Europlanet TA Scientific Report

PROJECT LEADER

Project number: 20-EPN2-046	
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TA Facility visited: Kangerlussuaq	

Project Title:

Scientific Report Summary.

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

The aim of this field campaign was to investigate the dynamics of aeolian mineral dust activity and organic carbon burial in western Greenland. Dust is an important component of the global climate system, and investigating its mobilisation, transport and deposition can reveal important information about regional climate and environmental development during the Holocene. Carbon burial in permafrost is one of the main mechanisms by which carbon is sequestered from the atmosphere, and may be linked to dust activity in high latitudes. The work focused on the area between the Greenland Ice Sheet margin and Kangerlussuaq, which represents a range of environmental conditions depending on distance from the ice sheet. We collected modern analogue samples of terrestrial windblown dust (loess) deposits to test and compare the performance of optically stimulated luminescence and radiocarbon dating. These samples were taken at a high resolution from the surface of the deposits and thus represent recent aeolian activity. Furthermore, we targeted aeolian deposits containing palaeosol layers to be able to independently compare radiocarbon and luminescence ages, and to identify climate phases which were favourable for soil formation and carbon burial. In addition to purely aeolian sediments, peat bogs were also sampled. These highly organic deposits complement the nearly purely minerogenic loess deposits because they effectively capture and preserve fine-grained wind-blown sediments. Further analysis of these samples and the use of different climate and carbon burial proxies will reveal important details of the regional climate history, dust-carbon burial dynamics, and provide insights into ice-proximal wind dynamics.

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.

During this field campaign, we collected a range of samples from deposits including loess, aeolian sand, peats, and soil transects from the Kangerlussuaq-Greenland ice sheet margin area (Fig. 1). In total, sixteen sedimentary deposits were sampled for dating of dust deposition and for paleoenvironmental and carbon burial reconstructions. Ten of these sites were sampled for luminescence dating, and four of which were also sampled at 1 cm-resolution for multi-method dating of modern analogues of sedimentary deposits using both luminescence and radiocarbon methods. The main aims were 1) to determine the most suitable methods of dating of these Holocene (current interglacial) sediment and climate archives; b) recover samples from sites which may contain useful records of past environmental changes in this sensitive arctic permafrost environment; and c) obtain samples for constraining the rate of dust accumulation and organic carbon burial in these sites.

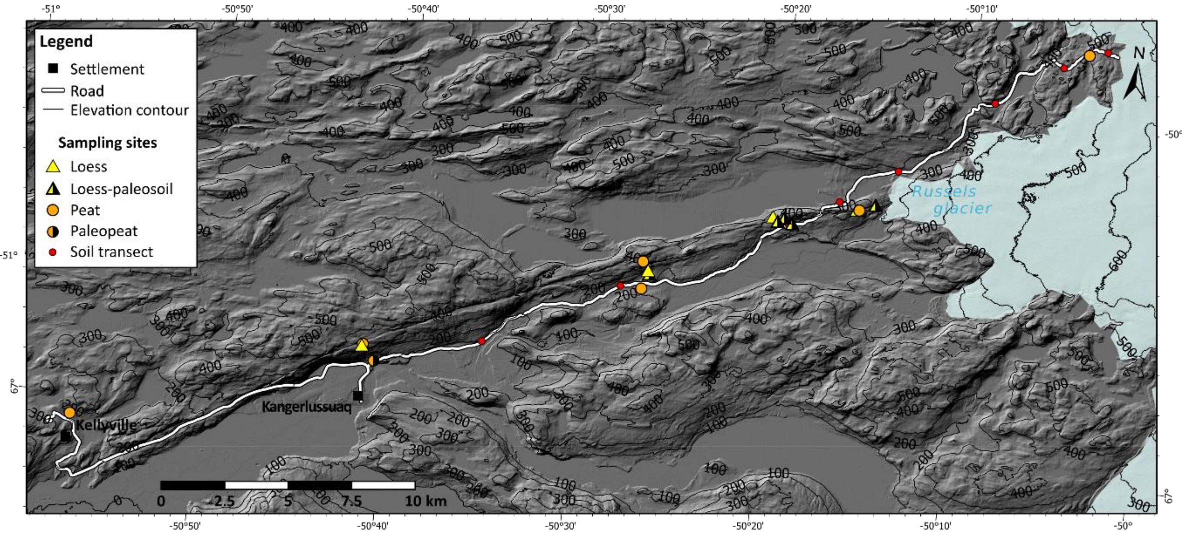

Figure 1. Overview map of the research area with detail of sample sites.

We returned to two previously sampled sites to achieve complementary high-resolution-sampling (1 cm depth increments) for modern-analogue dating and proxy work. This was undertaken to address inconsistencies between radiocarbon and luminescence methods. Furthermore, we collected aeolian sediments at high resolution (including modern analogue samples) from two new sites, which will be dated using luminescence and radiocarbon dating. The luminescence samples are light sensitive, so the sampling was conducted under light-proof tarps (Fig. 2). The ages of these deposits will, together with additional proxy and organic carbon content analysis, allow us to reconstruct dust and carbon dynamics in the area. We also targeted aeolian deposits which contained palaeosol layers (highly organic old soils; Fig. 3). The palaeosol organic matter enables higher confidence radiocarbon dating, providing suitable test material for comparisons of independent luminescence and radiocarbon ages. These comparisons are essential to test the performance of both dating methods for this specific regional setting, and for similar arctic environments generally. This knowledge is also vital for interpreting dating results from loess sediments with low organic matter where material for radiocarbon dating is absent.


Figure 2. Sampling modern analogue OSL/Radiocarbon samples under our light-proof tarp setup.


Figure 3. A fine-sand-palaeosol section close to the front of Russels Glacier.

In addition to purely aeolian sediments, we sampled highly organic mixed loess-peat deposits at six peatland sites (e.g. Fig 4) in the area, both near (several hundred metres) and far (approximately 30 km) from the ice sheet margin. We expect these sites to reflect the aeolian and climate-environmental development in the region since the last deglaciation (potentially for up to 8,000 - 10,000 years), which is a significant period for the understanding of Holocene climate development, and carbon and dust burial in peat bogs. These peat-rich deposits are likely to be excellent archives for dust activity, because the moisture and vegetation have high dust trapping capabilities (Fig. 5). This provides complementary information to the pure loess deposits, because even shorter and less intensive phases of dust deposition might be recorded in the peat sequences. Since the permafrost depth is very shallow in the peat deposits, organic proxies and biomarkers are frozen, and thus excellently preserved.

Figure 4. Peatland sampling.

Figure 5. The top 25 cm of a permafrost peat deposit, representing the active layer. Lighter parts are wind-blown minerogenic sediments trapped in the organic-rich peat.

We also sampled a sequence of alternating palaeosol-, palaeopeat-, and aeolian deposits just east of Kangerlussuaq (Fig. 6). This site appears to have been a wet depression in the landscape, prior to being excavated (likely for house/road construction purposes). During excavation, the peatland was drained, and a cross section of the organic-rich deposit exposed. This site presented an unusual opportunity for sampling and visual inspection of a palaeo-peat. Layers of purely minerogenic sands and silts interbedded in the otherwise anoxic peat will allow for a detailed reconstruction of dust activity and environmental conditions for the site.

Figure 6. The palaeo-peat deposit near Kangerlussuaq.

Two transects of near-surface soils and sediments were collected.

1) One elevation transect was collected along a hillslope north of Sandflugtsdalen (Fig. 7). Here, the change in grain size and sediment characteristics will be recorded as a function of elevation and distance from the Sandflugtsdalen floodplain, which acts as a major dust source in the area. The transect starts in the sandy valley and terminates at a mountain peak in the down wind direction and will allow better interpretation of various physical proxies in the sediment archives, such as grain-size.
2) The Greenland Soil Transect (GST) consists of sediment samples from the ice margin to the coastal fjord (Fig. 1). This transect records an elevation change of approximately 550 m, and a considerable range in environmental conditions (wind strength, temperature, humidity, vegetation cover). This variety will enable an independent methodological test of the biomarker proxies and how they are affected by changes in environmental conditions.


Figure 7. A sediment transect in the Sandflugtsdalen was collected from a slope in the down-wind direction from the major sand source in the area: the Sandflugtdalen outwash plain.

The collected materials will now be transported in frozen condition to Uppsala University and subsequently to Stockholm University for the analytical work.

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

- Dating paper
- Paleoclimate/carbon storage paper

- 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: 18-07-21 Arrived: 19-07-21	19-07-21	[1]	7	[0]	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	**11 August 2021**

- Project Leader confirmation

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Project Leader Name	Thomas Stevens
Project Leader Signature	
Date	**9th August 2021**