Further results on the *in situ* anaerobic corrosion of carbon steel and copper in compacted bentonite exposed to natural Opalinus Clay porewater containing native microbial populations

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**ABSTRACT**

In 2012 a long-term *in situ* corrosion experiment (IC-A) was set up in the Mont Terri Underground Research Laboratory in Switzerland to investigate the corrosion behaviour of candidate canister materials in realistic underground repository conditions, including native microbial populations. Specifically, the aims of the work were to (i) measure the *in situ* corrosion behaviour of carbon steel, two types of copper coating specimens (electrodeposited and cold-sprayed) and wrought copper in compacted bentonite, (ii) study the effect of the bentonite buffer density on microbial activity and microbially influenced corrosion, and (iii) study the effect of welding on the corrosion rate of carbon steel specimens. The test coupons were surrounded by compacted bentonite with a range of dry densities (1.25, 1.45 or 1.55 g cm‑3) and mounted in modules allowing free exchange with the local anoxic groundwater. Modules were periodically retrieved for analysis and replaced with new modules. During the experimental programme, samples are removed after a range of exposure periods to examine the evolution of their corrosion behaviour and the interaction of the corroding metal with the surrounding bentonite. To date, specimens have been removed after different exposure periods up to four years and several analytical techniques have been applied to characterise the composition of the corrosion product, the morphology of the corroded surface, the nature of the interaction between the corroding surface and the surrounding bentonite, and the microbial populations in the bentonite and surrounding porewater. A complex corrosion product was identified, consisting predominantly of magnetite for carbon steel specimens. The bentonite adjacent to the metal was more dispersed and enriched in iron. Aerobic, anaerobic and sulphate-reducing bacteria were identified both in the porewater surrounding the modules and in the bentonite. The overall average corrosion rate was determined from weight loss measurements. The results indicate average anerobic corrosion rate for carbons steel (1.2- 3.5µm/year) and very modest amount of alteration for both types of copper. Additionally, both bentonite density and the initial form of the bentonite have an influence on the rate of corrosion, across all materials. Building on previous publications [Smart et al. 2017], this paper will summarise the results obtained and discuss the relationship observed between exposure time and the evolution of the metal-bentonite interface for both carbon steel and copper.

**References**

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