Microbial biomineralization of uranium and its application

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Microbes are per definition small organisms and are specialists in adapting to changing environmental conditions. Thus they successfully conquer almost all kinds of environments even the harshest and most forbidden ones. One reason for that is, nature is very creative in the development of effective survival strategies. The various interaction mechanisms of microbes with radionuclides are therefor a good example. In general, microbes can not only inactivate reactive oxygen species formed by radiolysis of water or the Fenton reaction, but also detoxify the radio-metals themselves. First of all microbes are able to immobilize radio-metals by sorption, accumulation, mineralization or reduction. Furthermore, they can also mobilize metals by complexation or oxidation.

With regard to a molecular understanding of the microbe- uranium interaction and its possible application for the precautionary radiation protection and/or bio-remediation, sorption, accumulation and mineralization of uranium by living bacteria, fungi and algae were investigated. Interestingly, the different groups of organisms show significant differences in the interaction with uranium proved by different spectroscopic methods combined with electron microscopy. While the gram-positive bacterium *Lysinibacillus sphaericus* binds uranium via carboxyl and phosphate groups and subsequently forms meta-autunite like minerals outside the cell [1], the alga *Chlorella vulgaris* first binds uranium via same functional groups but afterwards desorbs the uranium by the secretion of complexing bio-ligands [2]. In contrast, the fungus *Schizophyllum commune* binds uranium at low concentrations (1 mg/L) outside the cell via organic phosphates but accumulates it inside the cell at higher uranium concentrations (100 mg/L) by forming inorganic phosphates [3]. Due to their high uranium resistance and high accumulation rates a fungal-based concept for the immobilization of released radionuclides was developed and is currently investigated.

[1] Merroun *et al*. (2005), *Appl. Environ. Microbiol*. **71**(9), 5532-5543. [2] Vogel *et. al* (2010), *Sci. Total Environ*. **409**, 384-395. [3] Günther *et al*. (2014), *Biometals* **27**,775-785.