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ABSTRACT TITLE: Linking Chemical Signatures and Microbial Communities that Affect Carbon Cycling in Northern Peatlands

ABSTRACT: Global peatlands sequester half as much carbon as that contained in the atmosphere. However, the response of these large carbon reservoirs to global warming remains uncertain. In this presentation the results of experiments designed to identify the reactive and refractory dissolved organic matter (DOM) pools and the composition of solid phase peat in a bog habitat within peatlands in the Marcell Experimental Forest, northern Minnesota, will be described, along with accompanying differences in microbial communities. These experiments included advanced analytical techniques[1] (ultrahigh resolution (UHR) mass spectrometry, PARAFAC modeled 3-D excitation-emission matrix [EEM] fluorescence spectroscopy), ^{13}C and ^{31}P NMR, FT IR spectroscopy and a combination of next generation sequencing and metagenomics.[2] Surface peat (0-10 cm) was characterized by high carbohydrate concentrations, high C/N , and relatively low aromaticity . Concentrations of organic P in the solid phase were relatively small and were dominated by orthophosphate monoesters (25–35 mg P $kg^{-}1$ soil), with smaller concentrations of orthophosphate diesters (5–7 mg P kg^{-1} soil). Surface DOM was characterized by high DOC concentrations, low aromaticity and abundance of amino-sugars and proteins derived from plant materials. In more decomposed layers at 30-50 cm depth, UHR mass spectra identified distinctly different reactive and refractory DOM pools, as well as the appearance of lipid-like compounds of apparent microbial origin both in the solid phase peat and DOM. PARAFAC modeled EEM revealed fluorescent components (products and reactants) that were consistent with microbial processing. An increase in the amount of phosphonates was observed at this depth and was coincident with a decrease in orthophosphate. This shift was accompanied by an increase in the organic nitrogen both in the solid and aquous phases. Below 75 cm, slower degradation of organic matter under anaerobic conditions and stable enzymatic activity was observed, along with an increase in the degree of humification of both the solid and aqueous phases that was reflected by an increase in the amount of condensed hydrocarbons. Inorganic phosphorus (orthophosphate) becomes the most abundant form of phosphorus below 75cm, suggesting a surprising reactivity or organic-P. Microbial community structure corresponded strongly to the vertical stratification of dissolved organic matter (DOM) and solid phase quantity and composition. Taken together, the microbial, chemical and spectroscopic analyses of different peat bog profiles have identified three distinct zones within the peat formation that have unique properties. Quantity and quality of DOM, solid phase peat and surface vegetation were significant variables governing microbial community turnover spatially and seasonally.