Influence of chemical reactions on the flow system and contaminant transport in a former salt mine

S. Wilhelm*, R. Schwarz*, G. Klubertanz*, P. Siegel* & B.Förster**

* Colenco Power Engineering AG, Groundwater Protection and Waste Disposal, CH - 5444 Baden, Switzerland

** GSF-Forschungszentrum für Gesundheit und Umwelt, Forschungsbergwerk Asse, Am Wald 2, D - 38319 Remlingen, Germany

The coupling of reaction and transport is generally considered in terms of chemical reactions either hindering or enhancing transport. Our focus is placed differently. We have investigated the influence of large scale chemical reactions on driving forces for fluid flow and contaminant transport in an underground waste repository located in a former salt mine.

The mobilisation of contaminants and their release from the repository into the biosphere is caused by intruding formation waters. The driving force for the outflux of fluids is a pressure build-up caused by i) the convergence of caverns as a result of creeping processes in the salt rock and ii) gas production. The build up of the gas pressure in the mine is a direct result of chemical processes such as corrosion of the metal inventory or microbial degradation of organic matter.

The processes influencing the convergence of the salt rock are mainly related to the interaction between the host rock and solutions. NaCl saturated solution is assumed to enter the mine. It actively reacts with the host rock in the deeper parts of the mine which consists partially of Mg-bearing salts. The reaction generates secondary minerals as well as additional solution by liberating crystal-bound water. With a solution-filled porosity of approximately 43% the resulting material is prone to convergence. The Mg content of the resulting solution acts as a measure for the system's reactivity.

A flow model was created based on these main driving forces for water flow and gas flow inside the mine. The mine's geometrical structure was represented by a skeleton model consisting of caverns, shafts and galleries. Different types of backfill materials and their physical properties were taken into consideration. The hydraulic pressures of the fluids were coupled and calculated taking into account the geometrical alterations of the mine over time, the spatial position, the stress field and the chemical behaviour. Despite the uncertainties associated with inventories and reaction rates, initial calculations have demonstrated that these chemical interactions have a significant impact on the flow system and, therefore, on contaminant transport. The magnitude of this effect for some cases is comparable to that of sorption or dissolution/precipitation processes.