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X-ray absorption spectroscopy analyses of arsenic biogeochemistry in contaminated wetland sediments impacted by historic gold mine tailings

VALENTINA LOPEZ REDONDO[1], ALEX M. BEAUCHESNE[1], DAVID M. LEWIS[2], E. EMILY V. CHAPMAN[2], LINDA M. CAMPBELL[2] AND JOYCE M. MCBETH[1]

[1]University of Regina
[2]Saint Mary's University

Muddy Pond, located in the Historic Gold Mining District of Waverley, Nova Scotia, is one of numerous wetlands impacted by gold mining activities in the region. Sediments in Muddy Pond are enriched in arsenic (As) due to disposal of tailings in the pond (1860s - 1940s). Elevated As levels have also been found in the pond water, plants, invertebrates, fish, and amphibians, demonstrating that As has moved and accumulated across the trophic levels. This raises concern because As is toxic, especially in its inorganic trivalent form [As(III)]. This study aims to characterize the spatial variability of arsenic biogeochemistry in Muddy Pond to support our ongoing evaluation of a Thin Reactive Amendment and Protective Capping (TRaP) system to remediate the pond. Triplicate sediment cores were collected along a hydrological transect that included: A) core from above the shoreline where the surface is generally exposed to the atmosphere and not fully saturated, B) intermittently saturated and submerged core from the shoreline of the pond, and C) permanently saturated and submerged core from the pond. The cores were split under argon gas, described based on visual inspection, and samples were taken vertically at 5 cm intervals, including the dark surficial organic layer (present in all cores). The cores exhibited strong changes in colour consistent with changing oxidation conditions, with greater evidence of oxygen ingress in the cores at the shoreline and above the shoreline (i.e., Core A was mostly orange throughout, Core B had an orange layer for the first 10 cm below the surface that transitioned to grey at depth, and core C was mostly grey). The chemical forms of arsenic and iron have been analyzed using synchrotron-based X-ray Absorption Spectroscopy (XAS) at the As and Fe K-edges; LCF results of those data will be presented here. Future planned work includes additional XAS analyses and μ-XRF mapping with μ-XAS, as well as mineralogical and microbiological analyses. This data will be used to study the chemical phase associations of arsenic (e.g., with iron and organic phases), as well as microbial influences on As mobility and bioavailability in this system.