Benchmark of reactive transport models within Cebama: Application to a concrete/clay interface

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- Reactive transport modeling of reactive interfaces in porous and fractured media View project
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Introduction and objectives

A benchmark modelling study of interactions between low-pH concrete and clay rock is presented here, conducted within the framework of the EC Horizon 2020 CEBAMA [1]. The concrete composition corresponds to the reference low-pH concrete manufactured and characterized in CEBAMA as an experimental benchmark [2]. Different modelling approaches were used for modelling and interpretation of experimental data generated within CEBAMA, with focus on reactive transport processes that can impact the physical properties of cementitious materials and their interface with clayey systems. Model and experimental results were satisfactorily compared [3]. A common modelling task was conducted to build confidence in the consistency of the different modelling approaches. The work aimed at benchmarking the capabilities of reactive transport codes to simulate physical and chemical processes governing long-term interactions at the concrete-clay interface. The benchmark also considered a set of sensitivity cases to test the effect of key parameters on the results. The main outcomes of the collaborative study are described in detail in [4] and presented here.

Methodology and description

1D reactive transport model setup

The studied system considers a generic concrete structure in contact with a clayey host rock under isothermal (25°C) and saturated conditions. Solute transport by Fickian diffusion and a simulation time of 100 kyr is considered. Several models of increasing complexity have been implemented and simulated, including a set of sensitivity cases.

Results - continued

Concrete degrades significantly over half of its thickness, with substantial dissolution of C-S-H, decreasing pH, and increasing porosity. Precipitation of calcite and brucite clogs the concrete porosity close to the interface. The high-pH plume into the claystone is negligible, also shown by the negligible dissolution of montmorillonite.

Results

As an example, results of the FRC are presented and compared to the case P3 in terms of mineralogical evolution of the system (Fig. 1), as well as pH and porosity changes (Fig. 2) after 100,000 years of interaction. Very good agreement is observed between the different reactive transport models and between the FRC and P3 cases (differing in the incorporation or not of kinetically-controlled mineral reactions).

References