Temporal variations of self-potential at summit area of Izu-Oshima volcano

Nobuo Matsushima[1], Yuji Nishi[1], Shinya Onizawa[2], Shinichi Takakura[1], Hideaki Hase[3], Tsuneo Ishido[1]

[1]Geological Survey of Japan, AIST, Japan, [2]Meteorological Research Institute, Japan Meteorological Agency, Japan, [3]Earthquake Research Institute, The University of Tokyo, Japan

E-mail: matsushima-n@aist.go.jp

Volcanic gas is released from magma which intrudes at the shallow crust. The detection of gas flow uprising to ground surface is important to estimate the increase of volcanic activity. We focus on the Self-potential (SP) variation associated with the degassing activity to develop a new method predicting the transition of volcanic activity. In this paper, we show SP in the dormant period at Izu-Oshima volcano to understand the annual change with climatic conditions. Then, SP variation caused by the supposed degassing activity is studied using numerical simulation.

SP is measured continuously at 11 stations in the summit crater of Izu-Oshima volcano from 2006. Electrical differences between sites are recorded every one minute. Rain fall and soil water content are recorded every ten minutes at one station. SP data commonly show the annual change; the values are high in summer and low in winter. The amplitude of the annual change is observed to be 100mV in maximum. The short period variations in several days are also observed after rain fall. These variations are produced by the change of soil water content near surface. On the analogy of the short period variation, the annual variation is thought to be caused by the seasonal change of soil water content at depth. The temporary trends excluding the annual variation do not show any signals suggesting the increase of volcanic activity.

We estimate SP variations when magmatic activity has increased using the simulation code named STAR. The simulation considers mass and heat transfer of vapor and liquid fluid within porous media, and calculates the drag electrical current with fluid flow and electrical potentials induced by the drag current. For the initial condition which is satisfied with the present state of SP distribution in Izu-oshima volcano (Onizawa et al., 2009), we simulate SP variation if magma intrudes at seawater level and degassing occurs at the top of magma. The resistivity of formations is approximated with the parallel circuit of solid and pore resistivity. The pore resistivity changes remarkably with dissolved component. We assume that the acid fluid produced by the condensed volcanic gas has the resistivity similar to that of sea water (0.25 Ωm). When permeability of the degassing vent is higher than the surrounding formations with two order of magnitude, and degassing occurs at the rate of 80 kg/s which corresponds to half the maximum vapor discharge rate during 1986 eruption, the positive SP anomaly up to 100 mV appears near the summit crater at 1 year after the onset of degassing, although volcanic gas does not reach to ground surface at that time. Due to the cooling of volcanic gas, the counter flow of upward vapor and downward liquid develops around the degassing vent. The drag electric current is produced only by downward liquid flow, but low resistivity of the acid liquid causes a strong positive anomaly at ground surface.