

## Microbially catalyzed electron transfer to iron oxides: From atomic to micron scale

K. M. KEMNER<sup>1\*</sup>, M. I. BOYANOV<sup>1</sup>, E. J. O'LOUGHLIN<sup>1</sup>,  
D. SHOLTO-DOUGLAS<sup>1</sup>, K. SKINNER<sup>2</sup>, B. LAI<sup>1</sup>,  
D. LATTA<sup>3</sup> AND R. COOK<sup>1</sup>

<sup>1</sup>Argonne National Laboratory, Argonne, IL 60439, USA

(\*correspondence: kemner@anl.gov)

<sup>2</sup>Coskata, Inc., Warrenville, IL 60555, USA

(\*correspondence: kskinner@coskata.com)

<sup>3</sup>University of Iowa, Iowa City, IA 52242, USA

(\*correspondence: drew-latta@uiowa.edu)

The biogeochemistry of Fe in many aquatic and terrestrial environments is driven largely by microbial activity, where Fe redox cycling by microorganisms is a significant component of C cycling and energy flux. In addition, Fe<sup>III</sup>-reducing microorganisms and the Fe<sup>II</sup> they produce have profound implications for many processes in aquatic and terrestrial systems, including the dissolution and precipitation of minerals, the availability of nutrients such as phosphate, and the fate and transport of organic and inorganic contaminants. Because U, a radioactive cold war legacy contaminant, often exists at dilute concentrations in the subsurface and is redox active, it can serve as a sentinel to describe biogeochemically driven redox processes that naturally occur in the subsurface. The microenvironment at and adjacent to surfaces of actively metabolizing cells is difficult to define, can be significantly different from the bulk environment, and can exert crucial control on Fe and contaminant transformations. Therefore, we have performed a series of x-ray fluorescence microprobe (150-nm resolution), and electron microscopy measurements on lepidocrocite thin films that have been inoculated with dissimilatory metal reducing bacteria (*Shewanella oneidensis* MR-1 and *Anaeromyxobacter* spp.) and exposed to 0.05 mM uranyl acetate under anoxic conditions. Our results indicate that these microbial species can reduce U<sup>VI</sup> to U<sup>IV</sup>, both at the site of adhesion to the film and at distant points. The presence of U<sup>VI</sup> at the point of attachment of cells to the lepidocrocite film is consistent with U acting as an electron shuttle. The presence of a reduced U species at points away from the surface-adhered cells, and x-ray absorption fine structure spectroscopy measurement results of abiotic control samples containing oxidized U species and Fe<sup>II</sup>, indicate the formation of entities of a biological origin that are distant from bacterial cells and capable of reducing U.