Adsorption of selenite by *Bacillus subtilis*: the overlooked role of cell envelope sulfhydryl sites in microbial conversion of Se(IV)

Qiang Yu[1,*], Maxim I. Boyanov[2,3], Jinling Liu[1,4], Kenneth M. Kemner[3], Jeremy B. Fein[1]

[1] Department of Civil & Environmental Engineering & Earth Sciences, University of Notre Dame, Notre Dame, IN 46556, USA (* presenting author, qyu@nd.edu)

[2] Bulgarian Academy of Sciences, Institute of Chemical Engineering, Sofia, 1113, Bulgaria

[3] Biosciences Division, Argonne National Laboratory, Argonne, IL 60439, USA

[4] State Key Laboratory of Biogeology and Environmental Geology, China University of Geoscience, Wuhan 430074, China

Microbial activities play a central role in the global cycling of selenium (Se). Microorganisms can reduce, methylate and assimilate Se, controlling the transport and fate of Se in the environment. However, the mechanisms controlling these microbial activities are still poorly understood. In particular, it is unknown how the negatively-charged Se(IV) and Se(VI) oxyanions that dominate the aqueous Se speciation in oxidizing environments bind to negatively-charged microbial cell surfaces in order to become bioavailable.

In this study, we measure the extent of selenite adsorption onto non-metabolizing *Bacillus subtilis* bacterial cells, and we explore the mechanisms controlling the adsorption. The role of sulfhydryl sites in the adsorption was determined by comparing selenite adsorption onto the biomass with and without sulfhydryl sites blocked chemically, and the Se speciation on the biomass was analyzed using X-ray absorption near edge spectroscopy (XANES) and extended X-ray absorption fine structure (EXAFS) spectroscopy. Our results show that the adsorption of selenite onto *Bacillus subtilis* bacterial cells is controlled by cell envelope sulfhydryl sites. Once adsorbed onto the bacteria, selenite is reduced, and forms reduced organo-Se compounds (e.g., R_1S-Se-SR_2). Because sulfhydryl sites are present within cell envelopes of a wide range of bacterial species, sulfhydryl-controlled adsorption of selenite likely represents a general mechanism adopted by bacteria to make selenite bioavailable. Therefore, sulfhydryl binding of selenite likely occurs in a wide range of oxidized Se-bearing environments, and because it is followed by microbial conversion of selenite to other Se species, the process represents a crucial step in the global cycling of Se.