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Sorption and reduction of uranium(VI) by a sulfate-reducing microorganism in synthetic Opalinus Clay pore water

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For a fully comprehensive safety concept of a nuclear repository, it is necessary to investigate not only the geological, geochemical and geophysical properties but also the influence of naturally occurring microorganisms in the deep geological layers. Clay rocks are a possible host rock formation for the long-term storage of the highly radioactive waste, with bentonite to be used as backfill material.

Various studies show that, among other sulfate-reducing microorganisms, *Desulfosporosinus* species are present in both clay rock and bentonite.[1,2] A phylogenetically close relative to the isolated species is *Desulfosporosinus hippei* DSM 8344, an anaerobic, spore-forming microorganism originally found in permafrost soils.[3] Therefore, this strain was selected to get a deeper insight into the uranium(VI) interactions with naturally occurring microorganisms from deep geological layers.

A time-dependent experiment in artificial Opalinus Clay pore water[4] (100 µM uranium(VI), pH 5.5) showed the removal of about 80 % of the uranium(VI) from the supernatants within 48 h. Corresponding live/dead images of the cells taken by fluorescence microscopy exhibit the formation of cell agglomerates and an increasing number of dead cells within the incubation time.

Further examination of the supernatants using time-resolved laser-induced fluorescence spectroscopic techniques revealed the presence of two uranium(VI) species, a lactate and a carbonate complex. The proportion of the carbonate species remained constant over the incubation period, whereas the lactate species decreased.

The comparison of UV/Vis band positions of the dissolved cell pellets with reference spectra provides clear proof of a partially reduction of uranium(VI) to uranium(IV), although bands of uranium(VI) were also still observable. Therefore, it could be that the ongoing interaction mechanism is a combined sorption-reduction process.

These findings are an important contribution to a safety concept for a nuclear repository in clay rock and provide new insights into the interactions of sulfate-reducing microorganisms with uranium(VI).

References

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