Towards unit-wise porosity mapping: MT investigations to image karstic reservoirs near Annecy (France)

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SUMMARY

The exploitation of deep geothermal energy for district heating applications requires that the risk of drilling unproductive wells – and that of generating induced seismic activity – be small. This requires sound knowledge of the nature, quality and boundaries of the targeted reservoir. The purpose of this project is to use broadband magnetotelluric (MT) data to investigate a low enthalpy karstic geothermal aquifer in the pre-alpine Molasse Basin at depths up to ~ 2km in the region of Annecy, France. Thrust faults offset different compartments of the target geological units, which are also intersected by the Vuache fault, an active strike-slip fault which caused a M_L5.3 earthquake in 1996.

A dataset of 34 full tensor MT sites was acquired. Data quality was mostly satisfactory up to 3Hz and sometimes up to 1s. Major problems were related to the presence of electromagnetic noise in this urbanized region, mitigated by the careful use of advanced processing methods (FFMT). For the 3D inversion required by the data (phase tensors, topography), we first inverted only induction arrows to provide a means of static shift correcting the full impedance tensor, then inverted phase tensors and induction vectors, then the full impedance tensor using the ModEM inversion code. This yielded a suitable 3D model, explaining all three data types reasonably well. The sensitivity matrix of this model is presented, computed using JacoPyAn.

A 3D geological model based on 2D seismic reflection and well data was built, in order to fix the geometry of the target karstic aquifers, aimed at undertaking a constrained inversion for resistivities within these units. Porosities can then be derived from Archie's law and a simple mixing model. Different approaches, and detectability, are discussed.

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