Université de Neuchâtel
Centre d'hydrogéologie
et géothermie

MSc in Hydrogeology and Geothermics

Thesis topic proposal 2026

# Controls on greenhouse gas emissions along a thaw gradient in Icelandic permafrost soils

## Context and objectives

**Figure 1.** Aerial photo of the palsa site showing intact palsas (pale green) and waterlogged, collapsed palsas surrounded by small ponds.

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 ($CO_2$ and $CH_4$). Recent research suggests that the iron biogeochemical cycle is a principal drivers of carbon release in thawing permafrost soils. However, little is known about coupled iron and carbon dynamics in permafrost soils in Iceland, where high rates of aeolian deposition lead to uniquely iron mineral-rich soils. Understanding mineral controls on the dynamics of soil organic carbon is key to predicting the effects of climate change on these carbon reservoirs. This project will investigate the role and importance of mineral-bound organic carbon across a thaw gradient at Orravatnsrústir; a dynamic palsa landscape in the Icelandic highlands.

## Methodology

This project will measure the release of greenhouse gases ($CO_2$ and $CH_4$) along a thaw gradient at the Orravatnsrústir palsa site in the Icelandic highlands. Field methods to be applied include sampling of soil cores, soil porewater, and streamwater. To complement these field measurements, a laboratory-based soil incubation will be conducted using soils collected along the thaw gradient. Here, in addition to gas flux measurements, a broad range of wet chemistry techniques will be employed, including measurements of pH, Eh, and dissolved organic carbon and dissolved Fe. All samples will be analyzed in the Environmental Chemistry laboratory at UNINE.

Field work is planned for July/August 2026, processing of some samples will begin in September at UNINE.

**Literature:**

Patzner, M. S.; Mueller, C. W.; Malusova, M.; Baur, M.; Nikeleit, V.; Scholten, T.; Hoeschen, C.; Byrne, J. M.; Borch, T.; Kappler, A.; Bryce, C. (2020) *Nature Commun.*, 11(1).

## Supervision and collaboration

The project will be supervised by Prof. Laurel ThomasArrigo and a Postdoc/PhD student in the Environmental Chemistry group (to be determined)

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