Redox properties of particulate organic matter from northern peatlands

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Northern peatlands are a major terrestrial carbon pool, storing an estimated 15-30% of the global soil carbon in the form of peat organic matter. While storing carbon, northern peatlands also emit the potent greenhouse gas methane (CH_4), at an estimated rate of 36 Tg C per year (Tg = 10^{12} g). Therefore it is critical to understand the processes that control CH_4 dynamics in northern peatlands. Based on field and laboratory studies of CO_2 and CH_4 emissions from these systems, it has been hypothesized that methane emitted from northern peatlands may be partially suppressed by peat particulate organic matter (POM), which may act as a terminal electron acceptor in anaerobic microbial respiration. A key gap in this hypothesis is the quantification of the redox properties of POM, specifically its electron accepting capacity (EAC).

Here, we introduce a spectrophotometric method to quantify the EAC of POM. We compared the new method to EAC determined by mediated electrochemical reduction, and tracked the redox state of peat over a reduction-oxidation cycle. The EAC of a model dried peat material was in the range of 0.3-0.4 mmol electrons per gram POM.

The spectrophotometric method developed here allows for direct and systematic evaluation of the redox state of POM without requiring access to electrochemical equipment. Combined with previous calculations that POM comprises >90% of the organic matter in peatlands, this work suggests that POM can act as a significant terminal electron acceptor in anoxic parts of peatlands and thereby significantly lower methane emissions.