3D magnetization structure of Aogashima Volcano by aero-, sea-surface and deep-sea magnetic vector surveys

Jun matsuo[1], Nobuhiro Isezaki[2], *Keizo Sayanagi[2]

1.OYO International Corporation, 2.Institute of Oceanic Research and Development, Tokai University

Measurement of magnetic anomaly vectors is absolutely essential to obtain a magnetization structure of the magnetized body. We have developed a new magnetometer for measurement of the vector magnetic field, called High Precision Magnetic survey System (HPMS), which can be used in various situations, for instance, in the air, on the sea surface and in the deep-sea. We have applied the HPMS as Heliborne Three Component Magnetometer (HTCM), Deep-tow Three Component Magnetometer (DTCM) and Shipboard Three Component Magnetometer (STCM) for airborne surveys (2006 and 2009) and marine magnetic surveys (2014) over and around the volcanic island, Aogashima. A helicopter of Nakanihon air service and Tokai University Vessel 'Bousei-Maru' were used for the HTCM surveys and for the STCM and DTCM surveys, respectively. The Aogashima Island is an active volcanic island included in the Izu-Ogasawara volcanic arc. The objectives of this study were to obtain magnetic anomaly vectors on Aogashima volcano by aero-, sea surface and deep-sea magnetic surveys, and to clarify 3 dimensional spaced 3 component magnetization structure of the volcano.

In the HTCM surveys, a towing frame mounted with the HPMS, GPS and wireless LAN devices was towed using a fiber rope below the helicopter. In the DTCM survey, the towing frame mounted with the HPMS, acoustic positioning (SSBL) and acoustic communication devices was towed near the sea bottom using a wire rope. In the STCM survey, the towing frame mounted with the HPMS and GPS devices was fixed on the after-deck of the ship. Three components of the observed geomagnetic field, F = (Hh, Hs, Hv), and gyro data (yaw, pitch, roll) are sampled in 10Hz. SSBL positions are fixed every 10 seconds. F, the vector in ship's coordinate (heading, starboard, vertical) is rotated to the vector in Earth's coordinate (X, Y, Z: north, east, vertical down) using the gyro data. From the rotated vector (X, Y, Z), the IGRF field is subtracted to get three components of a magnetic anomaly (dX, dY, dZ).

3D spaced 3 component magnetizations of the Aogashima volcano are analyzed by solving the linear least square equation for the obtained magnetic anomaly vectors. We tried 4 layer block model which consists of blocks with width of 500m, depth of 500m, and thickness of 250 m, 500 m, 750 m and 1000 m. The total number of the blocks is 2,492. The upper surface of Layer 1 approximates topographic surface. 25,536 data of three components of magnetic anomalies were inputted, and 7,476 data of three components of magnetization of 3D magnetized body were obtained by magnetization inversion with least square method using a dumping factor.

The figure shows three components of magnetization of each layer. Thin contour lines show the topography. The Aogashima Island is located at the center of each map. The shallower layers have complicated magnetization distribution, especially in Layer 1. There are larger magnetization to the north of the island as seen in Layers 1 and 2. The deeper layers such as Layers 3 and 4 have smooth magnetization distribution comparing with Layers 1 and 2. Layers 3 and 4 show the following characteristic distributions: relatively large positive north component of magnetization to the north of the island, contours of east component of that elongated along the ridge, and small downward component of that along the ridge in Layer 3 and under the island in Layer 4.

In conclusion, we have developed the versatile and useful equipment corresponding to a multiplatform that can survey the vector magnetic fields in the air, on the sea surface and in the deep-sea. That enables us to calculate the 3 dimensional and 3 components magnetization. The HPMS should make a contribution for more detailed and reliable magnetic geophysical surveys.

Keywords: three components of geomagnetic anomaly, magnetization vector, 3D magnetization structure, vector magnetometer for multi-platform, Shipboard Three Component Magnetometer (STCM), Deep-tow Three Component Magnetometer (DTCM)