

**Experiment title:**

Uranium(VI) reduction by anaerobic microorganisms isolated from the flooding water of the former uranium mine Königstein (Saxony/Germany)

Experiment number:

20-01-776

Beamline: BM20	Date of experiment: from: 02 Apr 2016 to: 08 Apr 2016	Date of report:
Shifts: 14	Local contact(s): André Rossberg (email: rossberg@esrf.fr) Kristina Kvashnina (email: kristina.kvashnina@esrf.fr)	<i>Received at ESRF:</i>

Names and affiliations of applicants (* indicates experimentalists):

Ulrike Gerber, Evelyn Krawczyk-Bärsch, Thuro Arnold, André Rossberg, Kristina Kvashnina, Andreas C. Scheinost

Helmholtz-Zentrum Dresden-Rossendorf, Institute of Resource Ecology, Bautzner Landstraße 400, 01328 Dresden / Germany

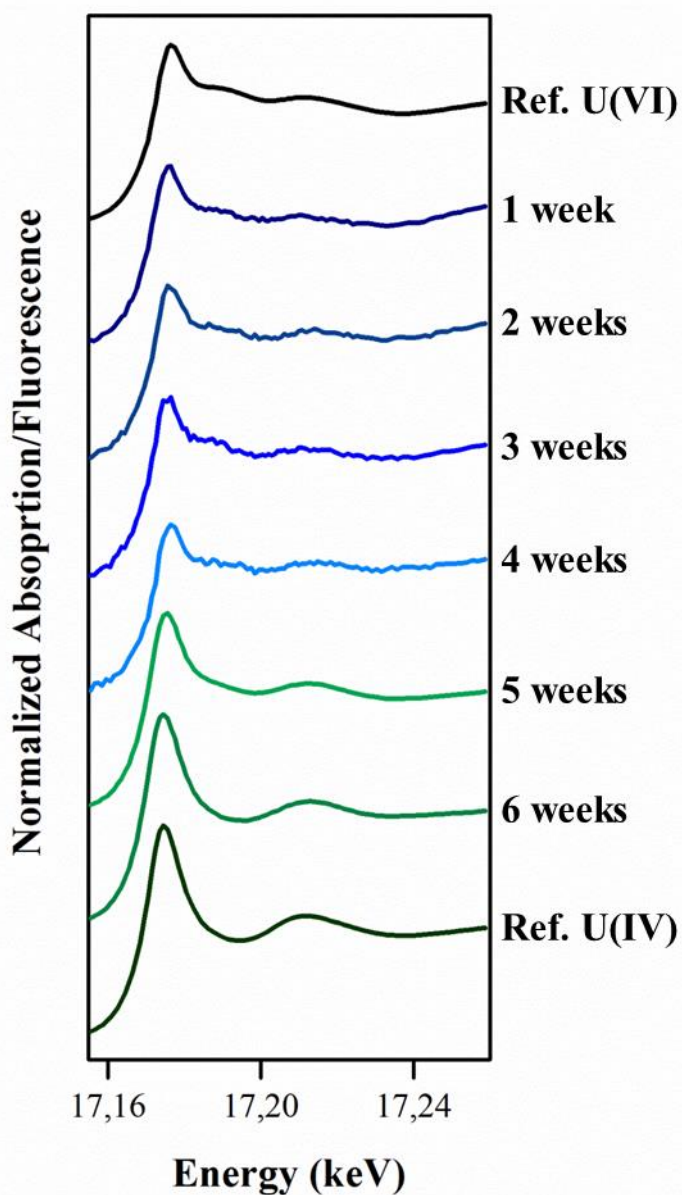
u.gerber@hzdr.de

Report:

Collected flooding water from the former uranium mine Königstein (Saxony, Germany) was supplemented with nitrogen and 10 mM glycerol. The samples were incubated at 30 °C for six weeks. Samples for EXAFS/XANES measurements were taken each week to investigate the microbial reduction of uranium(VI) to uranium(IV) kinetically. Previous experiments revealed that during an incubation time of six weeks the redox potential decreased from 660 mV to 300 mV.

The XANES spectra of the six uranium samples and two prepared references are shown in Figure 1. The XANES position and its fine structure revealed a biogenic uranium(VI) to uranium(IV) reduction after an incubation time of 5 weeks. The “yl-shoulder” at 17.175 keV is totally suppressed after 6 weeks incubation. Additionally, by Iterative Target-Factor Analysis (ITFA)^{1,2} (Tab. 1) the calculated amounts of uranium(VI) and uranium(IV) revealed that uranium(VI) is completely reduced to uranium(IV) after 6 weeks. After 5 weeks incubation the sample contains a mixture of both oxidation states. Within the first 4 weeks of incubation

there was no uranium(VI) reduction verifiable. The results show that naturally occurring anaerobic microorganisms within the flooding water of the former uranium mine Königstein are able, only in the presence of 10 mM glycerol, to reduce uranium(VI) to uranium(IV)



completely and thus could be an alternative for the conventional waste water treatment.

Tabelle 1. Fractions of uranium(VI) and uranium (IV) by ITFA.

Sample	U(VI) %	U(IV) %
U(VI) Ref.	100	0
1 week	88	12
2 weeks	97	3
3 weeks	87	13
4 weeks	100	0
5 weeks	48	52
6 weeks	8	92
U(IV) Ref.	0	100

Figure 1. U-L_{III} XAS spectra of microbial uranium(VI) reduction during 6 weeks incubation.

References

- (1) Rossberg, A.; Reich, T.; Bernhard, G. Complexation of uranium(VI) with protocatechuic acid - application of iterative transformation factor analysis to EXAFS spectroscopy. *Anal. Bioanal. Chem.* 2003, 376 (5), 631-638.
- (2) Rossberg, A.; Ulrich, K.-U.; Weiss, S.; Tsushima, S.; Hiemstra, T.; Scheinost, A. C. Identification of uranyl surface complexes on ferrihydrite: Advanced EXAFS data analysis and CD-MUSIC modeling. *Environ. Sci. Technol.* 2009, 43 (5), 1400-1406.