2000年三宅島噴火における傾斜ステップに伴う地磁気変化の再検討

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Magnetic changes accompanying tilt-step events during the 2000 eruption of Miyake volcano revisited

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A new caldera was formed at the summit during the 2000 eruption of Miyake-jima Volcano, central Japan. It began with the collapse on the top and was finally built up until the August 18 largest eruption. During the caldera formation, the ground deformation called the tilt-step occurred once or twice a day. The velocity wave form of the tilt-step was the seismic VLP event with 50 seconds duration. Although the amplitude of VLP event was different one by one, its duration was always constant. Associated with the tilt-step events, the geomagnetic and electric field variations were observed. The magnetic change was an abrupt step-like one similar to the tilt-step itself, while the SP variation had a single wave form with 100 seconds duration. Two different models were proposed for the generating mechanism of the tilt-step, i.e. Kumagai model (Kumagai et al., 2001: a cylindrical piston entering into the magma reservoir) and Kikuchi model (Kikuchi et al., 2001: underground explosion of a vapor reservoir injecting fluids into the surrounding rocks).

The total intensity changes were explained as due to the piezomagnetic effect accompanying the Mogi model. Forced injection of fluids produced the SP variation owing to the electrokinetic effect (Sasai et al., 2002; Zlotnicki et al., 2003). Currenti et al. (2005) obtained the best-fit parameters for the piezomagnetic Mogi source with the aid of the genetic algorithm. However, a new study on the cause of SP variation was presented by Kuwano et al. (2015), in which the fluid flow was induced within the poroelastic medium by the strain field of the tilt-step source. They employed the Kumagai model, which was approximated by a vertical tensile crack.

Recently, we obtained the 3-component magnetometer data at two sites MKK (NE) and MKT (SE) located on the eastern slope of Miyake-jima Volcano thanks to NIED. They are more precise (0.01 nT accuracy) and with higher sampling rate (1 Hz), which enable us to further investigate the generating mechanism of the tilt-step events. Based on new magnetic data as well as a different idea on the tilt-step proposed by Kuwano et al., we reexamined our previous model for the magnetic variations. We found that the Mogi model cannot explain the observed 3-component magnetic data. In particular, the D component variations at two stations are opposite in sign, which is one of the major defects in the case of the Mogi model.

However, 3-component magnetic data contain apparent changes owing to the rotation of the sensor in the geomagnetic main field, which are of the same order of magnitude as the piezomagnetic changes. Even if we take account of such apparent changes, the Mogi model cannot explain the observations, in particular those in the D and H component. A vertical tensile fault is preferable as the source for the observed magnetic changes both from the sensor rotation effect and of the piezomagnetic origin. Since flux-gate magnetometers fixed to the ground are widely used for tectonomagnetic studies, the apparent magnetic changes due to the sensor rotation should be carefully discriminated from true ””signals””.