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# Anaerobic corrosion of carbon steel in compacted bentonite exposed to natural Opalinus clay porewater: Bentonite alteration study.

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Carbon steel is a potential canister material for the disposal of high-level radioactive waste in deep geological repositories in clays and clay rocks. Bentonite is considered as a potential backfill material for those multi-barrier systems.

To predict the long-term performance and for safety assessment the knowledge of canister corrosion behavior is important. The formed corrosion products and mineralogically altered bentonite at the canister/bentonite interface can potentially provide an additional barrier against radionuclide migration.

In-situ corrosion experiments were performed at the Mt. Terri underground research laboratory. Coupons of carbon steel were embedded in Volclay MX-80 bentonite with controlled densities, installed in a borehole under simulated repository and anaerobic conditions and exposed to natural Opalinus Clay porewater for a period up to 5.5 years. The bentonite layer at the canister/bentonite interface was characterized by complementary microscopic and spectroscopic techniques (XPS, SEM-EDX, XRD) under anoxic conditions.

The interface revealed reddish-brown staining up to 2 mm depth into the bentonite in the zone adjacent to the steel. The SEM-EDX analyses of the interface (embedded crosscut with steel removed) showed calcium and iron enrichment in the bentonite adjacent to the metal.

µXRF analysis performed on the bentonite at the interface showed calcium enriched rim up to 100 µm into the bentonite (Fig. 1), while µXANES analysis revealed formation of iron silicate compounds in the reacted reddish-brown zone. The steel coupon was removed prior embedding, with the location marked as resin in Fig. 1. A line scan from the edge towards bulk bentonite did not indicate any systematic gradient in the $Fe^{2+}$ / $Fe^{3+}$ ratio. The formation of mixed $Fe^{2+/3+}$ silicate compounds appears to be heterogeneous.

This work contributes to an increased understanding of steel corrosion mechanisms in clay, which can improve the robustness of canister lifetime predictions.

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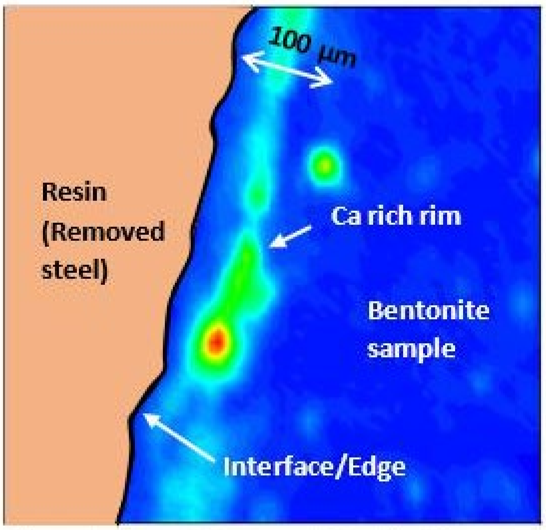


Figure 1: The µXRF map of the interface.