Factors influencing sediment methylmercury concentrations in a mercury contaminated creek

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East Fork Poplar Creek (EFPC) in Oak Ridge, TN, originating within the Y-12 National Security Complex (Y-12), has elevated mercury concentrations as a result of historical Hg use at Y-12. Streamwater total mercury (HgT) concentrations decrease downstream but methylmercury (MeHg), produced in-situ by microorganisms, increases downstream. To evaluate processes controlling the concentration of MeHg in this system, sediment cores were collected quarterly at two locations 17 km apart in EFPC between October 2010 and August 2012. MeHg sediment concentrations are most strongly correlated with organic carbon content, confirming the known influence of carbon in the production and storage of MeHg. Significant correlations ($p < 0.001$) were observed between MeHg and HgT, Fe(II) and reduced inorganic sulfide. Methylation and demethylation potentials were determined in sediment cores beginning in August 2011. Strong correlations ($p < 0.001$) exist between methylation potentials and ambient MeHg concentrations at both sampling locations, suggesting that sediment MeHg is partially due to an active MeHg production. Demethylation potentials were not correlated with ambient MeHg concentrations but average demethylation potentials were significantly higher at the upstream sampling location. Sediment cores were also collected from an ephemeral stream running through the EFPC floodplain and these cores were collected even when the stream was stagnant or dry. In core samples collected in October 2011 and January 2012, high concentration of MeHg were measured but methylation potentials were low indicating MeHg must be accumulating (e.g. not exported to the stream). In April 2012 MeHg concentrations were lower but methylation potentials were higher suggesting that MeHg had been transported out of the floodplain soils. Within the ephemeral stream, seasonally driven differences in temperature and water accumulation appear to strongly influence the cycling of MeHg.