

## EXPERIMENTAL ALTERATION STUDIES AT THE BENTONITE-CEMENT INTERFACE

Nickel, C.<sup>1,2</sup> & Warr, L.N.<sup>2</sup>

<sup>1</sup>Institute for Applied Geosciences, Graz University of Technology, Rechbauerstraße 12, 8010 Graz, Austria

<sup>2</sup>Institute for Geography and Geology, Ernst-Moritz-Arndt University Greifswald,

Friedrich-Ludwig-Jahn-Straße 17a, 17487 Greifswald, Germany

e-mail: claudia.nickel@tugraz.at

The Aspö underground laboratory site (Sweden) is a field study site designed for nuclear waste disposal in a granite-based repository. In order to guarantee the long-term sealing of the repository, a multi-barrier concept is being investigated consisting of a bentonite and cement buffer that surrounds the radioactive containing copper containers. Groundwater interactions with the bentonite buffer are generally well known, but alteration processes directly at the bentonite-cement contact are still poorly constrained. These processes may have a significant impact on the long-term stability and self-sealing capacity of both buffers.

In order to characterize the alteration processes directly at the bentonite-cement contact, two bentonite-cement leaching experiments and one bentonite control experiment were carried out. A water inflow scenario was simulated using a flow-through reaction-cell (WARR & HOFMANN, 2003) with distilled water as the leaching agent. During the hydration period, changes in the mineralogy and chemistry of both air-dried MX-80 bentonite and Portland cement clinker were monitored using X-ray diffraction and transmission electron microscopy analyses over an experimental period of one year.

Within the first 22 h the cement-influenced bentonite hydrated rapidly while the pure bentonite reached its maximum hydration after 963 h. Associated with the rapid water inflow in the cement-bentonite experiments the volume of the bentonite layer strongly increased and subsequently infiltrated the cement layer. Intense cation exchange of Na<sup>+</sup> (0.36 to 0.08 a.p.f.u) for Ca<sup>2+</sup> (0.08 to 0.12 a.p.f.u.) took place directly at the bentonite-cement contact zone, within the interlayer sites of the montmorillonite. This reaction was associated with the general depletion of the CaO content in the C-S-H phases by a factor of 2.5 compared to the unaltered cement. It was recognized that gypsum, an accessory mineral in the MX-80 bentonite, was completely dissolved during the first hydration period. Ettringite precipitated simultaneously, whereas neither ettringite formation nor gypsum dissolution was observed in the control experiment. It appears that ettringite can weaken the concrete and inhibit the formation of more cement minerals, i.e. C-S-H phases.

Our results clearly indicate that intense leaching occurs at the bentonite and cement contact in the presence of aqueous solution. The Ca substitution of Na reduces the montmorillonite swelling pressure, and significantly reduces the Ca required for the formation of cement phases. Thus, the cementation process close to the bentonite-cement alteration zone was determined to be incomplete. These alteration processes may have huge impact on destabilizing the clay-cement buffer.