Geochemical evolution of bentonite clays within the first alternative buffer material test (ABM) – a reactive transport modeling study

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Bentonite clays are regarded a promising material for engineered barrier systems for the encapsulation of radioactive waste because of their low hydraulic permeability, swelling potential, ability to self-heal cracks in contact with water and their sorption potential. For more than a decade, Swedish Nuclear Fuel and Waste Management Co. SKB have been conducting long term field scale experiments at the Äspö Hard Rock Laboratory in Sweden. In 2006, the "Alternative Buffer Material" project [1] was launched to investigate a range of different bentonite clays and their performance as potential buffers under in-situ conditions. Over a duration of 28 months data was recorded on the modifications to chemistry and mineralogy of the clays, while in contact with the host rock and ambient groundwater and while exposed to elevated temperatures as expected during encapsulation of radioactive waste. Following the test, a reactive diffusive transport model was developed. Its aim was to (i) provide a process-based description of the physical and geochemical processes controlling the chemical evolution of bentonite porewaters at the in-situ scale; (ii) to quantify the influence of groundwater on the chemical evolution of the different clays with time and (iii) to test it for the available field data set collected during the trial. Results suggest that contact to active groundwater circulation together with temperature dependent diffusion are the main controls on the geochemical evolution of the clays.

[1] Svensson D., Dueck A., Nilsson U., Olsson S., Sandén T., Lydmark S., Jägerwall S., Pedersen K. & Hansen S. (2011) Alternative buffer material - Status of the ongoing laboratory investigation of reference materials and test package 1. SKB Technical Report TR-11-06. SKB, Stockholm.