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Combination of 3-D Geological Modelling and Geothermal Simulation: a flexible workflow with GeoModeller and SHEMAT

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Accurate 3-D geological models as well as coupled numerical simulations of heat and fluid flow are becoming increasingly popular tools in exploration for geothermal resources and their evaluation. Many studies have been performed to simulate geothermal fields numerically. Still, these simulations are usually based on a static geological model. If more geological data become available, it is usually tedious to reconstruct the 3-D mesh for the geothermal simulation. Also, a lot of manual work is then normally required. We present a flexible and fast workflow that provides a short cut from raw geological data to a full 3-D process model of heat transfer and fluid flow in a geothermal field.

We combine two powerful tools: GeoModeller to construct the geological model, and SHEMAT for the coupled simulation of heat transfer and fluid flow. GeoModeller is a full 3-D structural geological modelling tool developed by BRGM and Intrepid. It uses an implicit potential-field approach that allows the construction of geological models directly based on input data and stratigraphic considerations (Calcagno, 2008). SHEMAT (Simulator for HEat and MAss Transport) is a finite difference reactive transport code that was developed for thermal and hydrogeological problems (Clauser, 2003). It has already been intensely used for geothermal applications.

To combine both programs, we developed the following workflow: firstly, the 3-D geological model is constructed with GeoModeller. The model is discretized into a voxet format and exported. This data is then reformatted and combined with other relevant data into a model input file for SHEMAT. To automate this step, we developed a set of python scripts. The geothermal simulation with SHEMAT can then directly be performed on this input file.

The major benefit is that this combination allows the use of a realistic full 3-D geological model as basis for the geothermal simulation in a simple and straightforward way. It is easily possible to change the geological model if new data become available and to incorporate the revised model into the simulation. Furthermore, this combination is ideal for hypothesis testing of flow geometry variation caused by different geological architectures.