Hg(0) oxidation by Anaerobic Bacteria

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Background and Objectives: Redox cycling between elemental [Hg(0)] and divalent [Hg(II)] mercury is a key control on the fate and transport of Hg in groundwater systems. Whereas dissolved gaseous elemental mercury [Hg(0)] is mobile in groundwater, while oxidized mercuric mercury [Hg(II)] readily sorbs onto mineral surfaces and organic matter. The objectives of this study were: 1) to determine if anaerobic bacteria catalyzes the oxidization of Hg(0) to Hg(II); and 2) to determine anaerobic Hg-methylating bacteria produce MeHg when provided with Hg(0) as the sole Hg source.

Research Methods: Hg(0) oxidation experiments were carried out with the obligate anaerobic bacteria Geothrix fermentans H5 and Desulfovibrio desulfuricans ND132 and the facultative anaerobic bacteria Shewanella oneidensis MR-1 and Cupriavidus metallidurans AE104. To demonstrate the formation of Hg(II), we performed ethylation experiments and X-ray absorption near edge structure (XANES) spectroscopy on Hg(0)-reacted cell. Finally, samples from experiments conducted with the methylating bacterium strain ND132 were analyzed for the production of MeHg.

Results: All four bacterial strains reacted with dissolved gaseous Hg(0) to form non-purgeable Hg. Derivatization of non-purgeable Hg to diethylmercury and the Hg LIII-edge position of the XANES spectra demonstrated that the Hg(0)-reacted bacterial samples had formed oxidized Hg(II). XANES analysis also revealed that cell-associated Hg(II) was covalently bound to bacterial functional groups, most likely to thiol moieties. Experiments with metabolically active and heat-inactivated cells indicated that both live and dead cells oxidized Hg(0) to Hg(II). MeHg analyses showed that live cells of D. desulfuricans ND132 produced large quantities of methylmercury. The results of this work demonstrate a potentially important pathway in the mercury cycle, whereby anaerobic bacteria produce MeHg when provided with dissolved Hg(0) as their sole Hg source.