Investigations of glacial forelands:
Tracing the impact of deglaciation on rock weathering and microbial colonization

Climate change is reshaping our planet, accelerating the retreat of glaciers, and exposing landscapes to new environmental conditions. This project examines these profound transformations in the Qaanaaq Glacier foreland in Greenland and the Athabasca Glacier foreland in Canada, focusing on how different rock types - sandstone in Greenland and limestone in Canada - adapt to these new circumstances. These sites provide a unique view into the past and present effects of climate dynamics on geomorphological and microbiological processes, offering critical insights into the changing world.

Our research aims to deepen our understanding of how these newly exposed landscapes evolve under different environmental conditions. The project will specifically investigate the pace and nature of rock surface decay and the colonization of these surfaces by microorganisms, which can influence mineral transformations and contribute to the ecological dynamics of these proglacial areas.

The project's objectives are:

- To determine the rate of weathering changes, development of micro-relief, and mineral transformations.
- To distinguish spectral characteristics of rocks recently exposed by glacier retreat from those that were covered by ice for longer periods.
- To identify geomicrobiological characteristics by analyzing the taxonomic composition of microorganisms on weathering rind.

Field studies will include measurements of physical changes on rock surfaces, from the youngest rocks near the glacier margins to the oldest from the maximum extent of the Little Ice Age (19th century). This will allow us to estimate the rate of rock surface degradation and changes in weathering processes. Advanced in-situ techniques such as UAV (Unmanned Aerial Vehicle) mapping; Schmidt hammer tests, electronic profilometry, and spectroradiometry will be used to collect detailed data on terrain morphology, rock hardness, micro-roughness, and the interaction of radiation with weathering rinds.

In the laboratory, we will conduct detailed analyses of samples, to support and extend the fieldwork findings, including optical microscopy to study mineral composition and texture, scanning electron microscopy (SEM) to examine surface microstructures and microbial communities, X-ray diffraction (XRD) to identify mineral changes and characterize weathering rinds, and DNA sequencing to identify microorganisms and analyze ecological interactions.

The following research hypotheses are proposed:

- There is a significant rate of rock surface decay (visible in a dozen or so years after deglaciation), manifested by rapid development of surface micro-roughness, weathering rind, rock surface weakening, and chemical alteration of minerals on the rock surface.
- These transformations can be detected using advanced spectral analysis techniques, potentially allowing for the relative dating of glacial formations.
- Microorganisms colonizing weathering rind play a crucial role in geochemical cycles, impacting rock weathering processes and ecosystem dynamics.

This project not only contributes to our scientific understanding of geomorphological and microbiological processes but also underscores the urgent need to address the impacts of rapid environmental changes. Through this study, we aim to achieve a deeper understanding of our planet's dynamics, emphasizing the importance of developing adaptive strategies in response to global climate challenges.