# Bayesian inference of porosity and salinity distribution based on resistivity at the Kakkonda geothermal field

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The supercritical geothermal energy is a promising power source. On the other hands, since possible supercritical geothermal reservoirs is deeper than the standard geothermal system, there are few observations about the porosity and salinity distributions in the deep parts. Thus, the estimation of the parameters is important based on existing information and assumptions. For the purpose, Bayesian inference is an effective approach because it enables to incorporate various probability distributions using the existing knowledge as a prior distribution. In this study, we used Bayesian inference to estimate porosity and salinity distributions based on resistivity. The application site is the Kakkonda geothermal field in Iwate Prefecture, Japan, where observed maximum temperature is over 500 ℃.
Temperature, salinity and porosity are major quantities that influence the observed resistivity. In this study, we used the following assumptions for the quantities. For the temperature, we assumed that the temperature shows the conductive pattern in the Kakkonda granite. Regarding the salinity, we assumed low concentration above the granite, while the salinity increases linearly with depth in the granite. For the porosities, the moving average models in the depth direction was used. Resistivity was calculated based on Glover et al. (2000). The possible ranges of the parameters contained in the above model were introduced as prior information of the Bayesian statistical model.
To validate the Bayesian statistical model, we firstly simulated the resistivity data, and estimated porosity and salinity from the synthetic data. The results of the synthetic data analysis showed that the error of the estimated salt concentration and porosity was less than 0.29%, indicating the validity of our model. Subsequently, we applied this Bayesian model to the resistivity obtained by the Magnetotelluric method, and estimated the porosity and salinity distribution. As a result, the central part of the analyzed area showed a higher salt concentration compared with the surrounding areas. Moreover, the porosity at the same area was also higher than the values at the surrounding areas. Based on the results, we interpreted that crustal fluid with a higher salt concentration exists in the pores at the central part of the analyzed area.

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