

LIMITED CARBON EMISSIONS FROM MINERAL PERMAFROST UPON INITIAL THAW

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ABSTRACT

Polar region temperatures are rising 2-3x faster than the global average and the top 3m of permafrost store ~2x the current atmospheric carbon (C) concentration. This warming is thawing permafrost and releasing greenhouse gases. I collected permafrost core from two sites near Fairbanks, AK and incubated samples from these cores at 2°C, 6°C, and 25°C to quantify potential C emissions. I incubated soil from the organic-rich (C_{org} -rich) active layer, talik (C_{org} -poor), and permafrost (C_{org} -poor). Only the C_{org} -rich active layer (all temperatures) produced CH_4 . After adding porewater from CH_4 -producing samples to permafrost samples, only some permafrost began producing CH_4 . These results show that C_{org} -poor soils do not produce CH_4 upon initial thaw and also suggest that recent, more labile, C_{org} is driving methanogenesis. CH_4 production may begin as C_{org} is transported, but other factors (i.e., limited methanogens) may still restrict methanogenesis. C_{org} -poor soils produce little CO_2 at colder temperatures, potentially from low microbial activity and/or mitigation by acetogenesis. Specifically, the highest CO_2 and CH_4 production occurred at 25°C, where C gas concentrations continue to increase over time (all samples). CO_2 concentrations in C_{org} -poor soils at 2°C and 6°C were stable or decreased. Overall, this study finds limited C emissions from C_{org} -poor soils, especially at colder temperatures. Permafrost C cycling is poorly represented in climate models and many incubation studies used to inform these models focus on near-surface, C_{org} -rich soils in poorly drained landscapes (e.g. bogs and fens). Those sites are often large C sources, but this study shows deeper, C_{org} -poor permafrost does not exhibit the same level of C emissions. Since mineral soils comprise ~87% of northern region permafrost, it is important to quantify C cycling across a range of C_{org} contents and soil depths to avoid overestimating C emissions from newly thawed permafrost.



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