Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.19606

The role of iron in thawing permafrost peatlands

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Association of organic carbon (OC) with iron (Fe) minerals has been identified as an important mechanism for protection of OC against microbial degradation [1]. This process has been mostly studied in oxic terrestrial soils and oxygen-limited marine sediments [2], but it is being increasingly recognised that Fe-OC associations can play an important role in thawing permafrost soils. Up to 20% of OC can be associated with Fe minerals in oxic peat of palsas (frozen peat mounds). However, under the waterlogged, anoxic conditions caused by permafrost thaw this association can break down during reduction of Fe and consequently release the previously protected OC [3]. Despite the potential importance of these Fe-OC associations for carbon storage and release in permafrost peatlands, our understanding of their stability, Fe minerals involved, and the role of Fe as a nutrient for greenhouse gas production in waterlogged peatlands rely on very limited data. We sampled peat and pore water across thaw gradients in eight palsa mires in the discontinuous permafrost region of northern Sweden and Norway to investigate the interaction of Fe and OC during permafrost thaw and palsa collapse. Our results indicate that mineral protection of OC is highly variable. Although dissolved OC concentrations were higher in peatlands with more pore water Fe, as expected, the amount of Fe released upon thaw varied across sites and appeared to be affected by peat depth and the composition of underlying sediment or rock. Understanding differences between these peatlands will help to predict different drivers of carbon emissions triggered by permafrost thaw across northern Scandinavia.

[1] Kaiser and Guggenberger (2000), Org. Geochem., 31, 711-725. [2] Longman et al. (2022), Global Biogeochemical Cycles, 36, e2022GB007447. [3] Patzner et al. (2020), Nat. Commun., 11, 6329.