Influence of hyporheic exchange on coupled S-Fe-C biogeochemical cycling in riparian wetland sediments

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Riparian wetland hyporheic zones, where oxic surface water and anoxic groundwater mix, exhibit spatiotemporally dynamic conditions that drive steep redox gradients and promote hotspots of diverse and fluctuating microbial activity. Growing evidence suggests that highly active “cryptic” sulfur redox processes drive the fate of iron and carbon in riparian wetlands including the production of reactive intermediate S species that promote further biotic and abiotic redox reactions such as those coupled with Fe reduction and methane oxidation, thus supporting higher rates of sulfur biogeochemical cycling than otherwise expected in these low sulfate environments. As “cryptic” sulfur redox processes are not well constrained in freshwater systems, much uncertainty remains as to how these processes effect the fate of Fe and CH_4 and respond to dynamic hyporheic fluxes in natural field settings. The overall goal of this research is to develop a mechanistic understanding of coupled biotic-abiotic Fe-S-C cycles in hydrologically dynamic wetland sediments. One of our specific objectives is to evaluate the microbial community structure and potential function driving these cycles. 16S rRNA and fungal internal transcribed spacer (ITS) sequencing was used to investigate the microbial communities inhabiting 6 different sites in an organic-rich riparian wetland at Tims Branch, part of the Argonne Wetland Hydrobiogeochemistry SFA. Preliminary results reveal a diverse microbial community dominated by phyla Proteobacteria, Acidobacteriota, Chloroflexi and Actinobacteriota. Fungal communities were dominated by Ascomycota, Mortierellomycota and Basidiomycota in these sediments. Seasonal variations in geochemical and hydrologic conditions and sediment depth affected the relative abundance of these phyla. For example in wetland sediments under gaining stream conditions, aqueous iron increased at depth, the relative abundance of Crenarchaeota decreased substantially at those depths in both January and August. In January, sulfate concentrations in the wetland sediments decreased at the top 0-5 cm interval and then increased at greater depths, which was reflected in a decrease in the relative abundance of sulfate-reducing Desulfobacterota from shallower to deeper depths. Despite an opposite trend in sulfate concentrations in the wetland sediments in August as a result of hyporheic fluxes, an opposite trend was not observed for the relative abundance of Desulfobacterota suggesting a potential role of abiotic Fe-S cycling processes. These results indicate that hyporheic fluxes and fast redox processes impact microbial distribution. Further work, with respect to this objective will focus on correlating hydrological and geochemical parameters with microbial community structure and function to acquire a deeper understanding of the role microbes play in Fe-S-C cycles in these wetlands.