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Biotic uranium mobilization of non-crystalline U(IV) and associated U isotope fractionation

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Environmental uranium (U) contaminations may be remediated via microbial reduction of mobile hexavalent [U(VI)] to more immobile tetravalent U [U(IV)] [1]. However, the subsurface stability of U(IV), usually present as solid-phase non-crystalline U, may be affected by reactions with ligands, oxidants or bacteria. Uranium isotopes are proposed as a tool to monitor these (im)mobilization processes. However, U isotope fractionation during potential U(IV) remobilization is not yet fully understood, limiting the applicability of U isotope signatures for prediction of the sustainability of microbially-reduced U(IV) at U remediation sides.

In this work, the efficacy of *Acidithiobacillus (At.) ferrooxidans* to mobilize non-crystalline U(IV) and the associated U isotope fractionation was investigated in controlled laboratory experiments. The starting material was produced by reduction of a U(VI) isotope standard with *Shewanella oneidensis* MR-1 in a phosphate-containing medium (WLP) [2]. *At. ferrooxidans* mobilized between 74% and 91% U after one week, and interestingly, U mobilization was equally observed for both, living and inactive cells.

The similar mobilization capability of active and inactive *At. ferrooxidans* cells suggests that the mobilization is based on the reaction with the cell biomass. Contrary to anoxic U mobilization with ligands, where ^{238}U is enriched in the mobilized phase [3], but similar to abiotic oxidation and mobilization of U(IV) from uranite [4], U mobilization by *At. ferrooxidans* did not cause significant U isotope fractionation. Potentially, this is because the speed-limiting process during U mobilization, e.g. U adsorption to the biomass in our case, does not generate significant isotope fractionation. Thus, U isotope signatures are unsuitable for tracking bacterial U remobilization and isotopic signatures found in nature are more likely generated by U reduction, or mobilization with ligands. The results of this study, combined with those of [3], challenge the long-term sustainability of in-situ bioremediation measures at U-contaminated sites.

[1] Basu, A. et al. (2015), *Environ. Sci. Technol.*, 49 (10), 5939–5947.

[2] Stylo, M. et al. (2013), *Environ. Sci. Technol.*, 47 (21), 12351–12358.

[3] Roebbert, Y. et al. (2021), *Environ. Sci. Technol.*, 55 (12), 7959–7969.

[4] Wang, X. et al. (2015), *Geochim. Cosmochim. Acta*, 150, 160–170.