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Influence of a concrete liner on the evolution of the near field of a HLW repository

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We investigate with help of reactive transport models the geochemical evolution of the planned Swiss deep geological repositories for radioactive waste. We present results for a case, in which a concrete liner as alternative tunnel support for high level radioactive waste emplacement tunnels might be necessary, due to uncertainties in the depth of the repository and the associated stress state.

Our calculations provide information on the extent of pH changes, on sequence and extend of mineral phase transformations, and on porosity changes for the specific materials that are foreseen for the Swiss high level waste repository. In the investigated case these materials are: MX-80 bentonite, low-pH concrete (ESDRED) and Opalinus Clay.

We found that the thickness of the zone with significant mineralogical alterations is a few centimeters to decimeters wide in both, the bentonite and the Opalinus Clay adjacent to the liner.

Near both interfaces, bentonite – concrete liner and concrete liner – Opalinus Clay the precipitation of minerals causes a reduction of the porosity. The effect is stronger and faster at the concrete liner – Opalinus Clay interface. In our simulation the significant changes of pH in bentonite and Opalinus Clay are limited to small zones below 10 centimeter thickness.

The principal mineralogical alterations in the bentonite compartment close to the concrete liner are the precipitation of calcite and hydrotalcite, and the replacement of Na-montmorillonite by [Ca,Mg,K]-montmorillonite.

In the Opalinus Clay compartment mineralogical alterations are more complex. We observe two alteration pathways: Very close to the interface, kaolinite and illite are transformed into montmorillonite. Depending on space and time, quartz, calcite and pyrite may dissolve, but partial neo-formation of calcite and illite is also possible.

In the concrete liner we predict the degradation of CSH phases with low C/S-ratio accompanied by the precipitation of hydrotalcite, phillipsite, clay minerals (illite, montmorillonite), gypsum and calcite.