Europlanet TA Scientific Report

PROJECT LEADER

Project number: 20-EPN2-044	
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TA Facility visited: Kangerlussuaq Field Site (DK)	

Project Title:

Scientific Report Summary.
(plain text, no figures, maximum 250 words, to be included in database and published)

Glacial systems are interesting for studying habitability and limits of life. They are extreme environments where indigenous microorganisms may survive prolonged exposure to subzero temperatures and background radiation for geological time scales. Glaciers and the surrounding cryo-environments (permafrost, glacial lakes, or melting streams) arise as relevant scenarios for studying the development of functional microbial cryo-ecosystems and may have implications in the search for past or extant life in icy worlds beyond the Earth. In the Solar System, Europa and Enceladus have been recognized as the icy worlds with highest likelihood to harbor life, largely because liquid water could be in contact with rocks. Both satellites are believed to contain a global ocean of salty water under a rigid icy crust that would provide the scenario for an interaction between briny water and rocks, and the conditions for life to arise.

The permanent Greenland Ice Sheet (GrIS) represents a possible analog of such icy worlds, constituting an important long-term repository of psychrophilic microorganisms. Around the GrIS, different formations such as glacial lakes, permafrost, or further peat soils represent diverse degree of succession upon the influence of the GrIS and its thermal destabilization.

We propose investigating molecular and isotopic lipid biomarkers of microorganisms inhabiting different cryo-ecosystems at and around the GrIS to obtain clues of a potential life development on analogous extraterrestrial cold environments (ice sheet), and learning how ecosystems evolves (biological succession) when the ice cover retreats and gets exposed to the atmosphere (glacier-melting streams, bedrock-erosion sediments, lake sediments, glacial soils).

Full Scientific Report on the outcome of your TNA visit

We encourage you to add figures to your report, which should be approx. 1 page of text plus figures.

In order to understand the limits of life in cold environments and to learn about life development (succession) in areas exposed to the atmosphere upon retreat of a glacier/ice sheet, we search for organics to study the molecular and isotopic composition of lipid biomarkers in environmental samples of different ecosystems from the west coast of Greenland (Kangerlussuaq region): 1) the ice sheet cryo-environment, 2) nearby glacier-influenced ecosystems in and around glacial lakes, and 3) longer time-exposed and further developed lacustrine and soil ecosystem.

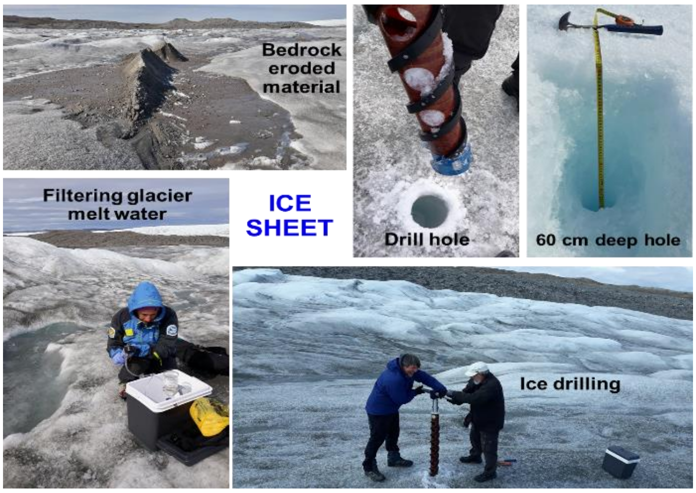
1) For the **ice sheet study**, we chose an ice sheet region in the *Issunguata Sermia* glacier system. There, we spotted four sites for sampling **ice cores**:

- One near the glacier front, where ice is relatively older and carries plenty of dark, grey, fine material from the bedrock erosion during the glacier advance.
- Two a bit further northeast in the ice sheet, where the ice is relatively younger and looked like slightly cleaner (i.e. whiter).
- One further north, in the highest height, where the ice looked cleanest (i.e. whitest).

In the four sites, ice drills were retrieved down to **50-80 cm depth** with a manual ice driller and, when the driller didn´t go deep enough, we dug a surface of ca. 35x35 cm^2 with a geologist hammer to collect as much ice as possible down to the deepest depth reached by the drill.

Together with the ice drills, we also collected **additional samples** from:

a. **Melt water** from a glacial stream flowing through the ice sheet.
b. **Dark grey sand-sized sediments** (with pebbles and small stones) from hill of deposits on the ice sheet coming from the erosion of the bedrock during the glacier advance.
c. **Dark blackish, fine sediments** outcropping from an ice wedge, also coming from glacial erosion of the bedrock.

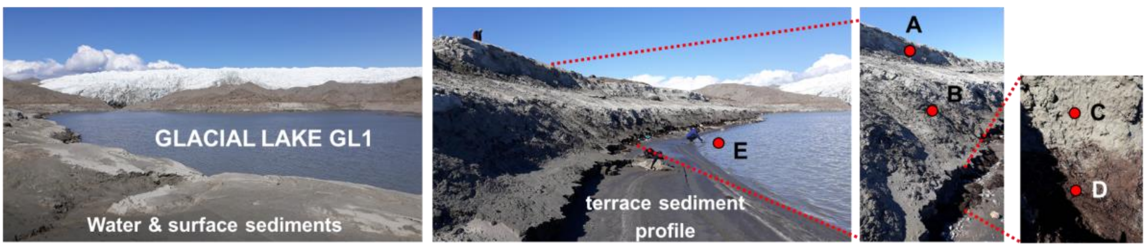


The four ice drills were melted and, together with the melt water sample, were filtrated through 0.7 µm pore size glass fiber filters, to recover the particulate matter and look for total organic carbon and lipid biomarkers.

2) For the study of the **glacial lakes study**, we chose two different systems:

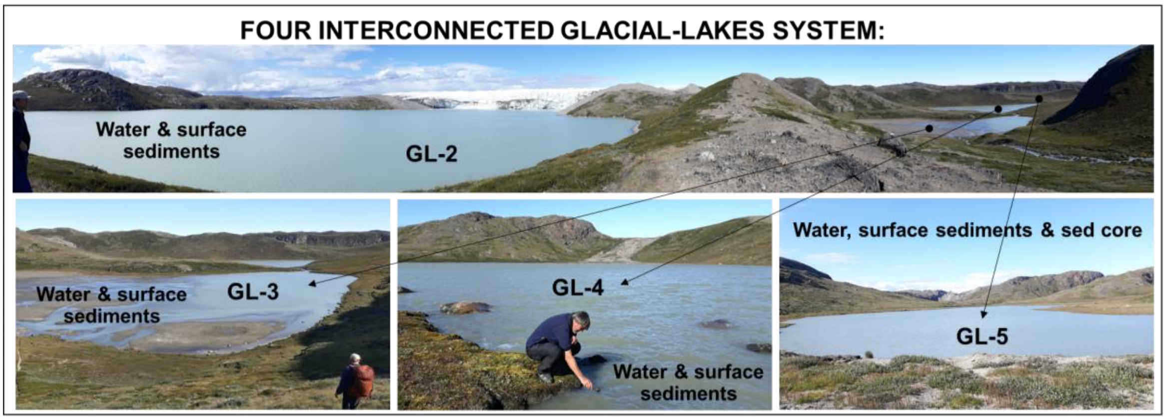
1. A **glacial lake (GL1) about 200 m apart from an edge of the glacier** *Issunguata Sermia*.

In this lake, we sampled a **surface sediment** from near the shore, together with sediments from an exposed terrace near the shore, corresponding to a **temporal transect**, where material at ground level represented the oldest and that at top of the terrace the youngest. The terrace was assumed to be composed of sediments accumulated in the past when the lake had a higher water level compared to nowadays.



2. A **multiple-lakes system next to an edge of the glacier** *Issunguata Sermia*.

The lacustrine system is composed by 4 interconnected glacial lakes, where the first lake (GL2; closest to the glacier edge) receives water from the glacier melting and feeds the second lake (GL3), which in turns feeds the third (GL4), and this the forth (GL5).

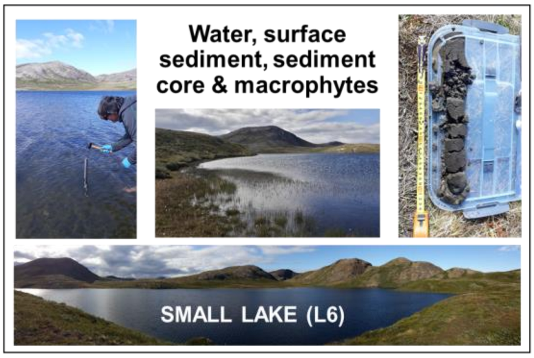


Here, we collected water (for chemical analysis) and surface sediments (for lipid biomarkers analysis) from the 4 lakes, and a 25 cm deep sediment core only from the forth lake (i.e. furthest from the glacier edge).

3) We aimed to assess the organic-composition differences between glacial and non-glacial lakes, so we also sampled a number of **non-glacial lakes** fed by meteoric (rain and surface runoff) water:

a. **A small lake (L6)**: a meteoric water lake about 1 km long and 0.5 km wide that is about 3 km apart from *Issunguata Sermia*.
b. **Long Lake (L7)**: a relatively larger lake about 10 km long and 1.5 km wide that is about 11 km apart from the same glacier.
c. **Salt Lake (SL)**: a lake about 600 m long and 500 m wide furthest from the glacier, and about 3-4 km apart from Kangerlussuaq.

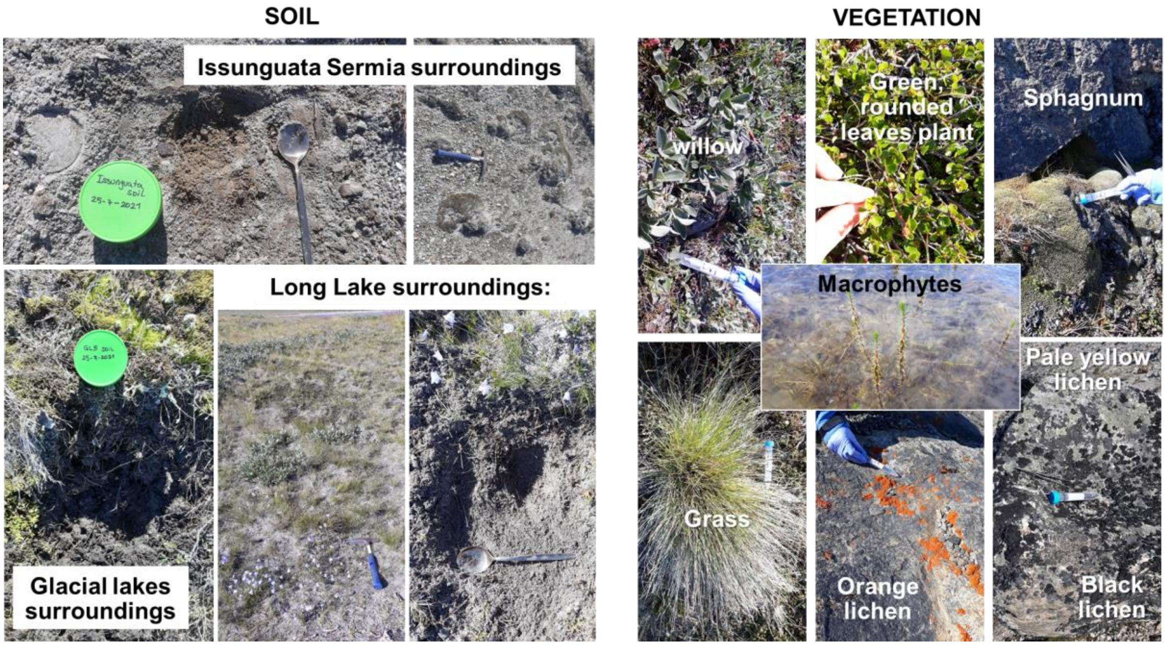
In the three lakes, we sampled **water** (for chemistry analysis) and **surface sediments** near the shore. Then, for the small non-glacial lake and Salt Lake, we collected a **sediment core** of 14 and 34 cm depth, respectively. At the Salt Lake basin, we also collected samples from a **terrace in the shore**, corresponding to past sediment/peat material piling up at the lake shore.



4) Finally, we wanted to learn about the soil development upon glacier retreatment, so we collected **soil samples** from a short of time transect:

   a. A young soil (poorly vegetated yet) from recently exposed ground near the present margin of the *Issunguata Sermia* glacier.
   b. A relatively older soil (more developed and vegetated) from the basin around the last lake of the 4 interconnected glacial-lakes system (i.e. GL5).
   c. An even older soil (the most developed) from the Long Lake surroundings.

In order to get a glimpse of the vegetal fresh endmember contributing to the soil lipidic fingerprint, we also collected samples from the most representative **vegetal specimens** found in the studied area: sphagnum; grass; rounded-leave creeping plant with white flowers; orange, black, and pale-yellow lichens; and submerged and emergent macrophytes (from GL1). Most vegetal samples were collected from the surroundings of glacial lakes GL1 and GL4.



- Give details of any publications arising/planned (include conference abstracts etc)

We believe we can get about **3 publishable stories** out of the set of samples we obtained during the Europlanet-2021 field campaign (20-EPN2-044 TA1):

1- Detection of psicrotrophic sources and metabolisms in the Greenlandic glacier *Issunguata Sermia*.
2- Molecular and isotopic distribution of lipid biomarkers in glacial versus rainwater lakes of the Greenlandic region of Kangerlussuaq.
3- Biological succession on Greenlandic soils after glacier retreat based on molecular and isotopic lipid biomarkers.

The plan is to submit them to **journals** such as Astrobiology, Frontiers in Microbiology, Scientific Reports, Science of the Total Environment, or Permafrost and Periglacial Processes, depending on the final results and discussion.

Preliminary results will be presented in **international conferences** and meetings such as Lunar and Planetary Science Conference, European Astrobiology Network Association, or Europlanet Science Conference.

- Host confirmation

Please can hosts fill in/check this table confirming the breakdown of time for this TA project:

Dates for travel to accommodation for TA visit (if physical visit by applicant)	Start Date of TA project at facility	Number of lab/field days spent on TA Visit pre-analytical preparation	Number of days in lab/field site for TA Visit	Number of days spent in lab for TA Visit data analysis	End Date of TA project at facility	Dates for travel home (if physical visit by applicant)
Departed: 17-07-21 Arrived: 19-07-21	19-07-21	[0-3] 1	7	[0-2] 1	27-07-21	Departed: 27-07-21 Arrived: 28-07-21

The host is required to approve the report agreeing it is an accurate account of the research performed.

Host Name	**Aarhus University**
Host Signature	
Date	**3 September 2021**

- Project Leader confirmation

Do you give permission for the full version of this TA Scientific Report (in addition to the 250 word summary) to be published by Europlanet 2024 RI on its website and/or public reports? YES / ~~NO~~

Project Leader Name	Laura Sánchez-García
Project Leader Signature	
Date	29-07-2021