The anaerobic corrosion of carbon steel and copper in compacted bentonite exposed to natural granitic porewater containing native microbial populations

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**ABSTRACT**

In 2014 a long-term, multi-national, *in situ* corrosion experiment entitled ‘MaCoTe’ (MAterials COrrosion TEst\*) was set up in the Grimsel Test Site (GTS) in Switzerland to investigate the corrosion behaviour of candidate canister materials in realistic conditions reflecting a granitic deep geological repository.

Specifically, the aims of the work were to (i) measure the in situ corrosion behaviour of carbon steel, electrodeposited and cold-sprayed copper coatings, wrought copper and 2205 duplex stainless steel in granular compacted bentonite, and (ii) study the effect of the bentonite buffer density on microbial activity and microbially influenced corrosion. Two different dry densities were used: 1.50 and 1.25 Mg m-3. These densities were selected to represent intact full swelling pressure bentonite and to simulate degraded or badly emplaced bentonite respectively. Initially, eight modules containing bentonite and metal coupons were set up in a single vertically descending borehole in GTS. The modules allowed a free exchange with the natural anoxic porewater in the borehole, which is at a temperature of 12-13°C. Two modules, one for each test density, were removed for analysis after an exposure period of approximately one year. A suite of analyses was carried out to determine the extent of corrosion (weight loss measurements), the composition of the corrosion product (using SEM/EDX, Raman spectroscopy, XPS), the morphology of the surface after exposure (using profilometry and SEM) and the effect of corrosion on the local bentonite mineralogy (by petrographical analysis and XRD). As a baseline for comparison, a set of “pristine” uncorroded samples were also analysed. In addition, after removal of the samples from the borehole a suite of microbial characterisation activities were performed on samples from the porewater and the bentonite The results indicate a relative low corrosion rate for carbons steel (~2µm/year) and very modest amount of alteration for both copper and stainless steel coupons. Additionally, to date, the results indicate no significant difference in corrosion rate in bentonite in different densities, although longer exposure period may be required to confirm these observations.

\*Partners of the experiment are: Nagra, NWMO, RWM, Súrao, NUMO, KIT/INE and KIGAM