

Deciphering the role of anaerobic microsites for hot spot/hot moment dynamics of metal redox chemistry and methane emissions within riverine floodplains

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Rates and reactions of biogeochemical (BGC) processes vary in space and time to produce hot spots and hot moments of elemental cycling. These dynamics are particularly complex at terrestrial-aquatic interfaces (TAIs), such as riverine floodplains with strong redox fluctuations. Anoxic microsites are zones of oxygen depletion in otherwise oxic soil environments, which can serve as redox hot spots at TAIs, generating and exporting anaerobic BGC products, such as CH₄, to the overall oxic surrounding environment. Particle-associated models explain methanogenesis in oxic lake waters. Similarly, rather than having special adaptations, we hypothesize that TAIs surface methanogen activity may be confined to anoxic microsites. However, despite the importance of anaerobic microsites in TAIs, significant knowledge gaps still exist regarding their abundance, spatial distribution, and specific contributions to BGC processes such as CH₄ production. Therefore, this study aims to quantify the abundance and contribution of anaerobic microsites to methanogenesis and elucidate their role in metal redox chemistry relevant to methane cycling at TAIs. Sediment cores from riverine floodplains in East River, CO with high and low in-situ methane fluxes are chosen for this study. To quantify the abundance, spatial distribution and chemical speciation of anoxic microsites, we will utilize the novel Laboratory for Observing Anoxic Microsites in Soils (LOAMS) approach that utilizes synchrotron-based X-ray fluorescence 2D mapping. We hypothesize that the redox chemistry and localized metal chemistry within anoxic microsites are strongly correlated to methanogenesis in bulk soils. In order to test the hypothesis, we characterize the bulk physico-chemical properties (pH, soil organic matter, elemental speciation) along with metal redox chemistry (Fe, Mn, S) within anaerobic microsites identified to exhibit the highest and lowest methane emissions. Additionally, collected pore-water samples will also be analyzed for aqueous concentrations of org-C, N, S, and metals. Anticipated outcomes include a comprehensive understanding of anaerobic microsite contributions to redox-active metal biogeochemistry and methane emissions in TAIs.