T-H-M-C Modelling of Geothermal Processes

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Abstract

In Geothermal or underground energy storage processes, the characterization of the evolution of the reservoir rock over time induced by the circulation of an aqueous phase is mandatory in order to optimize and control the process over time. For reservoir rock characterisation, experiments like percolation benches can give hints on the way the reservoir rock will behave once subject to an exogenous fluid circulation. For deep geothermal fluids, most of the time, apart from injection boundary conditions which can be accurately defined, some uncertainties linked to reservoir characterization do exist, uncertainties eventually induced by the way the reservoir is processed prior to being put in production. Thereby, considering geothermal processes, modelling can be considered as the most efficient way to enhance the understanding of the wells hydraulic, of their thermal and chemical behaviours. Therefore, we have to address multiphysical processes whose modelling is sometimes referred as T-H-M-C modelling. We will present here the way such processes are tackled in the frame of the etumos platform where open source tools like phreeqC [1] for aqueous geochemistry, and Elmer [2] or Openfoam [3] to handle physical processes like hydraulic, transport of aqueous species, heat transfer and mechanics, are coupled in a sequential way. Prior to their use within the platform, each of these tools is wrapped to become a python shared object with the ad-hoc methods enabling the communication between the different tools and with the user. As an example, aqueous ions transport induce mineralogy variations impacting porosity, porosity variations which have to be sent back to hydraulic and transport solvers. Python acts here as the glue between those shared objects and is used all along the modelling, from the definition of the physics to handle via the python formulated data model to the post-processing. We will present two applications of the coupling based on a direct comparison with analytical solutions and experimental results issued from the literature. They will be commented and serve as an illustration of the phenomenology that can be presently modelled; furthermore it will serve as algorithm performances assessment in the field of Enhanced Geothermal Systems, EGS systems.

References

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