4]; Jacques Zlotnicki[5]; Jane T. Punongbayan[4]; Hideaki Hase[6]; Toshiyasu Nagao[7]

[1] IORD, Tokai Univ.; [2] Disaster Prevention Division, Tokyo MG; [3] Aso Volcanological Laboratory Kyoto Univ.; [4] PHIVOLCS-DOST; [5] OPGC-Clermont; [6] ISV, Hokkaido Univ.; [7] Earthquake Prediction Res. Center, Tokai Univ.

Taal Volcano (120.99E, 14.00N), Philippines, is a 311 m high stratovolcano in which 75 m deep, 1.2 km in diameter, lake (Main Crater Lake, MCL) fills the centred crater. The 33 recorded eruptions of Taal from 1572 to 1977 include phreatic to phreatomagmatic eruptions. In the most famous 1965 eruption, base surges that originated from the southwest flank of the Island (Mt. Tabaro) killed 190 people when the surges traveled across the lake onto the southwest Taal Lakeshore. Because of its frequent eruption, Taal Volcano is considered as one of the decade volcano. Although the volcano has been relatively quiescent since 1977, swarms of seismic events excite the monitoring network time to time. The most recent volcano's status is at Alert Level 1 (Jan. 2008), however, the Main Crater (MC) is off-limits to the public because sudden steam explosion may occur or high concentrations of toxic gases may accumulate. More than 4,500 residents are living in the Volcano Island and many tourists visit view place on the crater rim by way of geothermally active area (Daang Kastila, DK) in the northern flank. Therefore, establishment of a system for early warning is considered as important issue to the Philippine Institute of Seismology and Volcanology (PHIVOLCS).

The monitoring network of PHIVOLCS consists of the seismometer, GPS receiver, water level data logger, tide gauges, EDM, and preceise leveling, which are mainly concerned with the detection of crustal movement. Considering about the recent progress of electromagnetic (EM) studies in volcanoes, additional EM parameters may provide more reliable information about the status of volcanic activity.

Since January 2005, EMSEV working group has conducted field surveys for 10 times with the PHIVOLCS [1]-[3]. In the 1st campaign in January 2005, combined measurement of SP, TMF, CO2 degassing and temperature was carried out inside and outside of MC. Furthermore, more than 20 benchmarks for repeat measurement of TMF were established. In the 3rd campaign in November 2005, small shelters for continuous measurements of SP and temperature were constructed in geothermally active areas in the northern flank (DK) and the north-eastern shore of MCL. In the 10th campaign in December 2007, proton precession magnetometers (KM-62; [4]) were installed near both of shelters. Obtained data are acquired in the flash memories. We will establish data transfer system with using the radiowave transmitters for real-time monitoring in the near future.

From the first and second surveys in January and February 2005, abnormal positive distributions of TMF and SP were found out in the both of geothermal areas in the MC and DK. The area of positive TMF and SP anomalies is almost same in DK, where east-west oriented active fissures have been generated and geothermal activity is high. The SP distribution suggests an existence of tectonic boundary just beneath the northern limit of fumarole area.

The authors reported that anomalous TMF distribution may be associated with the thermal demagnetization [2]. In this study, we estimated two-dimensional distribution of topographic effect and additional demagnetized block, since the observed TMF includes the topographic contribution. The result indicates that most of positive TMF anomaly can be represented by the uniformly magnetized (5 A/m) Volcano Island, but about 500 nT of residual component still remains, which may be interpreted by the thermal demagnetization. The result of modeling suggests that about 1.0~1.2 A/m of demagnetized block (width of 150 m, depth to the upper surface and bottom of block are 10 m and 200 m, respectively) exists beneath the fumarole area.

References

[1] M. Harada et al. (2005a) JEPS Joint Meeting, e011-012
[2] M. Harada et al. (2005b) Proc. Japan Acad., 81 (B), 261-266.
[3] J. Zlotnicki et al. Bull. Volcanology, in press
[4] Y. Tanaka (1993) J. Volcanol. Geotherm. Res., 56, 319-338.