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Evaluation of the mass flux of volcanic fluids using the electrical condutivity structure

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The efficiency of degassing of volcanic fluid in magma is one of the key parameters controlling the explosibility of eruption and the diversity of the volcanic activity (Eichelberger et al., 1986; Kagiyama, 2008). Therefore, it is possible to quantify the constraint condition which controls these phenomena by evaluating the mass flux of volcanic fluids released from magma. A portion of released volcanic fluids is discharged from the crater to the atmosphere; the rest is considered to be dissipated by groundwater flow of the aquifer under a volcano. The latter part has not yet been quantified precisely. The electrical conductivity structure of a volcano has a potentiality for estimating the volcanic fluid mass flux by groundwater flow of the aquifer, because the pore water dissolving volcanic fluids has a high electrical conductivity due to high salinity of the pore water. As well as pore water conductivity, matrix conductivity is also increased by hydrothermal alteration. Electromagnetic surveys on a volcano reveal the bulk conductivity, which contains both contributions of pore water and matrix. Therefore, it is required for the estimation of volcanic fluid fluxes using bulk conductivity to take both two conduction components into account.

In this study, the quantitative relation between mass flux of volcanic fluids and electrical conductivity structure is examined, by developing the simple model and using numerical simulations. Numerical simulations calculate the spatial distributions of salinity and temperature of pore water under the controlled condition of the mass flux of the volcanic fluids which are injected from the volcanic center(Komori and Kagiyama, 2008,2009; Komori et al., 2010).Using these distributions, the spatial distributions of pore water conductivity and surface conductivity are estimated (Komori et al.,2011). Eventually, the spatial distribution of bulk conductivity is estimated using these two conduction components by Revil's model (Revil et al.,1998; 2002).

These methods are applied to the bulk conductivity structure of Unzen volcano and Aso volcano obtained by wide-band MT (Komori et al., 2010; Utsugi et al, 2009). There is distinctive difference of the eruption style between these two volcanoes. To clarify the quantitative relationship between these eruption styles and the efficiency of magma degassing, the volcanic fluid fluxes at Unzen and Aso are evaluated.

Keywords: electrical conductivity structure, volcanic fluids, magma degassing, eruption style