Using Transient Availability Kinetics to Scale Methylmercury Production from Microcosms to Watersheds

GRACE SCHWARTZ,[1] SCOTT PAINTER,[1] KATHERINE MULLER,[2] SCOTT BROOKS[1]

[1]Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN, USA (schwartzge@ornl.gov)
[2]Earth Systems Science Division, Pacific Northwest National Laboratory, Richland, WA, USA

East Fork Poplar Creek (EFPC) in Oak Ridge, TN, USA is contaminated with high concentrations of mercury (Hg). In the EFPC ecosystem, anaerobic microorganisms transform mercury to methylmercury (MMHg), a neurotoxin that bioaccumulates in the food web. Our work develops a kinetic model for net MMHg production in EFPC sediment that accounts for competing processes that may reduce Hg availability for methylation and MMHg availability for demethylation. This transient availability model combines kinetic expressions for multisite sorption of Hg and MMHg, Hg(II) reduction/Hg(0) oxidation, and methylation/demethylation kinetics.

We conducted experiments in two EFPC sediment types: silty and sandy. Stable Hg and MMHg isotopes were used to determine Hg and MMHg sorption rates to the sediments and to track methylation and demethylation in sediment slurry microcosms. The silty sediment has a long water residence time and is relatively anoxic, carbon-rich, and metabolically active compared to the sandy sediment. We found a much higher MMHg production potential in the silty sediment compared to the sandy sediment. The high MMHg production potential, coupled with the long water residence time, indicate that the silty sediment would have greater overall MMHg production in EFPC. However, the sandy sediment displayed lower MMHg sorption, indicating that a large proportion of the MMHg that is produced could be readily delivered to the water column. Our results will be incorporated into a field scale model of EFPC to predict MMHg fluxes within the watershed.