

## **Dynamics of the rusty carbon sink along a permafrost thaw gradient**

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Significant amounts of carbon stored on Earth are locked away in the permanently frozen peatlands of high latitude and high altitude regions. Under current trends and future predictions of increasing temperatures due to climate change, substantial concern exists regarding the consequences of permafrost thaw for carbon mobilization and greenhouse gas emissions. Nevertheless, these future emissions are still missing from climate models and are currently considered as one of the greatest uncertainties in future climate predictions. It is well known that iron minerals can strongly bind carbon compounds, thus carbon bioavailability and consequently probably also CO<sub>2</sub>/CH<sub>4</sub> emissions may depend on formation, transformation and dissolution of iron minerals, in particular iron(III) (oxyhydr)oxides. However, it is unclear whether iron minerals play an important role in carbon storage in permafrost regions. In this study, we have characterized the dynamics of this “rusty carbon sink” across a thaw gradient in Abisko (Northern Sweden) where wetlands are expanding rapidly due to permafrost thaw. Using both bulk (selective extractions, EXAFS/XANES) and microscale analysis (correlative SEM and nanoSIMS) we have investigated changes in Fe-C associations. In palsas regions underlain by intact permafrost, up to 20% of the carbon is associated with poorly crystalline Fe(III) oxides. However, along the thaw gradient, we observed a transition to more reducing conditions alongside an increase in Fe(III)-reducing bacteria which led to mineral dissolution and increasing Fe(II) concentrations in the pore water (up to 1 mM). In the wet soils, Fe(II)-OM complexes are present (up to 30% of the iron is complexed to OM). Overall, the amount of iron associated with organic matter decreased along the thaw gradient (from up to 70% to 45% of the iron). Our results showed that poorly crystalline Fe(III) phases can protect up to 20% of the total organic carbon as long as conditions are not fully reducing. When these soils become waterlogged, the protected carbon is released into solution.