Constraining electrical resistivity structure of volcanoes using multiphase flow modelling: an example of Miyake-jima

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Measuring the electrical resistivity of rocks is a powerful and reliable method used to investigate volcanic edifices at depth. The electrical resistivity has two main contributions: (i) the conduction in the bulk pore fluid, associated to saturation, the ionic strength, and temperature of pore water, and (ii) the surface conductivity, related to the formation of secondary minerals. In volcanic environments, these two contributions are controlled by numerous interactions between hydrology, geology, tectonic settings and magmatic forcing. As a consequence, the evaluation of electrical resistivity images is strongly non-unique, and its interpretation remains complex.

Here, we propose a new approach to address this issue. First, we performed a 3-D electrical resistivity imagery of the Miyake-jima volcano using Magnetotellurics. Next, we combined the resistivity model obtained with hypocenters distribution. We revealed the sharp boundary between the saturated and unsaturated region, and a large conductive hydrothermal system connected to the main fumarolic area through a fractured region. Finally, we created a multiphase flow model of the volcano that constrains the resistivity model in term of temperature, fluid content and alteration.

Keywords: Hydrothermal system, Magnetotellurics, Miyake-jima, multiphase flow, electrical resistivity, alteration

