Microbial activity in nuclear waste repository systems

Johannes Raff, Margarita Lopez-Fernandez, Stephan Hilpmann, Sindy Kluge, Robin Steudtner, and Andrea Cherkouk
Helmholtz-Zentrum Dresden-Rossendorf, Institute of Resource Ecology, Germany (j.raff@hzdr.de)

A multi-barrier system in which the radioactive waste is encapsulated in metal containers surrounded by a geotechnical barrier (e.g. compacted bentonite) deep underground in a stable geological formation is one of the internationally accepted options for the disposal of highly radioactive waste. Bentonites have good properties such as high swelling capacity and low hydraulic conductivity, which makes them favorable as backfilling material. However, indigenous microorganisms may affect these properties. Bentonite samples were collected from the Full-scale Engineered Barrier Experiment (FEBEX) - Dismantling Project [1] at the Grimsel Test Site (Switzerland) to study their microbial diversity. For that, total DNA was extracted directly from the cores and from enrichments of sulfate- and iron-reducing microorganisms as well as microorganisms were isolated from those enrichments. The microbial communities of the bentonites, the enrichments, as well as the isolates were analyzed by 16S rRNA gene sequencing. The results showed that Actinobacteria and Alphaproteobacteria dominated the FEBEX bentonite microbial population, while the dominant phylum in both enrichments was Firmicutes: concretely, Bacilli and Clostridia classes. In addition, bacteria from the genera Desulfitobacterium, Desulfosporosinus and Clostridium were isolated from the enrichments. Desulfosporosinus hippoc DSM 8344 as a phylogenetic close relative was selected to study its interactions with uranium and especially its potential to reduce U(VI) to U(IV). This study revealed that microorganisms are present in bentonite samples after a long-term continuous heating. Sulfate- and iron-reducing microbes were enriched by using favorable conditions in specific media and the potential of the sulfate-reducing microorganisms on the reduction of uranium was verified. Therefore, it is important to characterize the microbial population of the bentonite, because microbes might compromise the safety of the deep geological repository of highly radioactive waste.