

Challenges and opportunities of mercury remediation in East Fork Poplar Creek, Oak Ridge, Tennessee

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At the Y-12 National Security Complex (NSC), Oak Ridge, Tennessee, the release of a large quantity of mercury (Hg) in the 1950s and early 1960s resulted in soil and groundwater contamination in source areas, as well as in water and streambeds of the East Fork Poplar Creek (EFPC). Remedial actions at Y-12 NSC have reduced Hg inputs into EFPC by >90% since the early 1980s, but the site and EFPC remain contaminated with inorganic Hg and methylmercury, leading to an elevated Hg in biota. The spatial distribution, speciation, and the extent of Hg contamination in the subsurface of the source zone remain poorly understood. Our research aims to both delineate mercury subsurface distribution and mercury transformation at the water-sediment interface where steep biogeochemical gradients are present.

We report initial research results on field coring/characterization, where large amounts of Hg were present as elemental Hg beads near the source area. Hg speciation analysis and chemical reduction to decrease Hg from the headwaters of EFPC were also studied. Our work shows the importance of kinetic controls in this system that receives a constant source of inorganic mercury which becomes increasingly complexed with natural dissolved organic matter (DOM, at <3 mg/L) along its flow path. The formation of strong Hg-DOM complexes prevents Hg(II) from being reduced by stannous chloride (SnCl_2), and the magnitude of the effect increases with distance downstream. Therefore, field manipulative tests were conducted at the headwater to evaluate chemical reduction using Sn(II) to convert dissolved Hg(II), to dissolved gaseous elemental mercury, Hg(0). Our results show that, when $\text{Na}_2\text{S}_2\text{O}_3$ was used as dechlorinating agent and SnCl_2 as the chemical reductant, approximately 35% of the total Hg in the headwater was converted to Hg(0). Additional Hg was mobilized in the drainage pipe by complexation with the added $\text{S}_2\text{O}_3^{2-}$. Using ascorbic acid as a dechlorinating agent, however, resulted in an effective removal of residue chlorine and also a conversion of ~15% of the Hg(II) to Hg(0). Addition of Sn(II) following dechlorination achieved an overall conversion of Hg(II) to Hg(0) of 92% in the headwater. The fate of residue Hg varies, but often results in methylmercury formation in natural waters. The biogeochemical factors are found to closely link to the type of the bacteria, as shown by the correlation of methylmercury and a sulfate reducer *Desulfobulbus* spp in EFPC. Efforts continue to seek a fundamental understanding of the mechanisms that govern Hg transformation and behavior, which may provide technology solutions to mitigate the adverse impact on the environment.