

Hg²⁺ Reactions at Bacteria-Water Interfaces: Implications for Hg Speciation in the Environment

BHOOPESH MISHRA¹, ELIZABETH SHOENFELT²,
JEREMY FEIN³ AND SATISH C. B. MYNENI^{2*}

¹Dept. of Physics, Illinois Institute of Technology, Chicago, IL, USA (bmishra3@iit.edu)

²Dept. of Geosciences, Princeton University, Princeton, NJ, USA (*correspondence: smyneni@princeton.edu)

³Dept. Of Civil Engineering & Geological Sciences, University of Notre Dame, Notre Dame, IN, USA (fein@nd.edu)

Mercury is a common contaminant in the environment, and bacteria are known to play an important role in Hg speciation and in the production of toxic methyl mercury. However, interaction of Hg at the cell membrane-water interfaces and cell uptake can be critical for Hg speciation.

We investigated the interactions of Hg with different Gram-positive and Gram-negative organisms at environmentally relevant Hg concentrations, and in the presence of Cl⁻ and dissolved organic molecules (DOM). The abundance of reactive thiols and the coordination environment of Hg at the cell-membrane-water interfaces were explored using fluoropores (and potentiometric titrations), and XAS, respectively.

Our studies suggest that Hg²⁺ forms Hg-(thiol)₃ complexes below 500 nM of Hg on *B.subtilis* and *S. oneidensis* MR-1, and the predominant complexes change to Hg-(thiol)₂, Hg-thiol, and Hg-carboxylate, progressively, as the Hg concentration increases. Whereas a methylating bacterium, *G. sulfurreducens*, did not exhibit detectable Hg-(thiol)₃ complexes, although their cell membranes have ~ 4-5 times more thiols than *S.oneidensis* MR-1. These differences in Hg-thiol complexes at different cell-membrane interfaces may have been caused by the presence of different types of thiol containing proteins. These Hg-thiol complexes are stable and form in the presence of competing ligands, such as Cl⁻ and DOM. Our results suggest that these Hg-thiol interactions on cell membranes are key players in determining the role of organisms in Hg speciation in the environment.