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Influence of temperature pulse on a cementitious near field

Georg Kosakowski (1) and Barbara Lothenbach (2)

(1) Paul Scherrer Institut (PSI), Department of Nuclear Energy and Safety Research, Villigen, Switzerland (georg.kosakowski@psi.ch), (2) Swiss Federal Laboratories for Materials Science and Technology (EMPA), Laboratory for Concrete and Construction Chemistry, Dübendorf, Switzerland (barbara.lothenbach@empa.ch)

The Swiss design for a deep geological repository for high level radioactive waste is based on a bentonite backfill surrounding the waste canisters. We investigated the performance of a CEM III/B based concrete as alternative backfill material replacing the bentonite.
Of special interest is the influence of temperature on the mineralogy, transport and long-term interaction with the surrounding host rock. Increased temperatures as expected in a backfill, accelerate not only the reaction of the cement and other materials, but affect also the composition of the hydrates and of the pore solution.

In a first step we modelled the effect of temperature on a completely hydrated cement. The stable phases as a function of temperature were calculated based on the PSI-TDB coupled with Cemdata18 database plus crystalline C-S-H phases from the Thermoddem database. The kind and the volume of C-S-H phases formed change strongly with the temperature. The formation of α-C2SH at high temperature agrees with experimental observations in blended Portland cement.

In a second step we used a reactive transport model to investigate the temporal geochemical evolution of the near-field in contact with the adjacent host rock. The models include the effect of thermal pulse on transport and chemical reactivity. We considered that at elevated temperatures the system evolves faster due to the increase of solute diffusivity with temperature, the change of solid solubility with temperature, and the change of kinetic dissolution/precipitation rates with temperature.
Porosity clogging at the concrete/Opalinus Clay interface is very likely to occur. Clogging times are highly uncertain. After clogging, mass fluxes between concrete and Opalinus Clay will be largely reduced which will slow down concrete degradation.