A procedure for analysing the effect of heat on chemical reactions in aquifers

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Temperatures in the subsurface can be altered significantly, when, for instance, heat is injected for energy storage or produced by radioactive nuclear waste. This not only affects thermo-hydro-mechanical properties, such as densities of fluids and solids, but also chemical reactions by altering thermodynamic constants and kinetic rates. In turn this can trigger other thermo-hydro-mechanical processes.

In this work we study the precipitation-dissolution of minerals as a results of temperature change. By using a procedure, similar to that of De Simoni et al. [1], we can derive analytical or semi-analytical solutions for cases when all minerals are assumed to precipitate-dissolve in equilibrium. Moreover, these solutions can give insight into the importance of the effects on precipitation-dissolution by various phenonema, such as heat conduction, retardation of heat fronts and mixing of end members (that is, waters of different hydrogeochemical origin).

We derived a semi-analytical solution for temperature driven dissolution-precipitation of calcite and applied it to an aquifer in which hot water was injected and cold water extracted during summer and viceversa during winter in order to store energy. Results show that calcite solubility drops with temperature and, as a result, calcite dissolves when hot water equilibrated with calcite is injected. The most important factor for this dissolution is the retardation of the heat front with respect to the water velocity.

[1] De Simoni et al. (2005), *Water Resour. Res.*, **41**, W11410.