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Assessing the influence of biogeochemical constraints on the enzymatic degradation and mineralization of peat

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Northern peatlands are important long-term sinks of atmospheric carbon (C) due peat accumulation rates greater than rates of decomposition. Slow decomposition in northern peatlands is due to the presence of water saturated and low oxygen conditions, low temperatures, and decay resistant plant litter. The activity of extracellular enzymes produced by soil microbes is the first step in decomposition however, the relative importance of these abiotic and biotic variables in constraining extracellular enzyme activity remains poorly known. To address the multiple proposed mechanisms of what constrains peat enzyme activity, this study manipulates the biochemical controls associated with the inhibition and stimulation of enzyme activity. These biochemical constraints are regulated by abiotic (redox conditions and temperature) and biotic (organic matter source) factors. A 90-day incubation was carried out using peat from hummock and hollow microforms and peat was maintained under oxic and anoxic conditions at 20°C. Replicates of each microform and redox condition was amended as the following treatments: control, Fe addition, phenolics addition, oxidative enzyme addition, pH manipulation, nutrient addition, and pH manipulation and nutrient addition. Extracellular enzyme kinetics and temperature sensitivity (Q_{10}) of 6 hydrolytic and 2 oxidative enzymes was determined for each microform prior to treatment. Respiration rates of CO_2 and CH_4 were monitored throughout the incubation period. Following the termination of the incubation the enzyme kinetics and temperature sensitivity was determined for each treatment. This study provides the first comparison of multiple proposed mechanisms of what constrains peat enzyme activity within a single study. These results improve our understanding of what controls peat decomposition by assessing the relative importance of environmental, biological, and molecular resistance to enzymatic decay.