Formation, Size, and Dissolution Behavior of HgS Nanoparticle: Implications for Release from Diffuse Source Zone Soils

E. M. PIERCE[1], J. R. ESKELSEN[1], M. CHIU[1], D. LEONARD[1], X. LU[1], AND B. GU[1]

[1]Oak Ridge National Laboratory, 1 Bethel Valley Rd., Oak Ridge, TN, 37831, USA pierceem@ornl.gov

Remediation of diffuse mercury source zones poses a unique challenge at a wide range of the 3000 mercury-contaminated sites globally. The existence of diffuse sources is particularly challenging in remediating a low-order stream system (i.e., East Fork Poplar Creek [EFPC]) located in Oak Ridge, Tennessee. The EFPC ecosystem received large point-source discharges during the 1950 and 1960s. Although upstream mercury discharges to EFPC have declined, mercury release persist from point and diffuse sources within the industrial facility where mercury was used and from diffuse downstream sources, such as contaminated bank soils. Previous studies identified the presence of mercury sulfide (HgS) in EFPC bank soils, but the processes that govern HgS formation remain unclear.

In this presentation, we report the results from high-resolution electron microscopy and secondary ion mass spectrometry measurements to systematically describe the processes that may lead to the formation of HgS enriched particles in soils. Soil samples were collected from EFPC stream banks and analyzed to identify mercury-enriched particles and to determine their size, elemental composition, and sulfur isotopic ratio. Results from the energy-dispersive X-ray spectroscopy data, confirmed that mercury is generally collocated with sulfur in mercury-enriched particles in EFPC bank soils. Further analysis of the microscopy images indicates that smaller HgS particles hundreds of nanometers in size, aggregate to form the larger micron-sized HgS clusters of 0.15 μm to 4.2 μm in diameter with an average size of 1.4 ± 1.1 μm. We suggest that, these nanometer-sized HgS particles are formed as a result of the precipitation of mercury with microbially produced sulfide. Nanoparticulate or colloidal HgS is widely recognized as a potential source of bioavailable mercury for methylating bacteria. Understanding the mobility and bioavailability of these nanometer-scale particles is an important step in predicting MeHg production in ecosystems.