Assessing Mercury and Methylmercury Bioavailability in Sediment Using Mercury-Specific DGTs

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Introduction: The primary objective of our research is to develop engineering tools for more cost effective assessment of Hg and MeHg bioavailability in undisturbed sediment. We have developed and optimized mercury-specific hydrogels, which operate on the principle of diffusive gradients in thin films (DGT), and provide a measure of Hg and MeHg lability in sediments. In a series of laboratory experiments, we evaluated the correlation between chemical lability and bioavailability by assessing the respective Hg and MeHg uptake dynamics of DGTs and macroinvertebrates. The results of these exposure experiments were used to assess the potential of the DGTs as biomonitoring surrogates.

Methods:
In a first phase of work, we optimized DGTs for deployment in mercury-impacted sediments by evaluating the effects of the DGT material, thickness, deployment time, and extraction methods on the overall performance. In a second phase of work, we deployed test organisms and DGTs simultaneously in a series of bench-scale time-series experiments to assess the relationship between DGT and benthic invertebrate tissue data. These experiments have been performed using various benthic organisms, and sediments with a range of organic carbon (OC) contents and Hg concentrations. The strength of the correlative relationship between tissue and DGT data was assessed for each of these experiments.

Results:
In the first exposure experiment, we deployed three organisms with separate feeding strategies (*Macoma nasuta*, *Leptocheirus plumulosus*, *Nereis virens*) together with DGTs in a series of exposure vessels containing estuarine sediment from the Penobscot River in Maine. Correlation between tissue and DGT data was good for *M. nasuta* and *L. plumulosus* (*M. nasuta* Total Hg shown in Figure 1), but not for *N. virens*, which physically damaged the DGT devices and oxygenated the DGT/sediment interface.

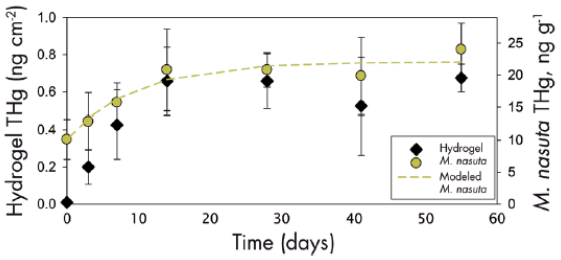

Fig. 1: *M.nasuta and DGT total mercury uptake*.

In the second exposure experiment, we deployed *M. nasuta* together with DGTs in a series of exposure vessels containing estuarine sediments from the Penobscot River in Maine with varying OC contents (8%, 4%, 2%, and 4% with activated carbon amendment). Correlation between tissue and DGT data was good in the 8% and 4% OC vessels, but generally lower than the previous *M nasuta* experiment.
In the third exposure experiment, we deployed *Lumbriculus variegatus* together with DGTs in a series of exposure vessels containing freshwater sediments from Dodge Pond in Connecticut with varying Hg contents (10 ppm, 4 ppm, 1 ppm). Correlation between tissue and DGT data was good for total Hg, but no material amounts of MeHg were observed in tissue samples, despite observing clear MeHg uptake in the DGTs.

Discussion: Though more experimental work and field testing is needed to assess the range of conditions suitable for this application of DGT technology, initial laboratory results demonstrate the potential of DGTs as a tool for assessing Hg and MeHg bioavailability in contaminated sediments.

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