Long-term evolution of porosity and mineralogy at cement-clay interfaces

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Clay-rich formations are selected by several countries as possible host rock for the development of an underground radioactive waste repository. In several zones of the repository cement and clay will come in contact. This leads to mass fluxes related to dissolution-precipitation reactions, which may affect relevant properties of the barriers. The porosity evolution and its correlation to the mineralogy are of particular interest regarding migration of water, solutes and gas across these interfaces. Investigation of the porosity by means of neutron imaging [1] and different chemical analyses were performed to study the interface evolution. Results of the neutron imaging measurements indicate a local decrease of the porosity inside the clay and an increase of porosity in the cement. Chemical examination evidence porlandite dissolution in the cement and a strong enrichment of Ca and Na on the clay side close to the interface. Na is likely to originate mostly from exchange of the Na-montmorillonite by Ca and K and possibly also from clay dissolution. The extension of the clay region with increased Ca and Na content, and the timing of the chemical enrichment of these elements, match with the evolution of the low porosity region observed by neutron imaging. Neutron imaging and chemical investigation clearly indicate that mineral precipitation on the clay side of the interface reduces the porosity and consequently the diffusive transport, which then feeds back on further interface reactions. Within the more than 6 years of interaction, no complete porosity clogging has been observed.

[1] Shafizadeh (2015) Physics procedia 69, 516-523.