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ESRF

Experiment Report Form

The double page inside this form is to be filled in by all users or groups of users who have had access to beam time for measurements at the ESRF.

Once completed, the report should be submitted electronically to the User Office using the **Electronic Report Submission Application:**

http://193.49.43.2:8080/smis/servlet/UserUtils?start

Reports supporting requests for additional beam time

Reports can now be submitted independently of new proposals – it is necessary simply to indicate the number of the report(s) supporting a new proposal on the proposal form.

The Review Committees reserve the right to reject new proposals from groups who have not reported on the use of beam time allocated previously.

Reports on experiments relating to long term projects

Proposers awarded beam time for a long term project are required to submit an interim report at the end of each year, irrespective of the number of shifts of beam time they have used.

Published papers

All users must give proper credit to ESRF staff members and proper mention to ESRF facilities which were essential for the results described in any ensuing publication. Further, they are obliged to send to the Joint ESRF/ ILL library the complete reference and the abstract of all papers appearing in print, and resulting from the use of the ESRF.

Should you wish to make more general comments on the experiment, please note them on the User Evaluation Form, and send both the Report and the Evaluation Form to the User Office.

Deadlines for submission of Experimental Reports

- 1st March for experiments carried out up until June of the previous year;
- 1st September for experiments carried out up until January of the same year.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report, in English.
- include the reference number of the proposal to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details. If the abstract is in a language other than English, please include an English translation.

ESRF	**Experiment title:** Effect of metal-reducing bacteria on uranium mobilization	**Experiment number**: 2001692
Beamline:	**Date of experiment**: from: 13. May 2009 to: 15. May 2009	**Date of report**: 11. Jan. 2010
Shifts:	**Local contact(s)**: Andreas C. Scheinost, Dipanjan Banerjee	*Received at ESRF:*
Names and affiliations of applicants (* indicates experimentalists): Kirsten Küsel Institute of Ecology, Friedrich Schiller University Jena, Dornburger Straße 159, D-07743 Jena, Germany		

Report:

The results of this experiment have been published or will be published in the following two papers:

1) Impact of Biostimulated Redox Processes on Metal Dynamics in an Iron-Rich Creek Soil of a Former Uranium Mining Area

Eva-Maria Burkhardt[1], Denise M. Akob[1, 2], Sebastian Bischoff[1], Jana Sitte[1], Joel E. Kostka[2], Dipanjan Banerjee[3,4], Andreas C. Scheinost[3,4], Kirsten Küsel[1]

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Abstract

Understanding the dynamics of metals and radionuclides in soil environments is necessary for evaluating risks to pristine sites. An iron-rich creek soil of a former uranium-mining district (Ronneburg, Germany) showed high porewater concentrations of heavy metals and radionuclides. Thus, this study aims to i) evaluate metal dynamics during terminal electron accepting processes (TEAPs) and ii) characterize active microbial populations in biostimulated soil microcosms using a stable isotope probing (SIP) approach. In biostimulated soil slurries, concentrations of soluble Co, Ni, Zn, As, and unexpectedly U increased during Fe(III)-reduction. This suggests that there was a release of sorbed metals and As during reductive dissolution of Fe(III)-oxides. Subsequent sulfate-reduction was concurrent with a decrease of U, Co, Ni, and Zn concentrations. The relative contribution of U(IV) in the solid phase changed from 18.5 to 88.7% after incubation. The active Fe(III)-reducing population was dominated by *δ-Proteobacteria* (*Geobacter*) in ^{13}C-ethanol amended microcosms. A more diverse community was present in ^{13}C-lactate amended microcosms including taxa related to *Acidobacteria*, *Firmicutes*, *δ-Proteobacteria*, and *β-Proteobacteria*. Our results suggested that biostimulated Fe(III)-reducing communities facilitated the release of metals including U to groundwater which is in contrast to other studies.

Zitation: Burkhardt, E.-M., D. M. Akob, S. Bischoff, J. Sitte, J. E. Kostka, D. Banerjee, A. C. Scheinost, and K. Küsel. 2010. Impact of biostimulated redox processes on metal dynamics in an iron-rich creek soil of a former uranium mining area. Environ. Sci. Technol. 44:177-183.

2) Sulfate-Reducing Activity Linked to Metal Retention in Contaminated Soil Located at a Former Uranium-Mining District (Ronneburg, Germany)

Jana Sitte[1], Denise M. Akob[1, 2], Christian Kaufmann[1], Kai Finster[3], Dipanjan Banerjee[4], Eva-Maria Burkhardt[1], Joel E. Kostka[2], Andreas C. Scheinost[4], Georg Büchel[5] and Kirsten Küsel[1]

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Abstract

Sulfate-reducing prokaryotes (SRP) can affect metal mobility either directly by reductive transformation of metal ions, e.g., uranium, into their insoluble forms or indirectly by formation of metal sulfides. This study evaluated *in situ* and biostimulated activity of SRP in groundwater influenced soils from a creek bank contaminated with heavy metals and radionuclides within the former uranium-mining district, Ronneburg (Germany). *In situ* activity of SRP, measured by the $^{35}S-SO_4^{2-}$-radiotracer method, was restricted to reduced soil horizons with rates ≤142 ± 20 nmol cm^{-3} day^{-1}. Although concentrations of heavy metals were enriched in the solid phase of the reduced horizons, porewater concentrations were low. XANES measurements demonstrated that ~80% of uranium was present as reduced uranium, but appeared to occur as a sorbed complex. Soil-based *dsrAB* clone libraries were dominated by sequences most closely affiliated to members of the *Desulfobacterales,* but also *Desulfovibrionales*, *Syntrophobacteraceae* and *Clostridiales*. ^{13}C-acetate and ^{13}C-lactate biostimulated soil microcosms were dominated by sulfate and Fe(III) reduction, which was associated with enrichment of similar SRP found using the *dsrAB* marker in soil and with sequences related to *Geobacter*. Concentrations of soluble nickel, cobalt, and occasionally zinc declined ≤100% during anoxic soil incubations. In contrast to other studies, soluble uranium increased in carbon-amended treatments reaching ≤1407 nM in solution. Our results suggest that (i) contaminated reduced soil with on-going sulfate reduction resulted in *in situ* metal attenuation and (ii) the fate of uranium mobility is not predictable and may lead to downstream contamination of adjacent ecosystems.

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