

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.

μ XRF analysis performed on the bentonite at the interface showed calcium enriched rim up to 100 μ m into the bentonite (Fig. 1), while μ XANES

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.

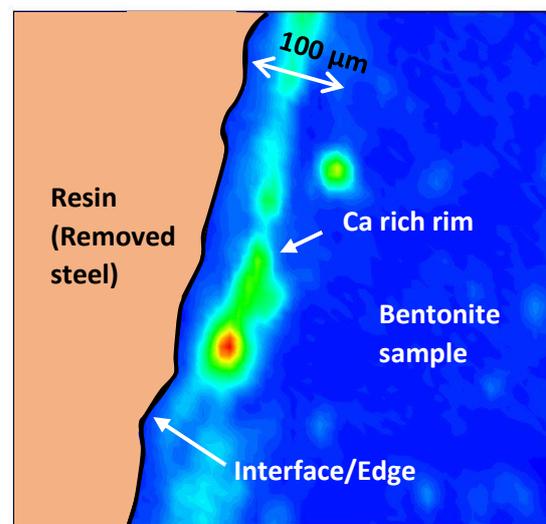


Figure 1: The μ XRF map of the interface.

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