R003-11
Zoom meeting A ：11/3 AM2 （10:45-12:30）
11:45-12:00

A hydrothermal model of Aso volcano based on multiphase flow simulation and resistivity structures from ACTIVE and AMT survey data

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Resistivity structures inferred by inversions of Magnetotellurics (MT) or other electromagnetic (EM) sounding data always face difficulty in interpretation. In volcanic regions, imaged low resistivity zones are considered to be hydrothermally altered rocks that sometimes act as impermeable cap rocks (e.g. Yoshimura et al. 2018, EPS), hydrothermal fluid-rich zones (e.g. Gresse et al. 2018, SR), sulfur-rich zones (e.g. Kanda et al. 2019, EPS), or zones for high fraction of partial melts (e.g. Hata et al. 2016, GRL). Hence, constraining the cause of low/high resistivity values requires additional information. Hydrothermal multiphase flow simulation appears as an effective choice to interpret shallow resistivity structures in volcanic regions. Multiphase flow model can deal with the phase change in hydrothermal fluid due to temperature-pressure conditions within volcanic edifice, where the temperature and the volumetric fraction of hydrothermal fluid in porosities are connected to resistivity values.
We tried to interpret the three-dimensional (3-D) resistivity structure inferred by AMT (Audio-frequency MT) surveys (Kanda et al. 2019, EPS) and the 3-D resistivity change model (Minami et al. 2018, EPS; 2019, SGEPSS), inferred by a controlled-source EM volcano monitoring system, ACTIVE (Utada et al. 2007), by multiphase flow simulation using the TOUGH2 code (Pruess et al., 1999). We constructed a simple hydrothermal model with input of magmatic source at depth of crater bottom (H2O source with high temperature-pressure) under axisymmetric configuration centering the first crater of Nakadake with azimuthally averaged topography. For the path of magmatic source, we set a cylindrical conduit of 65-m radius just below the crater bottom which has a relatively high permeability compared to the surrounding rocks. We set porosity to 0.2 and the heat capacity to 1000 J/kg/K homogeneously below the surface. After obtaining a hydrothermal model, we converted information of temperature, fluid phase, and rock properties to resistivity values via Archie's law, neglecting the surface conductivity. Our simple resistivity model based on the multiphase flow simulation succeeded in reproducing the macroscopic features of the 3-D resistivity structure of Kanda et al. (2019, EPS), hereafter referred to as “KA model". We found from the comparison that the high resistivity layer just below the surface of KA model corresponds to highly air-saturated zone, while the conductive cone below the crater bottom of the first crater of Nakadake in KA model can be attributed to temperature distribution due to upwelling hot hydrothermal fluid. Furthermore, our simple resistivity model generated high resistivity zone in the conduit ~100 m below the crater, possibly corresponding to resistive change 400 m below the crater bottom imaged by the ACTIVE inversion (Minami et al., 2018). This resistive change is due to pressure reduction and change to gaseous phase of the input hot hydrothermal fluid. The discrepancy in the elevation of the resistive change may be accounted for by the presence of impermeable zone beneath the crater bottom (Kanda et al. 2019, EPS), which is not included in our hydrothermal model currently.
As well as the hydrothermal modelling, we recently started to develop a joint inversion code incorporating ACTIVE and MT inversions. The part of ACTIVE inversion follows the methodology of Minami et al. (2018), while the MT part follows that of Usui et al. (2017). We are going to update the resistivity change model obtained by ACTIVE inversions (Minami et al. 2018, EPS; 2019, SGEPSS) by conducting joint inversions of ACTIVE and AMT to explain time evolution of ACTIVE responses and AMT survey data consistently. In the presentation, we plan to report our updated resistivity change model and their interpretation using a hydrothermal models based on the multiphase flow simulation.