Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.25689

Natural organic matter in a permafrost peatland – dual role as carbon source for CH_4 and CO_2 formation and electron acceptor for anaerobic CH_4 oxidation

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Permafrost peatlands represent a major stock of organic carbon. As a consequence of global warming and the resulting permafrost thawing, these peatlands are expected to turn into a carbon source due to the mobilization and rapid decomposition of accumulated organic carbon (natural organic matter, NOM) by microorganisms. However, the extent to which the organic carbon stored in the peatlands will become bioavailable and can be turned into greenhouse gases $CH_4$and CO_2 is not clear. On the one hand the association of the organic carbon with Fe(III) minerals was suggested to have the potential to protect the organic carbon from degradation in the peatland soil [1] as well as in thaw ponds where Fe-C_{org} aggregates form after permafrost thaw [2]. On the other hand, permafrost thaw leads to water-saturated anoxic conditions followed by microbial Fe(III) mineral reduction and dissolution leading to mobilization of the Fe-associated organic carbon [3]. Very recently we were able to show that the microbial reduction of Fe-C_{org} aggregates directly influenced the activity of microbes catalyzing fermentation and the degradation of complex organic matter as well as the formation and emission of CH_4 and CO_2 [4]. In this presentation we will show how the complex interactions of the biogeochemical carbon and iron cycle influences the mobility and bioavailability of organic carbon in a model permafrost peatland (Stordalen Mire, Abisko, Sweden). In particular we will discuss new work on the role of redox-active NOM as electron acceptor for anaerobic methane oxidation.

[1] Patzner et al. (2020) *Nature Communciations*, **11**, 6329.

[2] Chauhan et al. (2020) *Science of the Total Environment*, **946**, 174321.

[3] Patzner et al. (2022) *Nature Communications Earth & Environment*, **3**, 76.

[4] Voggenreiter et al. (2025) *Soil Biology & Biochemistry*, **203**, 109735.