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Approach to evaluating mass flux of volcanic fluids using the electrical conductivity structure of a volcano

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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. 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 presicely. 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 fluid has a high electrical conductivity due to the high salinity of the pore water.

So far, the authors have developed the dissipation model of volcanic fluids by assuming the aquifer with simple geometry and physical property, and have examined the quantitative relation between mass flux of volcanic fluids and electrical conductivity structure using the numerical simulations (Komori and Kagiyama, 2008, 2009; Komori et al., 2010). It was found that the attenuation of the conductance of pore water essentially corresponds to the mass flux of volcanic fluids.

In this presentation, the authors attempt to evaluate mass flux of volcanic fluids from the bulk conductivity structure of a volcano obtained from MT survey.

In general, bulk conductivity of a volcano contains both contributions of the pore water and the matrix. The contribution of the matrix to the bulk conductivity affects the pore water conductivity. This means that the contribution of the matrix also affects the evaluation of volcanic fluids mass flux using the bulk conductivity of a volcano. Therefore, it is necessary for evaluating mass flux of volcanic fluids to take the both contributions into account. The quantitative relation between mass flux of volcanic fluids and the spatial distribution of pore water conductivity has been revealed by our previous studies as mentioned above; on the other hand, the spatial distribution of the matrix conductivity has not been revealed yet. In this study, we assumed that the matrix conductivity is a function of temperature and salinity of pore water. The estimated distribution of matrix conductivity is connected to the distribution of pore water conductivity by Revil's model (Revil et al., 1998, 2002) to obtain the distribution of bulk conductivity. The distribution of bulk conductivity is converted into the conductance as a function of the distance of volcanic center. The mass flux of volcanic fluids is estimated by comparing the conductance obtained by MT survey with the catalogs of the conductance vs. the mass flux of volcanic fluids.

These methods are applied to the bulk conductivity of Unzen Volcano obtained by wide-band MT (Komori et al., 2010). In this presentation, some assumptions about the distribution of matrix conductivity are considered. The mass fluxes of volcanic fluids estimated under these assumptions are examined.

Keywords: electrical conductivity structure, bulk conductivity, pore water conductivity, matrix conductivity, mass flux of volcanic fluids