

Effect of iron-organic carbon coprecipitates on greenhouse gas release across a permafrost thaw gradient

EVA VOGGENREITER¹, MAIKE FRIEDEL¹, ANDREAS KAPPLER² AND PRACHI JOSHI³

¹University of Tübingen

²University of Tuebingen, department of Geosciences, Geomicrobiology

³University of Tuebingen

Presenting Author: eva.voggenreiter@uni-tuebingen.de

Permafrost soils currently store about twice as much organic carbon (OC) than the atmosphere. Due to climate change, large parts of permafrost soils will thaw, causing increased microbial activity and higher greenhouse gas (GHG) emissions. The association of OC with soil minerals is one important factor impacting the bioavailability of OC. On the one hand, minerals with high surface area, such as poorly crystalline ferric iron (Fe(III)) oxyhydroxides or Fe(III)-OC coprecipitates, could lower OC bioavailability under oxic conditions. On the other hand, increasingly waterlogged, anoxic conditions due to permafrost thaw will lead to microbial Fe(III) reduction which would directly produce CO₂ by respiration as well as release the previously associated OC, making it potentially bioavailable to other microorganisms. In this project, we thus aim to elucidate the role of Fe-OC coprecipitates on GHG release across a gradient of permafrost thaw from intact palsas to partly thawed bog and fully thawed fen areas. We first incubated synthesized Fe-OC coprecipitates *in situ* inside passive porewater samplers in a subarctic permafrost peatland (Stordalen Mire, Abisko, Sweden) across the three thaw stages. We quantified net GHG emissions of the soils around the samplers prior to and 7 weeks after the addition of coprecipitates. CO₂ and CH₄ emissions were both lower in the bog but higher in the fen upon addition of coprecipitates compared to the sites without coprecipitates. Second, we performed field-based measurements targeting dissolved Fe(II), organic carbon (DOC) and CH₄ concentrations in porewater from 5 to 43 cm depth. With increasing thaw, the average DOC concentrations decreased from 6.4 mM in palsa hills to 3.8 mM in fen areas while dissolved Fe(II) and CH₄ concentrations increased. To understand the processes behind these field-based observations, we set up a laboratory microcosm experiment in which ⁵⁷Fe-labelled Fe-OC coprecipitates were added to soils from palsa, bog, and fen areas. Over the course of the incubations, we followed Fe speciation in the dissolved and solid phase and quantified GHG emissions. The results of these experiments will ultimately elucidate the role of Fe-OC coprecipitates as a future OC sink or source in thawing permafrost peatlands.