Do all 'Bogs" have Similar Anaerobic Carbon Dynamics and Microbial Community Structure? Putting the SPRUCE Site in a Regional Perspective

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The S1 peatland in Minnesota where the SPRUCE experiment is located has typically been described as an ombrotrophic (i.e., rain-fed) bog, but recent evidence suggests that it is weakly minerotrophic (i.e., occasional ground-water inputs into surface peat layers). It also has extensive hummock/hollow development. We compared seasonal CH4 fluxes, anaerobic C cycling, and microbial gene and transcript abundance in S1 to a nearby poor fen (Bog Lake Fen [BLF]) and to a true ombrotrophic bog (Zim) to examine to what degree S1 represents regional Sphagnum-moss dominated, low pH peatlands. Zim differs from S1 in being primarily covered by Sphagnum hummocks, whereas BLF is primarily covered by a Sphagnum and graminoid lawn.

CH4 emissions were high in S1 and BLF but very low in Zim, with isotopic data suggesting extensive CH4 oxidation in Zim. In situ rates of CH4 production in July 2013 were relatively high in surface peat in S1 hollows and BLF but decreased dramatically with depth. Rates in Zim and S1 hummocks were low throughout the peat profile, partially reflecting for Zim lower soil temperatures. Production potentials over 153 days at 18°C showed Zim peat to have a longer (~ 1 month) lag period before substantial CH4 production compared to the other sites. All peats had very low CH4 production potentials in deeper peat. In situ porewater CH4 concentration profiles were similar for all sites. Isotopic data suggested that the acetoclastic CH4 pathway was most important in surface BLF peat and the H2/CO_2 pathway was dominant throughout the peat profile in S1 and Zim. Chemical characterization of DOM and solid peat generally indicated that S1 and Zim were similar at a particular depth and could not explain differences in CH4 production potentials.

There were no differences in mcrA gene or transcript abundance among sites, but the mcrA transcript-to-gene ratio was highest in S1, in concordance with its high CH4 production potential. Surface peat pmoA gene and transcript abundances were much higher in Zim and BLF compared to S1, and the transcript-to-gene ratio was highest in Zim, supporting an interpretation of high CH4 oxidation at that site.

Our results indicate substantial differences in CH4 emissions, anaerobic C cycling dynamics, and microbial functionality in these three peatlands despite them all having low pH and being covered by Sphagnum mosses. S1 appears to be intermediate in many ways between true ombrotrophic bogs and poor fens, reflecting its weakly minerotrophic status.