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Quantification of Mercury in Surficial Sediments Surrounding the Charleston Harbor System

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Mercury (Hg) is a globally distributed trace metal whose redox transformations and methylation to the neurotoxic molecule methylmercury, poses persistent ecological and human health risks. Coastal marsh and estuary systems are particularly vulnerable to Hg accumulation due to fine-grained sediment accumulation, elevated organic matter content, high rates of sulfide formation, and, oftentimes, proximity to industrial activity [1]. As sea-level rise, storm intensity, and shoreline erosion intensify, previously buried Hg can be remobilized, amplifying exposure risks in coastal communities and beyond. Despite extensive research on Hg biogeochemistry, knowledge of total Hg (THg) inventories and source attribution remains underconstrained in many southeastern U.S. estuaries. This study quantifies THg concentrations and sedimentological controls across the ~130 km^2 Charleston Harbor estuarine system in South Carolina, an industrialized coastal complex influenced by historic and modern contaminant inputs.

A sampling framework (n=70 sites) throughout the estuary integrates marsh platforms, back-barrier environments, harbor sediments, and urban margins. Sediment cores (0-30 cm) were sectioned to evaluate depth variability and relate to potential historic inputs. Approximately 500 samples from these sites were analyzed for THg using thermal decomposition (Milestone DMA-80 evo). Grain-size distributions (laser particle size analyzer) and organic matter content (loss-on-ignition) are quantified to assess sedimentary controls on Hg storage and mobility. Remote sensing and historical land-use records are incorporated to evaluate legacy industrial inputs to inform a conceptual Hg transport model under present and future climate scenarios.

Our preliminary data showed that mercury loading is approximately 2× higher on the Charleston peninsula than at sites away from it. By broadening the study area and integrating geochemical and spatial analyses, we further detail Hg distribution and possible sources in the Charleston region. We also examine how climate-driven hydrodynamic changes may impact future Hg remobilization. These results advance understanding of trace metal cycling at the land-sea interface and inform coastal resilience planning in a warming world.

[1] Sunderland, Gobas, Branfireun & Heyes (2006) *Marine Chemistry* 102, 111–23.