

Influence of temperature and selenium on bentonite microbial communities and titanium corrosion: implications for nuclear waste repository safety.

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Deep Geological Repository (DGR) is considered the best option for long-term disposal of high-level nuclear waste. This multi-barrier system encapsulates the waste in metal canisters surrounded by compacted bentonite as a buffer barrier. Novel materials, such as titanium (Ti), are starting to be considered for use as a metal coating in future canisters. Sulphate-reducing bacteria (SRB) could threaten the repository's integrity by causing microbiologically influenced corrosion (MIC) and potential metal canister failure. The ⁷⁹Se is one of the most critical radionuclides in DGRs and bentonite autochthonous microorganisms could affect the mobility of the stored radionuclides if a leak occurs. To better understand the impact of microorganisms on the safety of these repositories, the present work aims to simulate a worst-case scenario including canister failure with selenium leakage, water infiltration, and SRB activity.

Hyper-saturated bentonite microcosms were elaborated, adding electron donors and acceptors, along with sodium selenite [Se(IV)] as an inactive analogue of released radionuclides. In each one, Ti-Grade 2 discs were placed as a metal canister reference for corrosion studies. Moreover, a consortium of SRB was used to accelerate microbial processes. Microcosms were incubated under anoxic conditions for 12 months at two different temperatures: 30 and 60 °C.

After incubation, total DNA was extracted from the bentonite microcosms for 16S rRNA Next Generation Sequencing (NGS) to analyze the evolution of bacterial communities in each treatment. Additionally, viability of SRB was evaluated by culture-dependent techniques using Postgate's medium. Microcosms incubated at 30 °C were positive for growth of this bacterial group, whereas in microcosms incubated at 60 °C, there was only SRB viability in the presence of Se. Along incubation time, red spots appeared on the bentonite in the different treatments which in time changed to black, indicating probably a reduction of Se(IV) to amorphous Se(0)NPs and their allotropic transformation to trigonal ones. Scanning electron microscopy analysis showed no corrosion products at the surface of the

titanium discs.

These preliminary results demonstrate two key aspects for the safety of future nuclear repositories: titanium does not appear to corrode under favourable conditions of bacterial activity, and microorganisms would immobilize a selenium leak.