Methods to Quantify Mercury Bioavailability in Sulfidic Sediments

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The production of methylmercury (MeHg) in the environment depends, in part, on the speciation of inorganic mercury and the portion that is available for uptake into methylating microorganisms. This research investigated two methods to quantify the bioavailable fraction of mercury in sediments and other settings relevant for MeHg production.

The first approach is a selective leaching protocol that utilized an anoxic leachate comprised of glutathione, a strong chelating ligand for Hg that may mimic sulfhydryl-containing ligands on the surface of methylating microorganisms. For a pre-defined leaching procedure (1 mM glutathione, 1 gram of sediment per 10 mL, and 0.5 h holding time), the results indicated a correlation between glutathione-leachable mercury concentrations and the native methylmercury concentrations in 10 different marine sediments. Further experiments were performed with anaerobic sediment microcosms that were amended with different types of Hg with a known variation in methylation potential. The glutathione-leachable mercury concentrations in these microcosms experiments also correlated to MeHg production. The results demonstrated that a thiol-based leaching protocol may be a more appropriate approach than other methods (e.g. tin-reduction, sequential extractions) for the determination of Hg bioavailability in sediments.

Because of the promising results of the glutathione-based leaching test, we explored the use of diffusive gradient in thin-film (DGT) samplers, a thiol-based passive sampler that can be used as an in situ method for Hg bioavailability. This method has been used previously to determine dissolved metal concentrations in water. However, when DGT samplers are deployed in sediment settings, it is unclear how the presence of small particles affects the performance of the samplers. To test this question, DGT samplers were exposed to solutions containing different formulations of HgS nanoparticles. The amount of Hg accumulated onto DGT was quantified and compared with the dissolved Hg(II) in the solution (quantified by 0.02-i?-m filtration). The speciation of Hg on the resin layer was also identified by X-ray absorption spectroscopy. The results indicated that although the nanoparticles could not pass through the diffusion layer, they deposited on the surface of this layer and possibly clogged the pores of the sampler. As a result, the migration of dissolved Hg through the diffusion layer was retarded in the presence of the nanoparticles. Therefore, the Hg concentration predicted by DGT is smaller than the actual concentration in the bulk solution. The findings of our study have important implications for interpretation of Hg data obtained by DGT samplers in anoxic settings.