Combining Geochemical Measurements and Omics to Investigate Competitive Anaerobic Redox Dynamics in Sediments

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Both stream and wetland sediments are dynamic and play a large role in surface water quality based on the capture, release, and transformation of nutrients and contaminants (e.g., U and Hg). River sediments may be exposed to large variations in water discharge and particulate depostion, whereas particulates may collect for longer periods of time in wetland sediments. Despite the importance of these two environments in organic matter remineralization and contaminant mobilization, a comprehensive understanding of the biogeochemical processes taking place in these sediments is lacking and carbon transformation cannot be predicted accurately by current reactive transport models. In this study, a combination of meta-omic (genomic, transcriptomic, proteomic) and geochemical signatures were used to identify the main anaerobic microbial processes in Hg-contaminated stream sediments from East Fork Poplar Creek (EFPC) in Oak Ridge, TN (USA) and pristine wetland sediments from the Savannah River Site (SRS) in Aiken, SC (USA), as a proxy for U contaminated sediments. High resolution depth profiles of $O_{2(aq)}$, NO_3^-, Mn^{2+}, Fe^{2+}, soluble organic-Fe(III), SO_4^{2-}, and $\sum H_2S$ demonstrate Fe(III) reduction dominates anaerobic respiration processes in SRS wetland sediments, whereas EFPC river sediments are dominated by a combination of NO_3^- and metal reduction. Differences in peptides corresponding with redox zones were observed by mass spectrometry in EFPC sediment cores. Incubations conducted with sediment from both locations were amended with varying combinations of NO_3^-, Fe(III) oxides, and SO_4^{2-} as either single or dual terminal electron acceptors to investigate the competitive dynamics between metabolic processes from both a geochemical and omics prospective.