

Iron minerals as drivers of carbon release during permafrost thaw

Context and objectives

Permafrost soils are a major stock of soil organic carbon, storing an estimated 1300 Pg of carbon. However, this carbon stock is vulnerable to thaw; a process which releases large quantities of carbon in the form of greenhouse gases (CO₂ and CH₄). Recent research suggests that iron minerals and the iron biogeochemical cycle are principal drivers of carbon release in thawing permafrost soils. However, little is known about coupled iron and carbon dynamics in Icelandic permafrost landscapes, where high rates of aeolian deposition lead to uniquely mineral-rich peat soils and palsas. This project will investigate the role and importance of mineral-bound organic carbon in thawing permafrost soils from Orravatnsrústir; a palsa landscape in the Icelandic highlands.

Methodology

The project will be completed with soil, porewater and stream samples collected from the Orravatnsrústir palsa site; one of the largest and most well developed palsa sites in Iceland. If timing allows, the MSc student will participate in the field work (planned for early August, 2024). A broad range of field methods will be applied, including sampling of soil cores, soil porewater, and streamwater. Collected samples will be analyzed in the Environmental Chemistry laboratory at UNINE. Planned analyses include sequential extractions of soil samples targeting various iron mineral fractions and subsequent analyses of the amount of carbon found in each fraction. Analysis of total element contents and dissolved organic carbon in the porewater and stream samples will provide information on the amount of carbon exported out of the palsa site. The results of this project will provide first quantitative measurements of mineral-bound organic carbon in the active layers of Icelandic permafrost soils.

Supervision and collaboration

The project will be supervised by Prof. Laurel ThomasArrigo and a Postdoc/PhD student in the group (to be determined) and will be carried out in collaboration with Dr. Starri Heiðmarsson; guest professor at the Agricultural University of Iceland and Director of the Northwest Iceland Nature Research Centre.

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Figure 2. Aerial photo of the Orravatnsrústir palsa site (A) and examples of iron- and carbon-rich precipitates found in wetland streams in Iceland (B).