Influence of EPS on the Adsorption of Cd onto Three Bacterial Species

BUTZEN, MARGARET L.[1*], FEIN, JEREMY B.[2]

[1]Civil & Environmental Engineering & Earth Science, University of Notre Dame, Notre Dame, USA, (*correspondence: mbutzen@nd.edu)

[2]Civil & Environmental Engineering & Earth Science, University of Notre Dame, Notre Dame, USA, (fein@nd.edu)

The fate and bioavailability of heavy metals in the environment can be influenced by adsorption onto bacteria and onto extracellular polymeric substances (EPS), which are exuded organic molecules and major components of biofilms. Few previous studies of metal adsorption onto bacteria have attempted to quantify metal binding onto EPS molecules due to the difficulty of isolating intact EPS. Furthermore, previous metal-EPS binding studies yield inconsistent results on whether there is a need to differentiate between bacterial cell adsorption behavior and EPS binding behavior when modeling mass transport of heavy metals in aqueous geologic systems.

In this study, we measured the effect of EPS on Cd and proton adsorption behaviors by measuring the extent of adsorption onto biomass with and without the EPS removed via cation exchange resin. We conducted both Cd adsorption experiments and potentiometric titrations of biomass, using three common, EPS-producing bacterial species: one Gram positive (*Bacillus subtilis*) and two Gram negative (*Shewanella oneidensis*, *Pseudomonas putida*) species. The Cd adsorption experiments focused on the effect of metal loading in order to probe whether environmentally-low metal loadings lead to different adsorption mechanisms than the high loadings of most previous adsorption studies. We exposed each biomass to dissolved Cd in $NaClO_4$ at metal loadings of 1, 2, 5, and 74 umol/g. Surface complexation modeling (SCM) was used to determine stability constants for the important Cd-bacteria complexes, and the effect of metal loading on the resulting stability constants was determined.

In general, the measured bulk Cd adsorption behavior is unaffected by EPS removal. Our titration results indicate that EPS removal does alter the distribution of site types, but not the mass-normalized total site concentration. SCM suggests that high affinity sulfhydryl sites control Cd binding under low metal loading conditions for *B. subtilis* and *P. putida*, and that sulfhydryl sites are present both on the cells and within the EPS. Conversely, SCM is consistent with Cd-sulfhydryl binding being un-important on the EPS of *S. oneidensis*.