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Influence of the geothermal fluid rheology in the large scale hydro-thermal circulation in Soultz-sous-Forêts reservoir.

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Many numerical models have been developed in deep geothermal reservoir engineering to interpret field measurements of the natural hydro-thermal circulations or to predict exploitation scenarios. They typically aim at analyzing the Thermo-Hydro-Mechanical and Chemical (THMC) coupling including complex rheologies of the rock matrix like thermo-poro-elasticity. Few approaches address in details the role of the fluid rheology and more specifically the non-linear sensitivity of the brine rheology with temperature and pressure. Here we use the finite element Code_Aster to solve the balance equations of a 2D THM model of the Soultz-sous-Forêts reservoir. The brine properties are assumed to depend on the fluid pressure and the temperature as in Magnenet et al. (2014). A sensitive parameter is the thermal dilatation of the brine that is assumed to depend quadratically with temperature as proposed by the experimental measurements of Rowe and Chou (1970). The rock matrix is homogenized at the scale of the equation resolution assuming to have a representative elementary volume of the fractured medium smaller than the mesh size. We still chose four main geological units to adjust the rock physic parameters at large scale: thermal conductivity, permeability, radioactive source production rate, elastic and Biot parameters. We obtain a three layer solution with a large hydro-thermal convection below the cover-basement transition. Interestingly, the geothermal gradient in the sedimentary layer is controlled by the radioactive production rate in the upper altered granite. The second part of the study deals with an inversion approach of the homogenized solid and fluid parameters at large scale using our direct THM model. The goal is to compare the large scale inverted estimates of the rock and brine properties with direct laboratory measurements on cores and discuss their upscaling in the context of a fractured network hydraulically active.

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