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Redox transformation of uranium by iron-reducing bacteria as single culture and in artificial multispecies bio-aggregates

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Redox transformations have a strong influence on the mobility of different metal ions in the environment. A key process in influencing the migration of uranium is the reduction of highly mobile and water-soluble uranium(VI) to less mobile uranium(IV). Especially in the surroundings of former uranium mines, this radionuclide represents an important contaminant whose entry into the environment must be prevented. Different microorganisms, e.g. sulfate- and iron-reducing bacteria, are capable of reducing uranium under various conditions. Thus, microbes can offer an environmentally friendly remediation strategy for radionuclide-contaminated environments. Moreover, in this study, we introduce the use of artificial bio-aggregates of different bacterial genera as a potential bioremediation approach combining advantageous properties of the microorganisms in a complementary way.

Desulfitobacterium sp. G1-2, which was isolated from bentonite samples, was chosen as an important representative of iron-reducing bacteria in anaerobic environments. Furthermore, different *Desulfitobacterium* species were found in other natural environments, like clay formations as well. These bacteria were used to form artificial bio-aggregates with different other bacterial strains (e.g. aerobic marine inhabitant *Cobetia marina* DSM 50416) based on electrostatic modifications of the surface charge of the bacterial cells.

Time-dependent experiments of a pure *Desulfitobacterium* sp. G1-2 culture in 30 mM bicarbonate buffer as background electrolyte showed a decrease in uranium concentration in the supernatants (100 µM uranium(VI), 10 mM lactate, pH 6.8/5.5). Approximately 80% of the uranium were removed from the supernatants within one week. UV/Vis studies of the dissolved cell pellets verified the reduction of uranium(VI) in the samples. STEM imaging of ultra-thin sectioned samples of uranium-incubated cells coupled with EDX spectroscopy showed the presence of two different uranium-containing aggregates inside the microbes.

First experiments with artificial bio-aggregates that were formed from different bacterial genera (e.g. *Desulfitobacterium* sp. G1-2 and *Cobetia marina* DSM 50416) revealed a promising reduction capacity of uranium. Such artificial bio-aggregates have a potential in utilizing beneficial microbes in remediation strategies, even if they do not form biofilms themselves. Moreover, these investigations offer new insights in the complex interaction processes in multi-species environments.