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Sensitivity of predicted scaling and permeability in Enhanced Geothermal Systems to Thermodynamic Data and Activity Models

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A consortium of research groups from ETH Zurich, EPF Lausanne, the Paul Scherrer Institut and the University of Bonn collaborates in a comprehensive program of basic research on key aspects of the Enhanced Geothermal Systems (EGSs). As part of this GEOTHERM project (www.geotherm.ethz.ch), we concentrate on the fundamental investigation of thermodynamic models suitable for describing fluid-rock interactions at geothermal conditions.

Predictions of the fluid-rock interaction in EGS still face several major challenges. Slight variations in the input thermodynamic and kinetic parameters may result in significant differences in the predicted mineral solubilities and stable assemblage. Realistic modeling of mineral precipitation in turn has implications onto our understanding of the permeability evolution of the geothermal reservoir, as well as the scaling in technical installations.

In order to reasonably model an EGS, thermodynamic databases and activity models must be tailored to geothermal conditions. We therefore implemented in GEMS code the Pitzer formalism, which is the standard model used for computing thermodynamic excess properties of brines at elevated temperatures and pressures. This model, however, depends on a vast amount of interaction parameters, which are to a substantial extend unknown. Furthermore, a high order polynomial temperature interpolation makes extrapolation unreliable if not impossible. As an alternative we additionally implemented the EUNIQUAC activity model. EUNIQUAC requires fewer empirical fit parameters (only binary interaction parameters needed) and uses simpler and more stable temperature and pressure extrapolations. This results in an increase in computation speed, which is of crucial importance when performing coupled long term simulations of geothermal reservoirs. To achieve better performance under geothermal conditions, we are currently partly reformulating EUNIQUAC and refitting the existing parameter set. First results of the Pitzer-EUNIQUAC benchmark applied to relevant aqueous solutions at elevated temperature, pressure and ionic strength will be presented.