The 4th International PalaeoArc Conference
&
The 2023 NORDQUA Excursion

Akureyri, North Iceland
August 27th – September 2nd 2023

UNIVERSITY OF ICELAND
INSTITUTE OF EARTH SCIENCES

NÁTTÚRUFRÆÐISTOFNUN
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LETTERSTEDTSKA FÖRENINGEN

BOREAS An international journal of Quaternary research

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Vegagerðin

Geoscience Society of Iceland

Above: The eastern forefield of Skeiðarárjökull, SE-Iceland (ÍÖB 2022).

Above: The Mactra and Serripes zones of the Barmur group at Tungukambur, Tjörnes, North Iceland (ÍÖB 2023)

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Welcome!

On behalf of the local organizing committee, I would like to welcome you to the 4th International PalaeoArc Conference and the 2023 NORDQUA Excursion in North Iceland – held in joint sequence. The conference takes place in the Hof cultural center in Akureyri from the 27th to the 30th of August 2023, followed by a 3-day NORDQUA excursion in northern Iceland between August 31st and September 2nd.

PalaeoArc is a six-year international network research programme where the goal is to understand and explain the climatically induced environmental changes in the Arctic that have taken place throughout the Quaternary and continue in the present-day. There are four major themes to the programme: 1) the dynamics of Arctic ice sheets, ice shelves and glaciers; 2) the dynamics of high latitude oceans and sea ice; 3) the dynamics of the terrestrial environment and landscape evolution; and 4), the climatic response to, and interaction between, these different parts of the Arctic system. A further underlying rationale for PalaeoArc is that knowledge of past environmental processes and change in the Arctic are key to understanding the present and future of the Arctic, and vice versa. As a research network, PalaeoArc strives to bring together and build bridges between scientists from different countries and career stages, and from different disciplines in Arctic science. This includes marine and terrestrial researchers, working either with field data or on numerical modelling approaches.

PalaeoArc builds on and extends the legacy of previous network programmes that include PAST Gateways (Palaeo-Arctic Spatial and Temporal Gateways), APEX (Arctic Palaeoclimate and its Extremes), QUEEN (Quaternary Environment of the Eurasian North) and PONAM (Polar North Atlantic Margins – Late Cenozoic Evolution). A key focus of the network's activities is an annual international conference that brings together Arctic scientists from several disciplines and typically includes an excursion. The PalaeoArc network is led by an international Steering Committee representing nine different countries.

In addition, NORDQUA, The Nordic Union for Quaternary Research, is an organization of professional scientists from the Nordic countries that promotes interdisciplinary collaboration and communication through field excursions and symposia. When ideas emerged in both programs, somewhat simultaneously, of having a PalaeoArc conference and a NORDQUA excursion in Iceland, combining the two events seemed obvious. We chose to host these combined events in the beautiful town of Akureyri, North Iceland, because of the nice setting and interesting Quaternary geology in northern Iceland.

We hope you will enjoy the joint conference and excursions!

-Ívar Örn Benediktsson

Steering Groups:

Local Organizing Committee
Ívar Örn Benediktsson, research professor, University of Iceland, chair
Wesley R. Farnsworth, research specialist, University of Iceland and University of Copenhagen
Esther Ruth Guðmundsdóttir, professor, University of Iceland
Skafti Brynjólfsson, geologist, Icelandic Institute of Natural History
Hreggviður Norðdahl, research scientist emeritus, University of Iceland

PalaeoARC Steering Committee
Astrid Lysså, Geological Survey of Norway, Chair
Anne Jennings, INSTAAR, University of Colorado, USA
Caterina Morigi, University of Pisa, Italy
Chris Stokes, Durham University, UK
Ívar Örn Benediktsson, University of Iceland
Juliane Müller, Alfred Wegner Institute, Germany
Laura Bronzo, University of Pisa, Italy
Matt O'Regan, Stockholm University, Sweden
Monica Winsborrow, UiT- The Arctic University of Norway in Tromsø
Nikolaj Krog Larsen, Globe Institute, University of Copenhagen, Denmark
Pertti Sarala, University of Oulu, Finland
Witold Szczucinski, Adam Mickiewicz University in Poznan, Poland

NORDQUA Secretariat
Anna Hughes, University of Manchester, leader
Ívar Örn Benediktsson, University of Iceland, excursions officer
Henry Patton, UiT The Arctic University of Norway, communication officer
Daniel Wiberg, Geological Survey of Norway, treasurer

Location & Logistics:

The Capital of the North – Akureyri
Akureyri is situated in central-north Iceland, in Eyjafjörður, one of the longest fjords in the country, and is surrounded by mountains reaching 1000-1500 m. The Arctic Circle is only 60 km north of Akureyri but still the climate is relatively mild with average summer temperatures around 9-10°C but several days each summer reach up to 20-25°C. The winter temperature is around 0˚C. Akureyri and the inner half of Eyjafjörður is a relatively dry area with annual precipitation of about 400-500 mm/yr.

Akureyri is the second largest urban area after the capital area of Reykjavík, with a population of about 20,000. It is the center of trade and services in northern Iceland and also a town of culture and education. Akureyri builds on a firm foundation of fishing and harbor related industry, as well as tourism.

Akureyri is a popular tourist destination for short or long visits. The town offers a wide range of activities and interesting places e.g. notable museums, the world's most northerly botanic garden, one of Iceland's most popular swimming facilities, 18-hole golf course, the largest skiing area in the country, good hiking trails and a free city bus. Guests can choose between varied accommodation and an excellent range of restaurants.

Variable weather may be expected during the conference and excursions – from dry and warm (~15-20°C) to wet and cold (5-10°C), calm or windy. Weather forecasts for Akureyri/North Iceland can be viewed here: https://en.vedur.is/weather/forecasts/areas/northeast/, and here https://www.blika.is/spa/26.

Hof Cultural house:
The conference takes place in Hof Cultural and Conference Center (location: https://goo.gl/maps/bFCDPofeSNb3ZpLa8), starting Monday morning, Aug 28th, with registration opening at 8:30.

Registration & Icebreaker:
The Icebreaker will be held at the Akureyri Botanical Garden, Sunday 27th at 19:30 (location: https://goo.gl/maps/8NUPohYUebGRDp85A). The Icebreaker includes two drinks and snacks, but the bar will be open for those who are particularly thirsty. Participants can register at the icebreaker or alternatively on Monday morning, August 28th at the Hof Cultural and Conference Center.

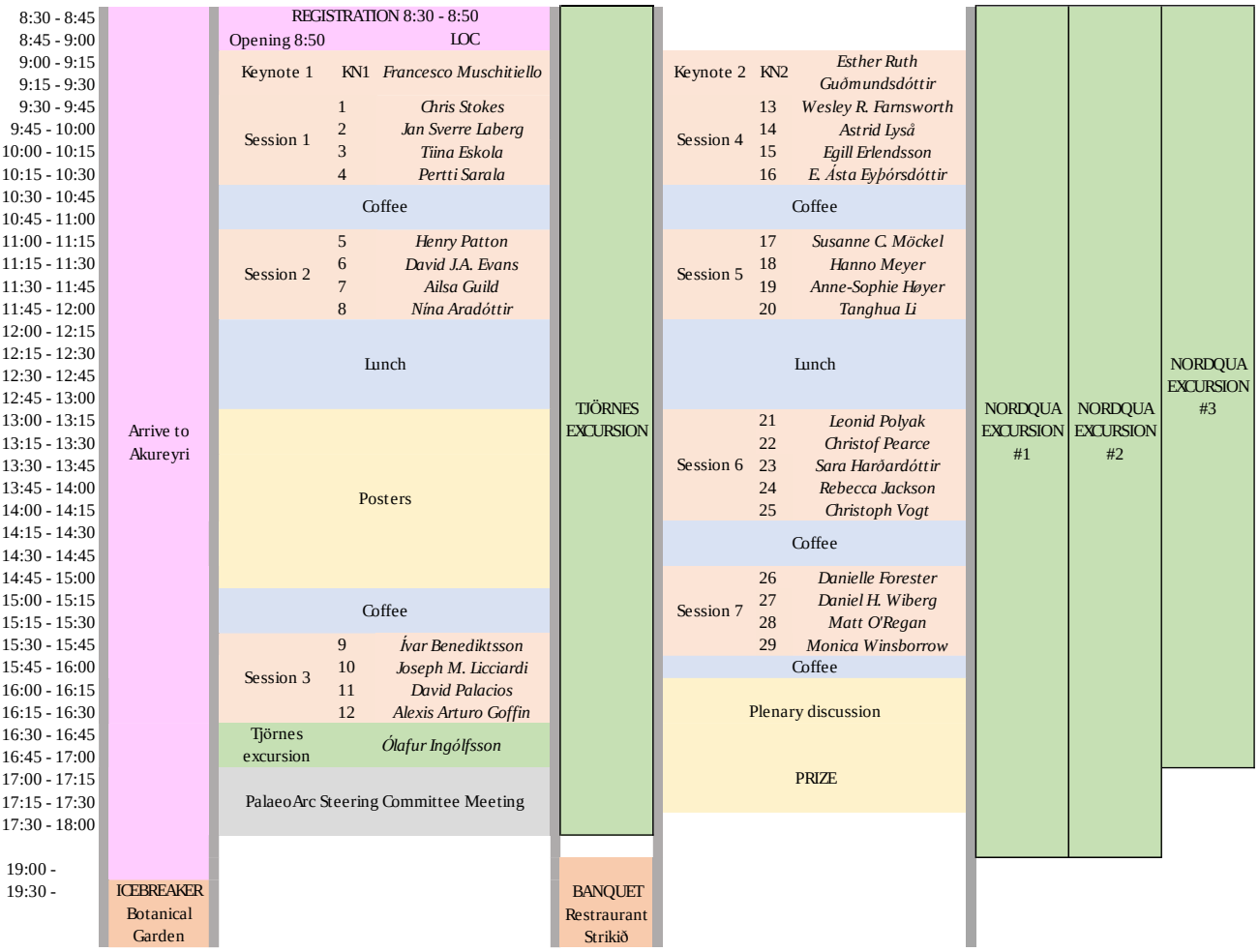
Conference Dinner:
The Banquet for those who have tickets, will take place on Tuesday, Aug 29th, at the Restaurant Strikið at 19:00 (https://strikid.is/).

Notes on Oral and Poster Presentations:

Oral presentations - should be about 12 minutes in duration, allowing a few minutes for questions in a 15-minute time slot. Powerpoint presentations should be uploaded to the auditorium computer prior to the start of each session.

Poster presentations - will take place on Monday, Aug 28th, from 13:00 – 15:00. However, posters (portrait) should be hung as early as possible and remain hanging for the duration of the conference. Participants are also encouraged to visit the posters during the coffee breaks.

Schedule: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19:30 -
Arrive to Akureyri
ICEBREAKER Botanical Garden
REGISTRATION 8:30 - 8:50
Opening 8:50
LOC
Keynote 1
KN1
Francesco Muschitiello
Session 1
1 Chris Stokes
2 Jan Sverre Laberg
3 Tiina Eskola
4 Pertti Sarala
Coffee
Session 2
5 Henry Patton
6 David J.A. Evans
7 Ailsa Guild
8 Nína Aradóttir
Lunch
Posters
Coffee
Session 3
9 Ívar Benediktsson
10 Joseph M. Licciardi
11 David Palacios
12 Alexis Arturo Goffin
Tjörnes excursion
Ólafur Ingólfsson
Palaeo Arc Steering Committee Meeting
TJÖRNES EXCURSION
BANQUET Restraurant Strikið
Keynote 2
KN2
Esther Ruth Guðmundsdóttir
Session 4
13 Wesley R. Farnsworth
14 Astrid Lysså
15 Egill Erlendsson
16 E. Ásta Eyþórsdóttir
Coffee
Session 5
17 Susanne C. Möckel
18 Hanno Meyer
19 Anne-Sophie Høyer
20 Tanghua Li
Lunch
Session 6
21 Leonid Polyak
22 Christof Pearce
23 Sara Harðardóttir
24 Rebecca Jackson
25 Christoph Vogt
Coffee
Session 7
26 Danielle Forester
27 Daniel H. Wiberg
28 Matt O'Regan
29 Monica Winsborrow
Coffee
Plenary discussion
PRIZE
NORDQUA EXCURSION #1
NORDQUA EXCURSION #2
NORDQUA EXCURSION #3

Conference Programme:

Sunday, August 27th
19:30 - Icebreaker and Registration – Akureyri Botanical Garden

Monday, August 28th

8:30 – 8:45	Registration
8:50 – 9:00	Welcome and Introduction LOC and PalaeoArc SC
	Session 1 – chaired by Tim Lane
9:00 - 9:30	KEYNOTE - Francesco Muschitiello **Improving the synchronization of paleoclimatic records using probabilistic methods and cosmogenic radionuclides**
9:30 - 9:45	Chris Stokes **Ice stream activity during deglaciation of the north-western sector of the Laurentide Ice Sheet during the last deglaciation**
9:45 - 10:00	Jan Sverre Laberg **Deglaciation of the NE sector of the Greenland Ice Sheet (~73 – 77oN)**
10:00 - 10:15	Tiina Eskola **The Middle Weichselian ice-free conditions in eastern part of Fennoscandia and their correlation to adjacent areas**
10:15 - 10:30	Pertti Sarala **Glacial morphology as the evidence of transitional cold – warm bed subglacial conditions in the central part of Fennoscandian Ice Sheet**
10:30-11:00	Coffee
	Session 2 – chaired by Greg P. De Pascale
11:00 - 11:15	Henry Patton **A time-transgressive perspective of glacial erosion and meltwater beneath the Eurasian ice sheet**
11:15 - 11:30	David J.A. Evans **Active temperate glacial landsystem evolution in association with outwash head/depositional overdeepenings**
11:30 - 11:45	Ailsa Guild **Structural glaciological evolution of receding temperate piedmont glaciers; implications for debris entrainment & landform development**
11:45 - 12:00	Nína Aradóttir **Formation of ribbed moraines during deglaciation of the Iceland Ice Sheet**
12:00 - 13:00	Lunch
13:00 - 15:00	Posters
15:00 - 15:30	Coffee

Session 3 – chaired by Ailsa Guild

15:30 - 15:45 Ívar Örn Benediktsson
Early Holocene deglaciation of eastern Iceland constrained by cosmogenic ^{36}Cl exposure ages and tephrochronology

15:45 - 16:00 Joseph M. Licciardi
Surface exposure dating of ice-sheet thinning and retreat along the northern periphery of the Iceland Ice Sheet during the last deglaciation

16:00 - 16:15 David Palacios
Divergent evolution of glaciers since the Younger Dryas in Tröllaskagi cirques (Northern Iceland)

16:15 - 16:30 Alexis Arturo Goffin
Last glacial cycle model for the Icelandic Ice Sheet

16:30 - 17:00 Ólafur Ingólfsson
TJÖRNES Overview and information for mid-conference excursion

17:00 - 18:00 PalaeoArc Steering Committee Meeting

Tuesday, August 29th

8:30 – 18:00 Mid-Conference Field Excursion to Tjörnes

Wednesday, August 30th

Session 4 – chaired by Nína Aradóttir

9:00 - 9:30 KEYNOTE - Esther Ruth Guðmundsdóttir
Iceland´s contribution to North-Atlantic tephrochronology: Knowledge gaps and challenges.

9:30 - 9:45 Wesley R. Farnsworth
Tephra constrains natural and anthropogenic changes in post-glacial Iceland sediments.

9:45 - 10:00 Astrid Lysså
Late Weichselian and Holocene glacial activity on a volcanic active island – Jan Mayen.

10:00 - 10:15 Egill Erlendsson
The Black Death in Iceland: environmental responses, climate and society.

10:15 - 10:30 Elísabet Ásta Eyþórsdóttir
Two farms, two environmental legacies: comparing social standing and environmental impact.

10:30 - 11:00 Coffee

Session 5 – chaired by Lis Allaart

11:00 - 11:15 Susanne Claudia Möckel
Interpretation of δ13C and δ15N depth trends in peatlands of aeolian environments.

11:15 - 11:30 Hanno Meyer
Hydroclimate and cryospheric changes in the Russian High Arctic.

11:30 - 11:45 Anne-Sophie Høyer
A novel method to incorporate geological knowledge into geophysical inversion.

11:45 - 12:00 Tanghua Li
Glacial isostatic adjustment with 3D earth models: A comparison of deglacial relative sea-level records from Norway and Russian Arctic.

12:00 - 13:00 Lunch

Session 6 – chaired by Laura Bronzo

13:00-13:15 Leonid Polyak
Quaternary history of the Arctic Ocean from the detrital and authigenic sediment isotope perspective.

13:15 - 13:30 Christof Pearce
Marine diatom assemblages in Arctic paleoceanography – integration of training sets.

13:30 - 13:45 Sara Harðardóttir
A needle in the haystack: Tracing and quantifying the sea ice diatom and IP25-producer Haslea spicula in environmental DNA samples.

13:45 - 14:00 Rebecca Jackson
Timing is everything: multi-method chronological constraints on late Pleistocene marine regime shifts in south of Iceland

14:00 - 14:15 Christoph Vogt
Reddish MIS1-4 layers of Svalbard Shelfs and Slopes-Origin and Relevance

14:15 - 14:45 Coffee

Session 7 – Rebecca Jackson

14:45 - 15:00 Danielle Forester
Is the extensive Late-Quaternary landslide distribution in North Iceland controlled by earthquakes from active faults in the Dalvik Seismic Lineament?

15:00 - 15:15 Daniel Hesjedal Wiberg
Preliminary lessons on integrated marine and terrestrial mapping of shoreline-crossing landslide processes, Skjerstadfjorden, Northern Norway.

15:15 - 15:30 Matt O'Regan
Calibrating estimates of modern carbon burial on the Canadian Beaufort Shelf.

15:30 - 15:45 Monica C M Winsborrow
Centre for ice, Cryosphere, Carbon and Climate (iC3)- closing large scale uncertainty in Polar ice sheet impacts on the global carbon cycle.

15:45 - 16:00 Coffee

16:00 - 17:30 Plenary Discussion and Prize

Field Excursion Overview:

Mid Conference Excursion:*

Pliocene-Pleistocene at Tjörnes: Transition from Pliocene warmth to Pleistocene glaciations

Excursion leader:	Ólafur Ingólfsson
Date:	August 29th 2023
Pick-up:	Hof Conference Center at 8:30
Drop-off:	Hof Conference Center c. 18:00
Lunch:	Brown bag lunch and small rest stop in Húsavík

The Tjörnes stratigraphic sequence in Northern Iceland is a classic site exhibiting the North Atlantic´s transition from Pliocene warmth to Pleistocene glaciations. Pliocene beds are generally fossiliferous marine silts (with occasional interbedded lignite seams and tuffs/lavas), which have been sub-divided into the Tapes Zone (oldest) the Macta Zone and the Serripes Zone (youngest). The sequence records the migration of Pacific species into the Atlantic following the opening of the Bering Strait oceanic gateway. Furthermore, the sequence transitions in to alternating beds of diamictite with volcaniclastic sediments and basaltic lava flows. The Pleistocene sequence is believed to consist of 14 tillites with the oldest roughly 2,5 Ma. Participants will get the opportunity to see well preserved marine and terrestrial fossils as well as products from some of Iceland´s earliest full glaciations.

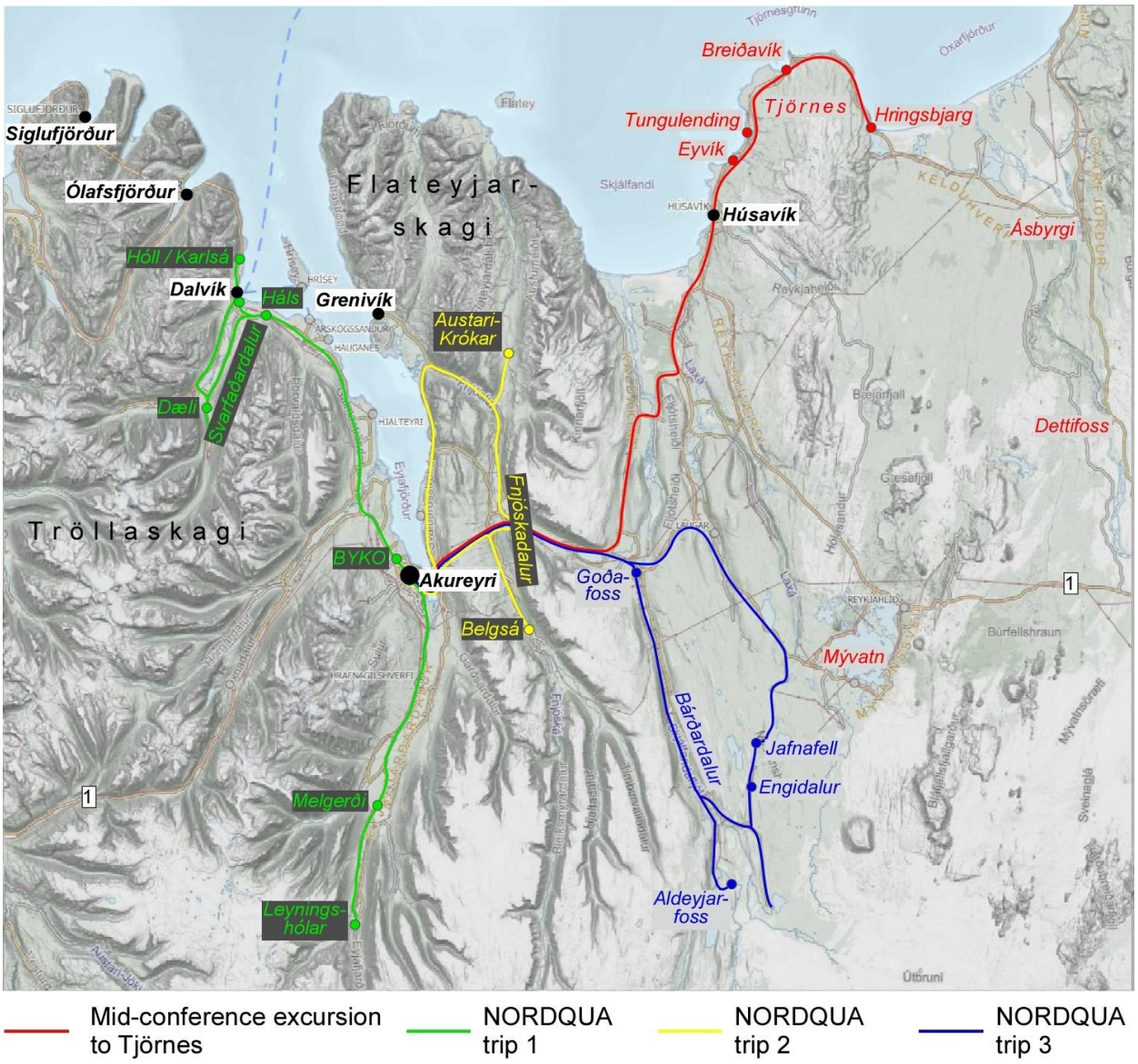
NORDQUA Excursion 2023 – North Iceland

Trip 1:
The alpine glacial landscapes and slope instabilities of the Tröllaskagi Peninsula.

Trip 2:
Signatures of deglaciation dynamics, ice-lakes and their tephrochronological age control in Fnjóskadalur.

Trip 3:
Geomorphological fingerprints of fast-flowing ice streams within the Iceland Ice Sheet in Bárðardalur.

*The mid-conference excursion to Tjörnes will include a 4-5 km long hike over partly uneven, moist/wet or dry terrain (grassland, sandy-cobbly beaches). Good hiking boots/shoes are highly recommended.



Map of North Iceland with overview of the PalaeoArc Mid Conference Excursion to Tjörnes (Red) and the NORDQUA Excursion consisting of three day trips (Green, Yellow and Blue).

Poster Presentations: Monday, Aug 28th from 13:00 – 15:00
Posters should be put up as early as possible Monday and be left hang for the conference.

Allaart, L. et al. **Paleoclimate projects in the GEUS surface department: landslides, tunnel valleys and seepage from the sea bed.**

Arnardottir, E.Ó. et al.**IRD in the Iceland Sea and palaeoceanographic changes during MIS 1-6.**

Blache, M. et al. **Atmospheric deposition-flux rates of microplastics particles recorded in Icelandic surface-lake sediments: a newly started project.**

Bronzo, L. et al. **Paleoclimatic events of the last 30,000 years registered by calcareous nannofossil associations on the west Spitsbergen margin.**

Davies, J. et al. **Distribution of modern benthic foraminiferal assemblages across the Northeast Greenland continental shelf.**

Dukki Han et al. **Ancient DNAs: Influence of Sedimentary Deposition on Bacterial Communities in Arctic Holocene Sediments.**

Einarsson, Á. et al. **Palaeoecology of Lake Myvatn, Iceland.**

Erlendsson, E. et al. **A Betula expansion and an inferred climate amelioration in the late Holocene pollen record of Iceland.**

Esch, J.R. et al. **Transhumance in Iceland: Land use, land degradation, and society.**

Farnsworth**,** W.R. et al. **Dynamic ice margins during a warm Late Glacial-Early Holocene, Northern Svalbard.**

Guðmundsdóttir, E.R. et al. **Benthic foraminifera – not always a signal of climate and oceanographic changes?**

Hannele Alatarvas, R.M. et al. **Clay mineral and Nd, Pb, and Sr isotope provenance of a MIS 4/3 sediment record from the Lomonosov Ridge, Arctic Ocean.**

Hill, C.J. et al. **Mapping of the 1991 surge of Skeiðarárjökull through structural glaciology and foreland geomorphology**

Hughes A. et al. **Exploring landform expressions of subglacial thermal regime transitions.**

Koenders, E., et al. **The Impact of Tourism on Icelandic Lake Ecosystems reconstructed from Chironomidae Remains.**

Lane, T.P. et al. **The Geomorphological record of an ice stream to ice shelf transition in Northeast Greenland.**

Lockwood-Ireland, C. et al. **Bottom current activity north of Svalbard on orbital and millennial-scales during the late Quaternary.**

Lyså, A. et al. **JAN MAYEN - Quaternary geological map.**

Palacios, D. et al. **Debris-covered glaciers and rock glaciers response to the Neoglaciation in Tröllaskagi (northern Iceland)**

Palacios, D. et al. **Late Holocene evolution of two highly responsive debris-free glaciers: Tungnahryggsjökull (Tröllaskagi, Northern Iceland)**

Andrés, N. et al. **Neoglacial maximum and subsequent evolution of the Gljúfurárjökull glacier (Tröllaskagi, northern Iceland).**

Palacios, D. et al. **Surface displacement monitoring of debris-covered glaciers and rock glaciers through historical aerial photographs in Tröllaskagi (northern Iceland).**

Palacios, D. et al. **Analysing the response of debris-free glaciers in Tröllaskagi (northern Iceland) to recent warming through differential interferometry.**

Palacios, D. et al. **Geomorphological mapping methodology applied to rock glaciers and debris-covered glaciers in Tröllaskagi, Northern Iceland.**

Poliakova, A. et al. **Diversity of non-pollen palynomorphs registered in the sediments of the high-Arctic lake Tenndammen, central Svalbard.**

Vogt, C. et al. **Revisiting NE Greenland RV Polarstern Slope Cores Data of Marine Isotope Stages 1-6.**

List of Abstracts:

K1
Improving the synchronization of paleoclimatic records using probabilistic methods and cosmogenic radionuclides

Francesco Muschitiello

University of Cambridge Cambridge United Kingdom

Improving absolute age scales and synchronizing climate records from different archives is vital to constrain the timing and mechanisms of abrupt climate change. In this talk, I will present new quantitative synchronization strategies for providing a coherent stratigraphic framework to paleoclimatic records and developing a common timescale for marine and ice core records. I will examine findings from three case studies focused on the Greenland Ice-Core Chronology 2005 (GICC05), the WAIS Divide Chronology 2004 (WD2014), and marine sediment records from the Iberian Margin, which provide the backbone of some of the most unique and detailed records of global climate change. The results are based on a novel automated method to align proxy records and quantify dating inconsistencies between the ice-core and U-Th timescales. Finally, I will present a new application of cosmogenic ^{10}Be in marine sediments as a tool to construct independent timescales for palaeoceanographic data that does not depend on the correlation of climate stratigraphies.

O-01

Ice stream activity during deglaciation of the north-western sector of the Laurentide Ice Sheet during the last deglaciation

Benjamin Stoker [1] Chris Stokes [2], Helen Dulfer [1], Martin Margold [1], Chris Clark [3], Colm O'Cofaigh [2], David Evans [2], Sophie Norris [4], Duane Froese [5]

[1] Charles University Prague Czech Republic
[2] Durham University Durham United Kingdom
[3] Sheffield University Sheffield United Kingdom
[4] University of Victoria Victoria Canada
[5] University of Alberta Edmonton Canada

Ice streams are an important component of ice sheet mass balance and their recent activity in Greenland and Antarctica is a major source of global mean sea-level rise. However, current observations of ice streams typically span only a few decades and it is unclear how their drainage networks may evolve over much longer time-scales. Reconstructions of palaeo-ice stream activity allows investigation of their longer-term behaviour and previous work has identified several ice stream 'footprints' in the north-western sector of the Laurentide Ice Sheet. This region experienced rapid retreat following the collapse of a major ice saddle that connected the Laurentide and Cordilleran ice sheets, but the role and evolution of ice streams during deglaciation is poorly constrained. Here we use established glacial inversion methods and a recently published glacial geomorphological map, generated from the high resolution ArcticDEM, to reconstruct ice flow dynamics during deglaciation. We show that the north-west sector experienced dramatic reorganisations with rapid switching of ice flow directions driven by changes in the dominant ice dispersal centres during the collapse of the ice saddle. The ice stream network was dominated by a series of transient ice streams (approx. 50 km to 300 km long), which switched on and off during deglaciation, rather than a more extensive and stable ice stream network that operated continuously during ice margin retreat. This suggests important but complex interactions between neighbouring ice stream catchments, likely driven by both external forcing and internal feedbacks relating to subglacial processes.

O-02
Deglaciation of the NE sector of the Greenland Ice Sheet (~73 – 77oN)

Jan Sverre Laberg [1] Ingrid Leirvik Olsen [2], Kevin Zoller [1], Tom Arne Rydningen [1], Matthias Forwick [1], Katrine Husum [3]

[1] UiT the Arctic University of Norway Tromsø Norway
[2] Geological Survey of Norway Trondheim Norway
[3] Norwegian Polar Institute Tromsø Norway

The NE-sector of the Greenland Ice Sheet (~73 - 77ºN) most likely extended all the way to the shelf break during the Last Glacial Maximum. Although the exact timing is poorly constrained, morainal ridges in the outer Store Koldewey Trough suggest that the early phase of the deglaciation occurred stepwise, with several stillstands and/or readvance of the ice front. A different suite of landforms has been found in the nearby Dove Bugt Trough, where mega scale glacial lineations, superposed by one large morainal ridge, indicate one major halt and/or readvance during the early deglaciation.

From the landform suite, dated marine sediment core samples, and onshore/offshore dates from other studies, it is inferred that the ice front receded to the coastline during the Younger Dryas period. For all fjord systems (however, not onshore), transverse ridges have been identified, implying temporal halts and/or readvances during a late phase of the deglaciation. The oldest dates from the inner fjords are 8.75 and 7.8 ka cal BP (Kejser Franz Josef fjord system), 7.8 ka cal BP (Tyrolerfjord), and 7.2 ka cal BP (Bessel fjord), representing a minimum age for the deglaciation of these fjords. The studied fjords in NE Greenland are, thus, interpreted to have been deglaciated in early Holocene, around the onset of the Holocene Thermal Maximum. The mean ice recession rates for the deglaciation of the studied shelf - fjords are ~29 - 34 m/yr, which is in conformity with results from fjord - shelf systems further north in Greenland.

O-03

The Middle Weichselian ice-free conditions in eastern part of Fennoscandia and their correlation to adjacent areas

Tiina Eskola Pertti Sarala, Juha Pekka Lunkka, Raisa Alatarvas, Kari Strand

University of Oulu Oulu Finland

Over the last decades, a number of studies have shown that there are tens of sites in eastern Fennoscandia where sands, gravels and organic-rich sediments are interbedded with till beds. A total of 32 luminescence (TL and OSL) obtained from sand- and organic-rich sediments occurring below the uppermost till (Late Weichselian, ~ MIS 2) at 20 of these sites yielded MIS 3 ages ranging from c. 23 – 57 ka. In addition, nine radiocarbon samples from organic-rich sediments and large mammal bones, mainly mammoth bones, also indicate that large parts of eastern Fennoscandia were ice-free mammoth steppe at least c. 27-29 ka and c. 33-36 ka.

A closer look at the luminescence and radiocarbon age results suggests at least five clusters in the MIS 3; at around 27 – 29 ka (Greenland interstadial, GI 3 - 4), 32 – 38 ka (between GI 5 – 8), 41 – 43 ka (GIS 10 – 11), 45 – 47 ka (GIS 12) and 50 – 54 ka (GIS 14). Half of the numerical ages obtained fall into Greenland interstadials defined by NGRIP $\delta^{18}O$ record. The age results indicating ice-free conditions in eastern Fennoscandia correspond well to ice-free interstadials of Ålesund and Austnes/Bø in western Norway, and to the age estimate of Pilgrimstad interstadial in Central Sweden and interstadials in southern Sweden.

Extent of glaciers during MIS3 is still questionable. If most part of Finland has been ice free, it conflicts with observation of MIS3 glacial advances in southern part of Baltic Sea.

O-04

Glacial morphology as the evidence of transitional cold – warm bed subglacial conditions in the central part of Fennoscandian Ice Sheet

Pertti Sarala

University of Oulu Oulu Finland

Airborne LiDAR (Light Detection And Ranging) glaciomorphological mapping has revealed new data which are useful for the interpretation of glaciodynamic subglacial processes in the centre of last glaciation. One of the studied areas in Finland was the Kuusamo Ice Lobe area in northern Finland, close to the Late Weichselian ice-divide zone. The glacial morphology is composed mainly of active ice moraine morphologies such as glacial streamlined lineations of the Kuusamo drumlin field in the eastern part, and different hummocky and ribbed moraines in the western part, close to onset area of the ice lobe. The large drumlin field was formed under fast moving glacier during the last deglaciation while the core part of the glacier remained cold-based. Eskers and delta formations represent melting of the glacier. Particularly, ribbed moraines represent the depositional formations formed under subglacial conditions at the transitional zone between the warm and cold based glacier. Typical feature is in the western part that erosional, subglacial meltwater channel network is cutting the ribbed moraine formations. Remains of transversal ribbed moraine ridges are covered by fluted, streamline surface indicating glacial reworking during the late phase of deglaciation. This gives new knowledge of the formation phases of subglacial moraine formations in the core part of Fennoscandian Ice Sheet.

O-05

A time-transgressive perspective of glacial erosion and meltwater beneath the Eurasian ice sheet

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The efficacy and controls governing glacial erosion over geological timescales are intricately linked yet remain poorly understood and contended. By assimilating geophysical data with modelling of the Eurasian Ice Sheet - the third largest Quaternary ice mass that spanned 49°N - 82°N - we decipher its erosional footprint during the last ~110 ka glacial cycle. Our results demonstrate extreme spatiotemporal heterogeneity in erosion with short-term rates ranging from 0 - 5 mm a^{-1}, and a net volume equating to ~130,000 km^3 of bedrock excavated to depths of ~190 m. A hierarchy of environmental controls ostensibly underpins this signature: lithology, topography and climate, though it is basal thermodynamics that ultimately regulates erosion, which can be variously protective, pervasive, or, highly selective. A notable signature of this thermomechanically regulated erosional footprint is an increase in the intensity of erosion across upland areas of Fennoscandia and within troughs in the Barents Sea during the last deglaciation compared to the long-term mean. New meltwater landforms mapped from multibeam bathymetry data collected in the Central Barents Sea capture insight into the evolving nature of the subglacial environment of the Barents Sea ice sheet as it thinned and collapsed; the apparent abundance of basal meltwater, which we interpret was increasingly being supplemented by inputs from supraglacial melting, likely contributed to elevated erosion of the sedimentary substrate and the mobilisation of subglacial sediments during the latter stages of deglaciation.

O-06

Active temperate glacial landsystem evolution in association with outwash head / depositional overdeepenings

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The response of temperate glaciers to rapid climate warming is reflected in the geomorphology (landsystem) resulting from snout recession. This study develops a locally diverse process-form model of active temperate glaciers through mapping and quantification of historical landscape change on the Fjallsjokull-Hrutarjokull foreland. Quantification of volumetric and areal changes on the foreland are based on time-series of archival aerial images for the period 1945-1998, high resolution satellite imagery for 2014, and digital elevation models of differences derived from time seris of UAV imagery for the years 2014, 2016, 2018, 2019 and 2022. Landscape change and glacier snout behaviour since 1945 highlights the importance of azonal and potentially intrazonal signatures in temperate glacial landsystems, particularly: 1) the development and collapse of partially supraglacial outwash fans to produce outwash heads fronting depositional overdeepenings; and 2) the emergence of ice-cored eskers that record the evolution of englacial drainage networks operating over overdeepenings. Such landform assemblages are manifested as substantial ice-cored hummocky terrains, a characteristic of deglaciating forelands that is likely to be widely replicated wherever ice-contact glacifluvial processes create outwash heads that act as depositonal overdeepenings. Due to its significantly greater supraglacial debris cover, complete de-icing of the Hrutarjokull snout in response to post-1945 warming was delayed until around 2014. This constitutes a prime example of incremental stagnation, which in a rapidly warming climate has resulted in siginficant landscape change (land surface elevation collapse of 0.8 m per year) over the last 8 years.

O-07

Structural glaciological evolution of receding temperate piedmont glaciers; implications for debris entrainment & landform development.

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Recent research on ice cap piedmont lobes has highlighted variations on ice flow patterns related to the interaction between topographic controls and glacier structure as the glaciers respond to climate change and become more susceptible to recession onto overdeepenings. This research provides a detailed understanding of the structural glaciological evolution and the implications for debris entrainment and landform development at Svínafellsjökull, Southeast Iceland. The structure of Svínafellsjökull has been impacted in recent years by a warming climate and this has initiated accelerated retreat of the glacier and pronounced thinning over an overdeepening. A debris transport process model for Svínafellsjökull and neighbouring Falljökull is proposed that incorporates various styles of debris-rich glacial ice formation, debris transfer pathways, and their glaciological controls. Changes in the structural configuration of the lower reaches of Svínafellsjökull, especially the development of radial crevasses, have impacted upon the landform record preserved within the glacier foreland. Geomorphological mapping of the foreland is presented and facilitates the development of more robust understanding of the spatially variable influence of structural glaciological and debris transfer processes on moraine construction since the Little Ice Age maximum.

O-08
Formation of ribbed moraines during deglaciation of the Iceland Ice Sheet

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Understanding the geomorphological fingerprinting of palaeo-ice stream is important for our perception of the behaviour of ice streams, as the formation of bedforms offer a window into the processes at the ice/bed interface. Mapping of streamlined subglacial bedforms (SSBs; drumlins and MSGLs) and crevasse-squeezed ridges reveal cross-cutting flow-sets of palaeo-ice streams and their dynamics within the Iceland Ice Sheet (IIS) in northeast Iceland during and following the Last Glacial Maximum (LGM). In this study we map transverse ridges, interpreted as ribbed moraines, together with glaciofluvial and ice-marginal bedforms on Haukstaða- and Jökuldalsheiði highland plateaus within the Vopnafjörður-Jökuldalsheiði flow-set. We combine the morphological data with sedimentological analyses of ribbed moraines to increase our understanding of their formation and dynamics of the IIS in northeast Iceland. Ribbed moraines are considered to form at the transition zone between cold-based and warm-based ice and have been linked to ice stream onset zones and their shutdown. In both areas, the ribbed moraines are superimposed on the SSBs, indicating that they post-date the formation of the SSBs and signify the final stage of ice streaming. This study has implications for the deglaciation behavior of ice streaming in the northeastern part of the IIS and sheds light on the role of ribbed moraines in palaeo- and modern ice sheets.

O-09

Early Holocene deglaciation of eastern Iceland constrained by cosmogenic ^{36}Cl exposure ages and tephrochronology

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The Iceland Ice Sheet (IIS) is thought to have extended to the shelf break around Iceland at the Last Glacial Maximum and then collapsed and retreated to a position inside the present-day coast during the Bølling-Allerød. Following the Younger Dryas (YD) and Preboreal readvances to coastal areas, the IIS retreated inland and deposited a number of end moraines of unknown age. Several records suggest that extant remnants of the IIS around 9 ka BP were smaller than present glaciers. However, the rate of retreat from the Preboreal position (just inside the YD position) to the interior highlands remains unresolved. Recent studies in NE-Iceland revealed the tracks of palaeo-ice streams, one of which extended from the highland interior north of the present Vatnajökull to the coast in Vopnafjörður. Several end moraines are preserved along the center flow line of this former ice stream, indicating periodic stillstands or readvances that punctuated its overall retreat. In this project, roughly 30 samples were collected for cosmogenic ^{36}Cl surface exposure dating of glacially scoured bedrock and end moraines along a ~120 km long transect from the coast in Vopnafjörður to near the northern margin of Vatnajökull. We expect exposure ages to gradually decrease from the coast towards the highlands and reveal a rapid deglaciation of the IIS during the early Holocene. The outcome of these dating efforts has important implications for our understanding of the rates and pattern of IIS decay and serves as a critical constraint for palaeoglaciological modelling of the IIS.

O-10

Surface exposure dating of ice-sheet thinning and retreat along the northern periphery of the Iceland Ice Sheet during the last deglaciation

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A more complete understanding of Icelandic Ice Sheet behavior during past warm intervals provides essential long-term context for recent observational records of glacier and climate changes in the Arctic that reveal accelerating ice retreat in response to rising temperature. Though many previous studies have improved our knowledge of Icelandic Ice Sheet history around the country, the precise timing of ice recession remains sparsely documented in northern Iceland. Here we compile a transect of cosmogenic nuclide surface exposure ages on glacial features across northern Iceland that constrain the timing of ice-sheet thinning and retreat during the last deglaciation. Our data synthesis includes a network of ^{36}Cl ages on glacially scoured bedrock and erratics from the Húnaflói region which date ice margin retreat inland of the modern coastline by ~10 ka. These ages align with published ^{36}Cl ages of deglaciated bedrock and moraines in the Vestfirðir peninsula. Further insight on the timing of ice recession comes from ^{3}He and ^{36}Cl exposure ages of tuya summits in the Mývatn area which are interpreted to date their emergence from the ice sheet as it thinned. Considered together, the moraine, bedrock, and tuya summit exposure ages suggest a broad regional pattern of ice-sheet thinning and margin retreat across northern Iceland from ~11–10 ka. These available surface exposure ages are being augmented by recent and ongoing ^{36}Cl dating of moraines and glacially scoured bedrock in northeast Iceland to develop a more comprehensive chronology of ice retreat from northern coastal regions to the interior highlands.

O-11

Divergent evolution of glaciers since the Younger Dryas in Tröllaskagi cirques (Northern Iceland).

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In the Tröllaskagi peninsula (Northern Iceland), many glacial cirques occur, and most of them include push-moraines on their distal parts, which have been dated by the ^{36}Cl cosmonuclide. These moraines are of late Pleistocene and Early Holocene and have been dated to 12 and 9 ka. They have been found, for example, in the Vatnsdalur (Svarfaðardalur area), the Fremri-Grjótárdalur and the Hóladalur (Víðinesdalur area) valleys and in three cirques of the Hofsdalur area. This age determination indicate that debris-free glaciers advanced in these cirques during the Younger Dryas and Preboreal times. Subsequently, those glaciers evolved into debris-covered glaciers and rock glaciers, and some of them collapsed, while others still have covered ice and remain active, but though with very limited mobility. Dating surface boulders from both debris-covered glaciers and rock glaciers in the abovementioned cirques, through ^{36}Cl, gave exposure ages of 9-7 ka in the collapsed formations. The ages of the boulders in formations still with covered ice gave ages of 6-2 ka, which suggest that they have been almost stagnant or with very little mobility since then. Thus, it is likely that debris-free glaciers, very close to each other, evolved either into debris covered glaciers or rock glaciers under similar climatic environments and only a few remained as debris-free glaciers. This paper presents these geochronological results and poses an explanation for this divergent evolution of the cirques, related to different intensities of the paraglacial processes that operated during the deglaciation.

O-12
Last glacial cycle model for the Icelandic Ice Sheet

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To date, the Icelandic Ice Sheet (IIS) has been poorly understood with regards to its configuration, dynamics and evolution during the last glacial cycle. This is particularly true for Marine Isotope Stages 5e-3 due to paucity of both terrestrial and marine data. The few glaciological modelling studies of the IIS have placed minimal or no attention on addressing model uncertainties. Thereby, the inferential value of such studies in relation to the actual glacial history is not interpretable. To address this, we present the results of a history matching of the 3D Glacial Systems Model (GSM) against a curated set of updated paleo constraints for the last glacial cycle IIS.

History matching identifies a set of model chronologies that are not ruled out given available data constraints and robust uncertainty analysis. As such, it aims to "bracket reality" as opposed to the much more difficult task of determining a meaningfully most likely chronology.

Our approach accounts for both model and data uncertainties. The GSM is run with hybrid shallow ice and shallow shelf/stream physics. Climate forcing includes a fully coupled energy balance climate model and glacial indexed climate forcing from PMIP3 (Paleo Model Intercomparison Project). The GSM configuration includes fully coupled visco-elastic glacio isostatic adjustment that accounts for the changing load of the adjacent Greenland ice sheet enabling physically self-consistent relative sea level predictions. Our presentation will focus on the uncertainty analysis and bracketing chronologies for the last glacial cycle IIS.

K2

Iceland's contribution to North-Atlantic Tephrochronology: Knowledge gaps & challenges

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Over the last three decades, knowledge of North-Atlantic tephrochronology has greatly advanced due to the need for time-parallel marker horizons, such as tephra layers that could provide robust timing and correlation of diverse paleoclimatic records. In the North Atlantic, Iceland is by far the greatest producer of tephra with over 30 active volcanic systems. Holocene eruptions have been on average every 3-5 years where the majority has emitted tephra. The tephrochronological framework of Iceland includes hundreds of tephra layers, where the Holocene record is the most comprehensive. This framework is largely based on terrestrial records in Iceland and, to some extent, marine records from the Iceland shelf. Over forty Holocene tephra marker layers of regional and local extent have been established within the Icelandic tephrochronology. However, much fewer marker layers have been established for the Pleistocene even though several tephra layers have been identified. Efforts must be made to extend the Icelandic tephrochronological framework beyond the Holocene. Knowledge on eruptive histories of volcanic systems that have been more active during the Pleistocene compared to the Holocene is sparse. Fundamental knowledge on volcanic products in proximal settings, such as stratigraphic constrains, distribution, full chemical range, and numerical age determinations is needed for defining new tephra markers layers. Thus, the main knowledge gaps are reflected in incomplete or sparse information on eruptive products of Pleistocene age in Iceland and the main challenges are associated with dating of volcanic products that have the potential to be become marker horizons.

O-13

Tephra constrains natural and anthropogenic changes in post-glacial Iceland sediments

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Iceland is an ideal setting to investigate naturally occurring shifts in climate and environment due its sensitive location, the geochronological potential of tephra and its human-free Holocene (following the documented settlement c. 871 AD). This investigation is based on a strategic network of tephrochronologically constrained lake records from around Iceland which span the Late Glacial and Holocene. The aims of this project are twofold: i) to better understand the glacial and volcanic history of Iceland following its dynamic deglaciation during the Late Glacial –Early Holocene and ii) investigate the impact of explosive volcanism, humans and land-use on the pristine natural environment. While these lake records are high resolution multiproxy recorders of natural and anthropogenic shifts through the last 14 ka BP, the application of environmental DNA on the sediment sequences allows for an unprecedented understanding of species colonization, vegetation establishment / resilience, as well as human impact and land-use.

O-14

Late Weichselian and Holocene glacial activity on a volcanic active island – Jan Mayen

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Jan Mayen is a volcanic island located in the Norwegian-Greenland Sea about 500 km east of Greenland. Due to its position between cold and warm surface currents, the island is very sensitive to climatic impacts from shifts of these currents. Jan Mayen is a young island, the oldest rocks are some 560.000 years, and volcanism is still active. The northern part is dominated by the 2277 m high, glacier-covered stratovolcano Beerenberg. The lower-lying middle and southern parts are also dominated by volcanic rocks and sediments. In these areas, glaciogenic material is found in windows between post-glacial lava flows, volcanic domes and pyroclastic deposits. This is why it, until recently, was disputed if the entire island had ever been glaciated.

Due to volcanic activity, the paleogeography of the island has changed dramatically, and volcanoclastic sediments interchanges with glaciogenic sediments in many ways. Following a large effort in mapping and more than 100 dates of different types, we can show that the entire island was glaciated during the LGM. In the Holocene, glaciers in the northern part expanded beyond the LIA limits at least once. Also in the southern parts, glaciers were present in the Holocene. Surprising in this regard, was the finding of a formerly unknown, tephra-covered, climatically dead glacier. Both during the last deglaciation and the retreat following the LIA, volcanic activity played an active part.

O-15
The Black Death in Iceland: environmental responses, climate and society

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Having supposedly escaped the first Black Death outbreak in Europe in the mid-14th century, the plague reached Iceland in AD 1402. Both the nature of the plague and mortality rates are debated, estimates of the latter range between 25% and 60%. Palaeoecology can contribute to this debate by examining if reduced land use pressure, caused by the reduction in population, can be observed in environmental archives. This paper examines published and unpublished palaeoecological data from West and North Iceland in relation to climatological and historical records. A change from vegetation regression to succession is observed at several sites in and around the 15th century AD, in the form of recovery of Betula woodland and/or shrubs. Further signals vary between sites, but include raised organic content values, increased values for Salix and/or other grazing sensitive taxa, and reduced numbers of Poaceae, coprophilous fungal spores and microscopic charcoal. Judging from assessment of the available data, the climate regime of this time can hardly be seen as causal factor in this development. We conclude that the decline in human population associated with the plague and, presumably, a consequent reduction in livestock (grazing) and wood harvesting, was of sufficient magnitude to leave its mark firmly in the Icelandic environmental archive. The results highlight the role of anthropogenic influence in post-settlement land degradation, while they also indicate a degree of continuity and resilience within the Icelandic farming system following the Black Death.

O-16

Two farms, two environmental legacies: comparing social standing and environmental impact.

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The interdisciplinary "Two Valleys" project examines settlement patterns, and social and environmental change in Svarfaðardalur and Hörgárdalur valleys, with the aim of providing a holistic overview of spatial and temporal changes in both nature and society. As part of the Two Valleys project, this investigation focuses on land use and access to, and management of, resources, with results presented here for the farms Kot and Sakka in Svarfaðardalur.

Historical and archaeological data were used to build hypotheses for the palaeoenvironmental work. According to historical sources and archaeology, Kot was established around AD 1100 as a farm of low social standing in the remote area of Skíðadalur, while Sakka was settled earlier in the lower reaches of Svarfaðardalur and was a large, wealthy farm of high social standing. By comparing the two farms, the two main questions are addressed here: 1) the timing and nature of human impact, and 2) environmental change as result of land use and (lack of) land management.

Peatland samples proximal to the farm locations were collected and analysed using palynology and soil properties. The results demonstrate a belated decline in birch woodland at both farms. In the case of Kot, this is probably the result of the farm's late establishment. Explanation for a late woodland decline at Sakka is more challenging; possible causes include resource management, population expansion and methodological aspects such as sampling site location.

O-17

Interpretation of δ13C and δ15N depth trends in peatlands of aeolian environments

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Depth patterns of stable isotope ratios of $\delta^{13}C$ and $\delta^{15}N$ in peatlands are used to reconstruct the peatlands' environmental history, e.g. hydrology, degradation and temperature changes. However, the suitability of $\delta^{13}C$ and $\delta^{15}N$ for such reconstructions needs to be verified by studies in a diverse range of environments. Here we present results of a study on the suitability of $\delta^{13}C$ and $\delta^{15}N$ to reconstruct the degradation history of peatlands in Iceland and associated environmental constraints. Iceland is largely comprised of highly active aeolian environments, due to volcanic ejecta, and windborne material from eroding drylands. The study is a step toward assessing if depth profiles of $\delta^{13}C$ and $\delta^{15}N$ are a sound proxy for peat degradation in aeolian environments. We compare $\delta^{13}C$ and $\delta^{15}N$ with approved proxies of decomposition (dry bulk density, C/N ratio and two ratios derived from ^{13}C NMR spectra). We also interpret variations in $\delta^{13}C$ and $\delta^{15}N$ in relation to pedogenic minerals. The complexity of depth trends of $\delta^{13}C$ and $\delta^{15}N$ increases with proximity of the peatlands to source areas of windborne material. There are variations and turning points in $\delta^{13}C$ and $\delta^{15}N$ adjacent to major tephra layers, which appear to be related to the influence of the volcanic deposits on factors like hydrology and fertility of the peatlands, microbial activities and vegetation composition. It is clear that depth trends of $\delta^{13}C$ and $\delta^{15}N$ in peatlands of aeolian environments need to be interpreted in relation to multiple proxies reflecting the organic matter chemistry, and mineral soil constituents.

O-18

Hydroclimate and cryospheric changes in the Russian High Arctic

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The Arctic is exposed to major climate changes, with temperatures increases at rates 2-3x higher than the global mean. Recent climate warming has implications for the cryospheric stability such as a drastic retreat in sea ice extent. Ice-free shelf seas may act as “new Arctic” moisture source impacting on regional hydrology. During the Arctic Century expedition, we targeted the hydroclimate situation of High Arctic Islands, by studying firn/ice cores from three ice caps: Windy Ice Dome (Franz-Josef-Land) and Akademii Nauk ice cap (AN, Severnaya Zemlya) have been revisited after more than 20 years, now complementing earlier longer ice cores. The University ice cap (UN, Severnaya Zemlya) has been cored for the first time. Key observations are intensive near-surface melt and percolation of meltwater at AN and UN ice caps, which complicating drilling. Based on the isotopic composition ($\delta^{18}O$, δD, d excess) of firn cores, density and snow profiles, temperature and accumulation changes in the Eurasian Arctic are investigated. The results are complementarily related to meteorological data from nearby stations as well as to stable isotope data from longer ice-core records drilled on the ice caps in the 1990s to validate recent hydroclimate patterns in the region. First results suggest that recent $\delta^{18}O$ values of ice cores are high, at levels unprecedented in the past hundreds of years. The Arctic Century 2021 Expedition was jointly organized by the Swiss Polar Institute, the Arctic and Antarctic Research Institute, Russia and the GEOMAR in Germany.

O-19

A novel method to incorporate geological knowledge into geophysical inversion

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The presentation is based on the first work in a grand solution project ('INTEGRATE') from the Innovation Fund Denmark, focusing on optimized mapping of construction aggregates with the purpose to decrease the transport distances of these materials. In Denmark, the construction aggregates (gravel and sand) are excavated in different glacial environments. These geological environments are typically: 1) proglacial meltwater plains, 2) old glacial landscape from the Saalian in so-called 'hill-islands', 3) moraine plateaus, 4) buried valleys and 5) dead-ice landscapes. In the current workflow, construction aggregates are mapped using manual co-interpretation of geological and geomorphological maps, borehole information and often, geophysical information obtained by the tTEM method (towed Transient ElectroMagnetic). In this workflow, the geophysical data are inverted by geophysicists using standard starting models, resulting in one or two different inversion results. However, geophysical models are indeed models, and multiple resistivity sections can fit the same raw data!
In INTEGRATE, we are developing a method to perform probabilistic inversions of geophysical data with the use of geological prior information. Hereby, the outcome of the geophysical inversions is a range of models fitting both the geological and geophysical prior information. The end-goal of the project is to make a user-friendly interface, where end-users can "ask" specific questions, relevant for construction aggregate mapping, to this probabilistic model. The idea is to deviate from the typical sequential workflow and prioritize geological knowledge as a guidance for the geophysical inversion and thus, ensure improved consistency and resolution of the subsurface models.

O-20

Glacial isostatic adjustment with 3D earth models: A comparison of deglacial relative sea-level records from Norway and Russian Arctic

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Norway and the Russian Arctic were covered by large ice sheets during the Last Glacial Maximum, and have been key areas for glacial isostatic adjustment (GIA) studies. Previous GIA studies applied 1D earth models while only a few studies included 3D earth structures but without considering the lateral heterogeneity differences across the two regions. Here, using the latest relative sea-level (RSL) databases from Norway and the Russian Arctic, we investigate the effects of 3D structure on GIA predictions and explore the magnitudes of the lateral heterogeneity in both regions.

We compute gravitationally self-consistent RSL predictions using the Coupled Laplace-Finite Element method. The 3D earth structure consists of 1D background viscosity model and lateral viscosity variation, the latter is derived from the shear velocity anomaly from seismic tomography model and controlled by scaling factor denoting the magnitude of lateral heterogeneity. The Norway RSL database includes 413 sea-level index points (SLIPs), 175 marine limiting data and 433 terrestrial limiting data, while the Russian Arctic database includes 353 SLIPs, 78 marine limiting data and 92 terrestrial limiting data.

We find 3D earth structures have significant influences on RSL predictions and the optimal 3D model notably improves the fit with RSL data. However, we realize RSL data from Norway and the Russian Arctic prefer different 3D structures to provide the best fits. The Russian Arctic database prefers a softer background viscosity model, but larger scaling factor than those preferred by the Norway database, partly due to neglecting ice model uncertainty.

O-21

Quaternary history of the Arctic Ocean from the detrital and authigenic sediment isotope perspective

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Isotopic composition of radiogenic elements in the Arctic Ocean sediments has been shown highly useful for paleoclimate and circulation reconstructions. We analyze the isotopic composition of the detrital (Nd-Sr-Pb) and authigenic (Nd-Hf) sediment phases in several sediment cores raised across the Arctic Ocean. Most of these cores cover several glacial cycles, with a stratigraphically longer record obtained north of the Bering Strait, the Arctic-Pacific gateway. We combine the isotope data with sediment stratigraphy and relate them to oceanographic and glacial events. This approach allows us to characterize sedimentary and hydrographic inputs and related history of Quaternary Arctic glaciation and oceanic circulation. Interglacial-type sediments have a relatively mixed detrital isotope composition representing sea-ice contributions from various circum-Arctic shelves carrying products of mostly platform rocks. Pacific inputs via the Bering Strait carry igneous isotope signature. In comparison, glacial intervals feature a wide range of isotopic ratios indicative of igneous vs. cratonic provenance impacted by ice sheets. The major identified end-member sources include the Siberian Large Igneous Province and the Canadian Shield/platform rocks eroded by the Eurasian and Laurentide ice sheets (EAIS and LIS), respectively. Authigenic isotope data corroborate this pattern by indicating radiogenic/unradiogenic glacial inputs from the EAIS/LIS sources and radiogenic Pacific signature in the preglacial sediments. The long-term evolution of the sediment isotope composition appears to be affected by brines from sea-ice formation in the interglacials and by glacigenic hyperpycnal flows during glaciations/deglaciations.

O-22
Marine diatom assemblages in Arctic paleoceanography – integration of training sets

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Diatoms are one of the most important primary producers in the world's oceans. They secrete siliceous frustules that are often well preserved in sediments, and due to their diversity and selective environmental preferences, they are ideal proxies for paleoceanographic studies. In the Arctic, fossil assemblages of marine diatoms are used to reconstruct sea-surface conditions, including temperature (SST), salinity, and sea-ice cover. Reconstructions range from qualitative (e.g., presence of sea ice) to quantitative (e.g., seasonal SST values), but their robustness as paleoenvironmental indicators fundamentally depends on our understanding of the modern autecology of individual species. Although diatom autecology can be studied through plankton surveys, sediment traps, and lab-culturing, the most common approach is by the study of surface sediment diatom assemblages and subsequent linkage of assemblages to surface ocean conditions (so-called training sets). During the last decades, hundreds of Arctic surface sediments have been analyzed for calibration. This work has been carried out by several independent research groups around the world, often using slightly different methodologies and definitions in diatom taxonomy. In light of these challenges, the newly-formed PAGES Working Group MARDI (Marine Arctic Diatoms) aims to align and integrate the various surface datasets resulting in an open-access Pan-Arctic diatom dataset to enable the full potential usage of quantitative diatom-based surface ocean reconstructions.

O-23

A needle in the haystack: Tracing and quantifying the sea ice diatom and IP25-producer Haslea spicula in environmental DNA samples

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Anthropogenic climate change is amplified in the Arctic, where sea ice is rapidly declining. Sea ice harbors a unique biodiversity of unicellular microorganisms with fine-tuned evolutionary traits. sedaDNA has recently been shown to be a promising tool for reconstructing past marine biodiversity but for sea ice this remains a challenge. Most sympagic species only account for a fraction of the biota, are understudied, and DNA references are missing in databases. A few species of diatoms produce a lipid biomarker, IP_{25}, that can be preserved in the seabed for millions of years and is widely used as a proxy for sea ice. The environmental and physiological conditions controlling the production of IP_{25} are not well understood and detecting the species itself might provide more robust reconstructions. In diatom microfossil assemblages and in DNA studies, the IP_{25} producers are usually not detected. Here, we explore the potential to detect and quantify past occurrences of Haslea spicula in sedaDNA records. Several strains of diatoms from Hudson Bay in the Canadian sub-arctic were isolated into monocultures, among them three strains of H. spicula. The strains were confirmed to produce IP_{25}. We isolated a molecular signal from the rbcL gene and designed a beacon specific to H. spicula that can be used to trace and quantify this species in marine sediments. DNA was isolated from ~ 100 surface sediment samples in Baffin Bay and Northeast Greenland, as well as from locations outside the seasonal sea-ice regime to compare with sea-ice concentrations and biomarker profiles.

O-24

Timing is everything: multi-method chronological constraints on late Pleistocene marine regime shifts in south of Iceland

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Lying at the confluence of oceanic currents, proximal to deep-water formation sites and impacted by subpolar gyre dynamics, the waters south of Iceland provide a unique location to study how shifts in global atmospheric and oceanic circulation patterns affected the local marine and ecosystem regimes through time and space. We apply a range of geochronological techniques including radiocarbon dating, paleomagnetic dating (relative paleointensity, paleosecular variation) and tephrochronology to a selection of cores from south and southwest Iceland that extend back to at least Marine Isotope Stage (MIS) 3. We constrain the timing of sea (sub-) surface temperature regime shifts derived qualitatively (planktonic foraminifera assemblages) and quantitatively (stable isotopes and Mg/Ca palaeothermometry). Chronological constraints independent of global climatic variation (such as tephrochronology and relative paleointensity dating) allow us to establish appropriate local reservoir corrections to marine radiocarbon dates back through time. Furthermore, by avoiding tuning our proxy records to canonical recorders of global climate change (e.g., ice core stratigraphy) we can better constrain the lead/lag time of local oceanic and ecosystem regime shifts south of Iceland to millennial-scale global changes. This multi-method approach to chronology will allow us to establish a much-needed reference event stratigraphy for future paleo-studies in this dynamic region.

O-25
Reddish MIS1-4 layers of Svalbard Shelfs and Slopes-Origin and Relevance

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Reddish sediment layers in western and northern Svalbard Fjord and Shelf regions were related to particular short time (deglacial) events of Svalbard glaciers. Here we describe the occurrence, timing and in particular the lateral distribution and thickness of these layers throughout a set of RV Polarstern cores of the Western shelf region off Kongsfjorden towards the Yermak Plateau. Up to now the color was the major recognition tool of these layers in a few cases combined with physical properties data.

We add a chemical and mineralogical analysis of these layers for provenance investigations. For this purpose, nine sediment cores of the western continental slope of Spitsbergen, Svalbard, were studied by high-resolution linescan images in initial stage. Due to the high resolution line and XRF scanner analysis layers which were not visually recognizable could be examined. As the relevant sections are located in Isotope Stage 3 and in the lower Stage 2, a stratigraphic framework was initially constructed and thus the sedimentation rates were calculated. By using the measured data a system was developed to classify the intensity and the thickness of the reddish layers. Because of the high resolution of the data it was possible to detect even very thin layers. The identified pink layers were now transferred to a map, so that an overview of the current pattern could be obtained. Deglacial vs. warm Atlantic water intrusions are discussed as origin of the reddish layers deposition process which is not the same for every layer according to our findings.

O-26

Is the extensive Late-Quaternary landslide distribution in North Iceland controlled by earthquakes from active faults in the Dalvik Seismic Lineament?

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Earthquakes are major drivers of post-glacial landscape change and major, deep-seated Late-Quaternary landslides are commonly found in the Micocene Volcanic rocks of North Iceland. These landslides geomorphically overprint post-glacial landforms around the Troll Peninsula (ie. Tröllaskagi ~66º N). This area has abundant seismicity and is the location of several instrument-recorded earthquakes >Mw 5 in the past ~100 years and with several historical accounts (since ~800 C.E.) of major earthquakes that damaged infrastructure in the area. I propose that these two processes, landslide occurrence, and earthquakes, are interrelated – i.e. that the location and frequency of major landslides are correlated with the location of active tectonic faultlines that that are accommodating Iceland's plate boundary tectonic deformation and when these fault slip generating earthquakes, the strong ground motions trigger major landslides in the highly fractured rocks near active faults. Data compilation of previous landslide mapping and analysis combined with new fit-for-purpose remote mapping and field validation yields interesting preliminary results, i.e. landslide distribution and frequency appear to be correlated with seismicity. Interestingly, because previous analysis suggest that the landslide distribution is not clearly related to glacial debutressing, patterns or lithology, thus distance from earthquakes (thus a proxy for active faults) may be the main control on landslide occurrence here. Once the landslides initiate due to strong ground motions – other factors including periglacial processes may aid movement, however as shown from these preliminary results, earthquake frequency and location appear to be the main control on landslide distribution and frequency in North Iceland.

O-27

Preliminary lessons on integrated marine and terrestrial mapping of shoreline-crossing landslide processes, Skjerstadfjorden, Northern Norway

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For several decades it has been common to separate Quaternary geological mapping into either marine or terrestrial, due to differences in the applied methodologies. With advances such as the availability of onshore LIDAR data it has become easier to do comparative studies across the shoreline. In an ongoing mapping project at the Geological Survey of Norway (NGU), around the inner part of Skjerstadfjorden in Nordland County, marine and terrestrial datasets are integrated to get a thorough understanding of the Quaternary geology across the shoreline. We use a combination of onshore field observations, remote sensing data (LIDAR, Bathymetry, and high resolution 2D seismic), and sediment samples (Gravity corer). We will here present preliminary data from the mapping, with a focus on three locations where we have observed suites of on- and offshore landforms reflecting mass-wasting processes that have crossed the shoreline. The onshore landforms include landslide scars in marine emerged sediments whereas the subaqueous landforms involve channels, plunge pools and landslide debris. The slide events are interpreted to have mainly happened during the Holocene glacioisostatic rebound. Where one recent event, which involved the entire fjord head at Soksenvika happened in 1881, and likely involved quick clay which is still present along the shoreline.

O-28
Calibrating estimates of modern carbon burial on the Canadian Beaufort Shelf

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Large quantities of sediment and organic carbon (OC) are delivered to the Beaufort Sea by the Mackenzie River and erosion of coastal permafrost. Knowledge on offshore burial rates of OC is a pre-requisite for determining the fate of this carbon, and quantifying the amount that is mineralized in either the water column or sediments. Canadian Beaufort Shelf estimates of OC accumulation rates are based on data compiled over 25 years ago when no direct measurements on sedimentation rates were available. Instead, they were derived from the seismically imaged thickness of sediments deposited since post-glacial transgression. Potential errors in this approach are large, particularly the assumption that sediment accumulation has remained constant throughout the Holocene. The aim of this study is to test the accuracy and applicability of these long-term OC burial estimates for studying modern carbon cycling on the shelf. We use marine sediment cores and geophysical data collected from the CCGS Amundsen in 2021 during the Permafrost Carbon in the Beaufort Sea (PeCaBeau) expedition. We compare estimates from the approximated thickness of post-transgression sediments with ^{210}Pb, ^{137}Cs, and ^{14}C dating (foraminifera and mollusc shells). Preliminary data from two sites (western shelf break, 74 mbsl; eastern middle shelf, 50 mbsl) indicate that modern sedimentation rates are 40-60% higher than maximum estimates from post-transgression sediment thicknesses. However, due to higher porosity in surface sediments, mass accumulation rates are only 5-40% higher. Here we will present data from additional sites to assess the magnitude and origin of these differences across the shelf.

O-29

Centre for ice, Cryosphere, Carbon and Climate (iC3)- closing large scale uncertainty in Polar ice sheet impacts on the global carbon cycle

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Recently funded for 10 years by the Research Council of Norway centres of excellence scheme, iC3 aims to fill a major research gap in polar science by quantifying the future impact of ice sheet change on Earth's carbon cycle over policy-relevant timescales. It will achieve this by uniting complementary expertise at UiT The Arctic University of Norway, the Norwegian Polar Institute and a network of collaborators in an unprecedented research endeavour spanning both the Arctic and Antarctic. In developing an integrated, interdisciplinary hub of experts studying the cryosphere, oceans, atmosphere and geosphere, iC3 will close order of magnitude uncertainty in polar carbon budgets, addressing the hypothesis that changing ice sheets (and aligned cryosphere) profoundly impact Earth's carbon cycle, directly affecting human societies via feedbacks to our future climate and invaluable polar ecosystems.

The centre will leverage excellent Norwegian infrastructure and innovative technologies to gather and integrate novel datasets at both poles, with state-of-the-art numerical models to assess future impacts at regional to global scales. iC3 will deliver high impact via initiatives dedicated to Innovation and Training Future Leaders, alongside strategic, internationally-visible programmes to drive engagement with academics, the public and policy makers.

POSTERS

P-01
JAN MAYEN - Quaternary geological map

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The Geological Survey of Norway recently published a Quaternary geological map of Jan Mayen, scale 1:50 000. The map is made in accordance with procedures for mapping of surficial deposits and landforms on mainland Norway. As post-glacial volcanic rocks and sediments commonly occur on the island, these are also included in the map.

Jan Mayen is a volcanic island, remotely located in the Norwegian-Greenland Sea. The island is younger than 600.000 years, and volcanism is still active. A research project funded by the Research Council of Norway had as one of its goals, to study the glacial history of the island. This was largely unknown, and it was even disputed if the entire island had ever been glaciated. For this study, geo-referenced observations were needed from the ground over large parts of the island. Jan Mayen has gone through many volcanic eruptions in the Holocene which obscures and covers other surficial deposits. We therefore had to traverse the island by foot in the search for glaciogenic deposits between lava flows and volcanoclastic material, and to collect samples for dating. This resulted in many hundreds of ground observations that were combined with satellite images in an ArcGIS 10.6 project for further interpretations and delineation between different sediment and rock types.

Reference: Lysså, A., Larsen, E. & Hiksdal, A. 2022: JAN MAYEN, Quaternary geological map scale 1:50 000. Geological Survey of Norway. The map can also be downloaded as pdf at https://www.ngu.no/.../Publikasjoner/Kart/JanMayen_KV50.pdf

P-02

Bottom current activity north of Svalbard on orbital and millennial-scales during the late Quaternary

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The last glacial period was characterised by multiple, rapid climatic fluctuations on millennial-scales, known as Dansgaard-Oeschger (D/O) events or Greenland stadials and interstadials. These events are closely linked to the variations in the strength of convection in the Nordic Seas. Here, we present the results from an investigation of past bottom current activity in relation to climate change and meltwater input on orbital (glacial-interglacial) and millennial (D/O event) scales from a deep-sea sediment core recovered from the northern Svalbard margin in the Fram Strait at 1031 m water depth. The Fram Strait is an oceanographically important region through the exchange of deep and surface water masses between the Nordic Seas and the Arctic Ocean, where Atlantic water is currently transformed from a warm surface current into a colder subsurface intermediate water current. The results of the investigation are based on the records of sortable silt grain size (10-63 μm), planktonic and benthic foraminiferal oxygen and carbon isotopes, ice-rafted debris, and AMS ^{14}C dates. Fining of the sortable silt indicates a weaker bottom current strength during periods of colder climate (Greenland stadials/Heinrich Events and the Last Glacial Maximum). The weaker bottom currents were possibly caused by increased meltwater input, leading to stronger stratification and a reduced exchange of the water masses. The outcome of the study aims to provide further insight into the causes of variations in the strength of bottom currents in relation to past climate change and the possible input of meltwater during the last interglacial-glacial-interglacial cycle.

P-03

Revisiting NE Greenland RV Polarstern Slope Cores Data of Marine Isotope Stages 1-6

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In 1997 RV Polarstern gained a multiple set of long sediment cores from the NE Greenland Slope between 79 and 82° N. Kastenlot Core PS2887-1 was investigated in detail for stratigraphic, IRD and $d^{18}O$/ $d^{13}C$ data. A reconstruction of two glacial-interglacial cycles could be established of which the Last Glacial to Holocene sequence was published in 2003.

Here we will show the whole sequence as well as new data on IRD composition and core scanning measurements. With the core scanning data more details on several sediment units with strong layering in a mm range can be shown. On top of this we intend to draw several neighboring cores from AWIs core repository for a correlation and investigation of the lateral extend of in particular deglacial layers of the cores. By using the XRF Scanner of the AWI the chemical composition of the sediment can be determined and may lead towards a better understanding of the provenance of the sediment in combination with IRD data.

These results shall enhance the in depth understanding of across slope redeposition triggered by the NE Greenland Ice Sheet history vs. the slope parallel ocean currents including the Atlantic Water Recurrent System in the intermediate water level.

P-04

Neoglacial maximum and subsequent evolution of the Gljúfurárjökull glacier (Tröllaskagi, northern Iceland).

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The Gljúfurárjökull glacier is located at the headwall of the Skíðadalur valley, under the Blástakkur peak (1379 m), in the Tröllaskagi peninsula (northern Iceland). It is one of few debris-free glaciers in the area and the most studied in recent decades due to its easy accessibility. Its terminus is framed by a long series of push moraines. Those moraines closest to the ice front are related to small advances inferred from aerial photograph records (e.g. mid-1990s). The more distant ones were until now interpretated to be formed during the Little Ice Age (LIA), based to the first lichenometric dating surveys in the area. In this work, cosmic-ray exposure dating was applied, through ^{36}Cl cosmonuclide. Due to logistic constraints and the large number of moraines, we sampled 1-2 promising boulders from each moraine, which seems to be stable and located far from unstable slopes. The exposure ages obtained with the ^{36}Cl cosmonuclide agreed with the chronostratigraphic grouping: e.g. moraines furthest from the ice front gave ages of 5-3 ka, while those located closest to the terminus position (based on the aerial photograph from 1946) date back to the 15th century. These results corroborate that the maximum glacial advance during the Neoglaciation was prior to the LIA, as it had been previously recognized in the nearby eastern and western Tungnahryggsjökull glaciers. Moreover, our results show that the maximum extension of Gljúfurárjökull during the LIA occurred before the 19th century, probably in the 14th-15th centuries, as in the other referred glaciers.

P-05

The Geomorphological record of an ice stream to ice shelf transition in Northeast Greenland

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Understanding ice stream dynamics over decadal to millennial timescales is crucial for improving numerical model projections of ice sheet behaviour and future ice loss. In marine-terminating settings, ice shelves control ice-stream grounding line stability and ice flux to the ocean. However, few studies have investigated the long-term terrestrial geomorphological imprint of ice shelves during deglaciation. We document the terrestrial deglacial landsystem of Nioghalvfjerdsfjorden Glacier (79N) in northeast Greenland, following the Last Glacial Maximum, and its transition to a floating ice shelf. High elevation areas are influenced by local ice caps and display autochthonous to allochthonous blockfields that mark the interaction of local ice caps with the ice stream below. Below 600 m a.s.l. glacially abraded bedrock surfaces and assemblages of lateral moraines, 'hummocky' moraine, fluted terrain, and ice-contact deltas record the former presence of warm-based ice and thinning of the grounded ice stream margin through time. In the outer fjord ice shelf moraines, dead-ice topography, and ice marginal glaciofluvial outwash were produced by an ice shelf during deglaciation. Along the mid- and inner-fjord areas this ice shelf signal is absent, suggesting ice shelf disintegration prior to grounding line retreat under tidewater conditions. Below the marine limit, the geomorphological record along the fjord indicates the expansion of the 79N ice shelf during the Neoglacial, which culminated in the Little Ice Age. This was followed by 20th century recession. These mark rapid ice shelf thinning and typify the present-day ice shelf landsystem in a warming climate.

P-06

Distribution of modern benthic foraminiferal assemblages across the Northeast Greenland continental shelf

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Analysis of benthic foraminifera in surface samples from 23 sites on the Northeast Greenland continental shelf reveal key regional assemblage differences. Principle component and cluster analysis was used to divide sites into two clear faunal zones: 1) glacier proximal and 2) mid and outer shelf sites. These assemblages differ significantly, as glacier proximal sites are characterised with a high percentage and concentration of calcareous species, whilst mid and outer shelf sites are dominated by agglutinated taxa. We propose that the formation of seasonal sea ice and the Northeast Water polynya creates brine formation and a highly productive environment, resulting in the dissolution of calcareous tests in the mid and outer shelf region. The calcareous assemblages at almost all sites are dominated by the cool Atlantic Water species Cassidulina neoteretis and Polar Water species Cassidulina reniforme. Glomulina oculus and other miliod species, Stetsonia horvarthi and Oridorsalis tenerus are found to be key calcareous species in many sites in the glacier proximal zone, but rare to absent in the mid and outer shelf. Canonical correspondence analysis shows that September sea ice cover and clay content of the sediment (a proxy for glacial plumes) are key drivers of benthic foraminiferal assemblages at glacier proximal sites, whereas TOC and silt are driving those in the mid and outer shelf region.

P-07

Dynamic ice margins during a warm Late Glacial-Early Holocene, Northern Svalbard

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The time-transgressive deglaciation of the Svalbard-Barents Sea Ice Sheet was driven by sea-level rise, the incursion of North Atlantic waters around Svalbard, and enhanced summer warmth. However, ice retreat was interrupted by asynchronous re-advances that occurred into high relative seas during these periods, associated with warm regional waters and elevated summer temperatures. Better understanding of this style of deglaciation and dynamic ice-sheet response to a warming climate can serve as valid analogues for modern warming and today's ice sheets. Here we present evidence from Northern Svalbard of glacier re-advances during the Late Glacial-Early Holocene transition in hand with local sea-level history and the occurrence of thermophilous molluscs.

P-08

Ancient DNAs: Influence of Sedimentary Deposition on Bacterial Communities in Arctic Holocene Sediments

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Community assembly principles driving microbial biogeography have been studied in many environments, but rarely in the Arctic deep biosphere. The sea-level rise during the Holocene (11–0 ky BP) and its resulting sedimentation and biogeochemical processes can control microbial life in the Arctic sediments. We investigated subsurface sediments from the Arctic Ocean using metabarcoding-based sequencing for characterizing bacterial 16S rRNA gene composition, respectively. We found enriched cyanobacterial sequences in methanogenic sediments, suggesting past cyanobacterial blooms in the Arctic Mid-Holocene (7–8 ky BP). Bacterial assemblage profiles with a sedimentary history of Holocene sea-level rise in the Arctic Ocean enabled a better understanding of the ecological processes governing community assembly across Holocene sedimentary habitats. We found that the Arctic subsurface sediments deposited during the Holocene harbor distinguishable bacterial communities reflecting both geochemical and paleoclimate separations. These local bacterial communities were phylogenetically influenced by interactions between biotic (symbiosis–competition or immigration–emigration) and abiotic (habitat specificity) factors governing community assembly under paleoclimate conditions. We conclude that bacterial profiles integrated with geological records seem to be useful for tracking microbial habitat preference, which reflects climate-triggered changes from the paleodepositional environment (the so-called ‘ancient DNAs’).

P-09

Clay mineral and Nd, Pb, and Sr isotope provenance of a MIS 4/3 sediment record from the Lomonosov Ridge, Arctic Ocean

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Quantitative clay mineralogy analysis and the determination of Nd, Pb, and Sr isotopes from clay fraction were applied to trace the provenance of sediments from core 96/12-1pc from the Lomonosov Ridge, Arctic Ocean. The clay mineral assemblage and the isotope signatures indicate distinct changes during the MIS 4/3 transition corresponding to the Middle Weichselian deglaciation. This transition is characterised by a homogeneous, dark grey, silty clay layer with a distinctive IRD concentration, which forms a prominent marker bed for the central Arctic Ocean sediments. The elevated smectite and kaolinite contents in this grey sediment layer are possible weathering products of the Siberian basaltic rocks, such as the Putorana Plateau, transported to the Kara and western Laptev Sea shelves. The Nd and Sr isotope values from the layer are compatible with the input from the basaltic rocks and fall within the isotopic range of sediments from these shelves. The abrupt changes in the Nd, Pb, and Sr isotopic data from this grey layer attributed to the MIS 4/3 transition likely mark a pronounced deglaciation event. Increased coarser debris content in the layer indicates a change in the sedimentation regime with a strong ice-rafted component. This change may also be related to a sudden release of meltwater from an ice-dammed lake in the northern Siberia.

P-10

Paleoclimatic events of the last 30,000 years registered by calcareous nannofossil associations on the west Spitsbergen margin

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The study of calcareous nannofossil (cn) associations has shown to be a reliable tool for the paleoclimatic reconstruction of Arctic margins because the nannoflora is highly sensitive to water column feature variations (i.e., temperature, insolation, nutrients). The piston core GS191-01PC was collected on the Bellsund Drift crest along the west Spitsbergen margin during the PREPARED cruise (Lucchi et al., 2014). It was drilled in a water depth of 1647 meters and it recovered 19.67 m of sediments distinguished by a complex stratigraphy. The core is characterized by bioturbated and laminated sediments, with sparse to massive Ice Rafted Debris, oxidized layers and two tephra layers. It was extendedly studied by Caricchi et al. (2019, 2022), providing a strong age model for the area.

The last 30,000 years Before Present were examined for cn associations throughout 13,90 m of the core (140 samples, 10 cm-resolution). The distribution of species Emiliania huxleyi and Coccolithus pelagicus was considered along with reworked specimens, total nannofossil abundance (number of specimens/10 mm^2) data and the E. huxleyi/C. pelagicus ratio (H/P; Carbonara et al., 2014). In the Late Pleistocene the distribution of E.huxleyi and of the reworked specimens highlights Heinrich (3, 2, 1) and the Melt Water Pulse-1A abrupt events. From the Younger-Dryas and throughout the Holocene the variations of total nannofossil abundance and of the overall composition of the association evidence i.e., the Holocene Thermal Maxima, the 8.2, 4.2 and 2.8 events as well as the deposition of the tephra layers identified by Caricchi et al. (2019).

P-11

Geomorphological mapping methodology applied to rock glaciers and debris-covered glaciers in Tröllaskagi, Northern Iceland

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The Tröllaskagi peninsula is home of many debris-covered glaciers. They coexist with rock glaciers and other periglacial features in nearby cirques or even within the same cirque. Intermediate transitional stages are frequently found between these two of formations, sometimes preceding or overlapping old push moraines. These formations may be active, inactive, or collapsed, i.e. without inner ice core. Geomorphological mapping is a key technique to unveil the origin and evolution of these landforms. This work illustrates the mapping techniques in the valley/cirques of Hofsdalur, Héðinsdalur, Hólardalur, Svarfaðardalur, Lambárdalur, Fremri-Grasárdalur, and Nautárdalur (central Tröllaskagi).

The maps result from the combination of analogical techniques of photointerpretation and 2D hand drawing with digital techniques where the geomorphological symbology is implemented over a high-resolution Digital Surface Model and 3D stereo pairs of the study area. The production of geomorphological mapping has consisted of several steps: 1) visual inspection of aerial photographs (from 1946 to 2019); 2) in-situ field validation (from 2010 to 2022); 3) landform mapping onto an acetate paper over orthophotos (from 2000 and 2019, at 1:4,000 scale) as a; 4) high-resolution scanning; 6) georeferencing in a GIS software; 7) production of a relief hillshade (2x2 m resolution); and 8) vectorization and final edition of the main geomorphological units and features, in a CAD platform (MicroStation) and/or GIS software (ArcGISPRO). The results enhance a impressive view of the landforms. Rendering tools have made possible to obtain more realistic 3D views that facilitate the understanding of the evolution of these landforms.

P-12

A Betula expansion and an inferred climate amelioration in the late Holocene pollen record of Iceland

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Prior to the human colonisation of Iceland in the late 9th century (Landnám), the primary force of ecological and environmental change was climate. The palynological reconstruction of past terrestrial ecosystems in Iceland has proven a useful means of discerning fluctuations in Holocene climate. Here, palynological data from six pollen sampling sites in south, southwest, west and northern Iceland reveal rising values in Betula (birch) pollen between AD 550 and 850. Raised Betula values infer an improved flowering environment and increased Betula coverage and density within the Icelandic landscape at this time. This is coincident with raised values for other pollen and spore taxa, although these vary between the sampling sites. Contemporaneous sedimentary data also reveal a stable environment, with limited minerogenic input visible. The combination of vegetation and sedimentary conditions would suggest a brief period of climate amelioration c. AD 550-850. Such findings demonstrate the ongoing potential that palynology harbours with regard to the reconstruction of Holocene climate regimes in Iceland, especially when applied in association with other proxy data.

P-13

Surface displacement monitoring of debris-covered glaciers and rock glaciers through historical aerial photographs in Tröllaskagi (northern Iceland):

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The Tröllaskagi peninsula (Iceland) hosts many rock glaciers (RG) and debris-covered glaciers (DCG). To understand the dynamics of these formations, several RG and DCG have been selected in the Hofsdalur, Hóladalur, Lambárdalur, Fremri-Grasárdalur, and Nautárdalur valleys. The mobility of their surface boulders has been monitored, by means of photogrammetric techniques applied over historical aerial photographs (1980, 1994, 2019-2021). The x, y and z coordinates of prominent and easily identifiable boulders and features considered to be stable, were captured. From them, surface displacement and associated uncertainty were obtained. These data were cross correlated in a GIS to obtain displacement vectors, elevation changes for each boulder and to produce maps of the velocity fields.

Results of surface horizontal displacements during the periods 1980-1994 and 1994-2019 show very low mean velocities in the RG and DCG (values 0.12 and 0.33 m yr^{-1}, respectively). For example, in the Nautárdalur RG, the average of 1994-2021 period is 0.135 m yr^{-1}. In addition, an overall surface lowering is observed in all RG and DCG, with mean values ranging between -0.63 m and -1.91 m. The subsidence has increased since 1994. For instance, the Hofsdalur DCG and the Nautárdalur RC show a mean surface elevation change of -3.5 m and -2,79 m, respectively in the period 1994-2019. Produced maps show that horizontal and vertical displacement occurs mainly in the frontal areas of these formations, except for the scattered collapse depressions. These RG and the DCG can be considered practically static, with their main dynamics being surface lowering.

P-14

Analysing the response of debris-free glaciers in Tröllaskagi (northern Iceland) to recent warming through differential interferometry

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Debris-free glaciers are highly sensitive indicators of climate change. Some of the best examples in the Tröllaskagi peninsula (northern Iceland) include: Eystri- and Vestari-Tungnahryggsjökull, Gljúfurárjökull, Eystri-Skíðadalsjökull, Þverárjökull, Barkárdalsjökull and Héðindalsjökull. The present work aims to analyse the relations between of the evolution of these glaciers and the recent warming. Variations in ice volume and glacier surface, the evolution of their mass balance and the increase of their debris-covered surface area were analysed. The glacier surface was outlined from historical aerial photographs and satellite images from 1946 to 2022; the snowline was inferred for each year using two methods: band quotient in optical images and snow/ice unsupervised classifications with synthetic aperture radar (SAR) images. Differential interferometry was used to measure the variations of ice surface elevation by accounting the volume of ice lost or gained in each hydrological year and reconstructing the mass balances from 2016 to 2022. Finally, the increase in debris-covered surfaces and its influence on glacier mass balance was analysed.

The results have allowed us to quantify the retreat rate of these glaciers - especially significant since 2000 -, as well as their volume loss and the frequency of negative mass balance years. Their debris-covered surface has increased, especially on glaciers at the foot of vertical walls. The increase in debris surface seems to counterbalance with ablation and, therefore, slowing down the glacier retreat.

P-15

Benthic foraminifera – not always a signal of climate and oceanographic changes?

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Iceland is located at a climatic frontier in the North Atlantic storm-track path at the present-day boundary between Polar and Atlantic surface water masses. Research on the North Icelandic shelf sediments shows that there is a relationship between foraminiferal species distribution and oceanographic changes throughout the Holocene.

The location of Iceland on the North Atlantic ridge, superimposed on a mantle plume, gives rise to frequent volcanic eruptions. Numerous tephra layers have been identified in the marine sediments on the Iceland shelf. The motivation for this study was the observation of apparent increase in abundances of the opportunistic taxon Elphidium excavatum f. clavata, concurrent with tephra horizons in marine shelf sediments. Here we test the hypothesis that tephra deposition on the sea floor can influence certain benthic foraminifera significantly and that ecological changes in the benthic environment can be caused by volcanic events.

It appears that Elphidium excavatum f. clavata is tolerant enough to bloom when the sea floor is disturbed by tephra fall. The percentage is in some instances very high, up to >50. These blooms are apparently a consequence of ecological changes, which are not related to oceanographic and climatic factors.

Elphidium excavatum f. clavata is an important indicator for Late Holocene climatic changes on the North Icelandic shelf, including changes during the so-called Medieval Warm Period and the Little Ice Age - generally increasing in abundance during cool intervals. The present results show that working on climatic reconstructions, the knowledge of such “non-climatic” effects is crucially important.

P-16
Exploring landform expressions of subglacial thermal regime transitions.

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Basal thermal regime - and, by extension, basal hydrology - is fundamental to ice sheet stability, ice flow, and discharge. Frozen and thawed basal conditions are known to vary beneath ice sheets both spatially and through time, yet with poorly resolved consequences for ice sheet behaviour, particularly so over the scales and life cycle of a continental ice sheet. The extent and longevity of cold-based conditions (where the basal ice is below pressure melting point) are key to ice sheet evolution, and in the landform record assumed essential for preservation of older landscapes within glaciated regions. Yet it is transitions in thermal regime that likely determine rates and patterns of ice sheet evolution, and are implicated in several glacial landforming processes, such that these landforms may offer insights into the spatial scales and persistence of basal thawing. Using examples from the deglaciated marine and terrestrial sectors of the former Eurasian ice sheets, we explore landform expressions of subglacial thermal regime transitions across a range of glaciological and bed conditions. With such insights, we hope to refine approaches to inverting the preserved glacial landform record for interpretation of subglacial thermal regime, and assess to what degree it can inform on the pace, distribution and impacts of changes in subglacial thermal state.

P-17

Diversity of non-pollen palynomorphs registered in the sediments of the high-Arctic lake Tenndammen, central Svalbard

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A 700-year-long detailed reconstruction of vegetation dynamics and environmental changes in Colesdalen, Svalbard, is reconstructed based on a lacustrine sediment core Te2019 (N 78°06.118′; E 15°02.024′, water depth ca. 2 m; altitude 5 m asl; 85 cm long and 60 mm in diameter) obtained from the shallow lake Tenndammen. Multi-proxy paleoenvironmental study was performed on the sedimentary ancient DNA (sedaDNA), pollen, spores, non-pollen palynomorphs (NPP), plant macrofossil remains, lithology and biogeochemistry. Age control was provided by a composite model using thirteen ^{14}C datings (nine of which were reversed), and three tie points obtained from the record of spheroidal carbonaceous particles (SCP) reflecting a regional coal burning history. Plant microfossil diversity of 15 spore types, 56 pollen types and 60 NPPs was described.

Among the NPPs fungi spores dominated with 40 types of the preliminary identified ascospores, 6 basidiospores, 4 algae types, 3 micro-fragments of the plant tissues, and 7 microfossils of indeterminate nature. The frequency of NPP occurrence in the studied sediments was generally scarce. The most frequently encountered NPP types were the mosses embryophytes (registered in 40 of total 73 samples and in 150 of 325 microslides), spores of Sporormiella sp., and indeterminate black to blackish-brown globose fungi spore (both registered in 7 samples and in 12 slides). Additional 10 NPPs were tentatively described as exotic, i.e. extra-regional palynomorph types: their natural occurrence is usually related to the areas with higher temperatures than in the High Arctic. We tentatively discuss their occurrence in terms of bird of human migration.

P-18
Palaeoecology of Lake Myvatn, Iceland

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Lake Mývatn is a shallow, eutrophic lake known for its high biodiversity and its rich wildlife. Several palaeoecological studies have been made to reconstruct the history of biota. This includes analyses of diatoms, green algae, insects and crustaceans, as well as plant pigments and chemical composition. The lake's wildlife undergoes dramatic fluctuations on a decadal scale and have their origin in oscillating food-web dynamics. These fluctuations also appear in the sediment record, together with trends associated with changes in water depth due to sedimentation. There is, however, a significant anomaly in the sedimentary record that may indicate a crisis in the lake's history in the period 150-550 C.E. It is characterized by a change in cladocera, chironomids and diatoms, indicating some sort of hardship. We have a new sediment core from the lake that is aimed at testing the hypothesis that the lake suffered from hypoxia (lack of oxygen) in this period. We will be looking for evidence of simultaneous deposition of sulphur and iron (pyrite). Understanding this anomaly may be instrumental for the long-term management of this lake.

P-19

Atmospheric deposition-flux rates of microplastics particles recorded in Icelandic surface-lake sediments: a newly started project

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Microplastics (MPs) have been detected across most environmental compartments globally and can even be found in large quantities in remote areas such as the Arctic. Pathways for MPs towards northern latitude remain greatly unknown. However, atmospheric transport could play a major role in the transfer of particles towards polar regions.

To assess whether atmospheric deposition is a major component of microplastics fluxes in Iceland, we collected surface-sediment samples from Icelandic lakes using short coring device. Three remote crater lakes, with small and well-defined catchment areas, and no apparent main in- or outflows, were targeted, to reduce potential contributions from runoff and to avoid local sources of MPs. For comparison, we also investigate three other lakes, located closer to populated areas, using sediment traps to estimate microplastics fluxes in the deepest part of each lake. In addition, the iconic lake þingvallavatn was selected to study spatial variability of MPs within the lake, considering Öxarárdal as point source for microplastics particles from tires, littering and clothing due to intense tourism in the area. Composite data from a surface-sediment-sample transect, a sediment trap, short cores and modelling are used to investigate transport and spatial variation of MPs, and to assess the lake status regarding microplastics pollution.

On a broader scale, this project aims at producing the first data on MPs in Icelandic freshwater habitats and will therefore provide baseline data for the state of Icelandic lakes in the Anthropocene.

P-20
IRD in the Iceland Sea and palaeoceanographic changes during MIS 1-6

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The Arctic and the Nordic Seas are presently undergoing considerable and rapid changes in sea ice cover. Sea ice cover plays a vital role in polar regions and is one of the most variable components in the Earth´s climate system as well as influencing a number of processes in the oceans. Terrigenous debris in marine sediments, ice rafted debris (IRD), at high latitudes provides information on past sea ice cover, iceberg trajectories, and ocean currents. We present results from a study of IRD in two sediment cores from the Iceland Sea spanning a full glacial-interglacial cycle (Marine Isotope Stage (MIS) 1 to 6). The aim is twofold; i) to reconstruct changes in the IRD concentration to provide information on sea ice cover and iceberg transport in the Iceland Sea during the Late Quaternary, and ii) to characterize types of IRD identified to infer source regions and potentially aid in distinguishing between sea ice rafted debris (SIRD) and IRD sourced from glacial deposits in icebergs. To support IRD interpretation, planktic foraminifera, $\delta^{18}O$, $\delta^{13}C$, Magnetic susceptibility, XRF elemental abundances and grain size analyses were used. The study area is sensitive to climate change and ocean circulation being geographically located in the vicinity of water mass boundaries such as the Polar Front and sea-ice limits (Arctic Front). Results indicate that during this glacial-interglacial cycle, IRD concentration varies significantly, with the highest fluctuations occurring within MIS 6. Variations in the types of IRD are observed between different MIS stages and between the two cores.

P-21

Paleoclimate projects in the GEUS surface department: landslides, tunnel valleys and seepage from the sea bed

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Our aim is to present some of the ongoing research projects in the GEUS SURFACE department. The ongoing landslides project in Greenland, focusing on mass transport deposits in Karrat Fjord and Vaigat, has the potential to reveal the frequency and magnitude of landslides (or rock avalanches) and tsunamis in West Greenland, their relation to climate change and the variability of the Greenland ice sheet, and their impact on benthic habitats. Thus, we propose to utilize the nearshore landslide record in West Greenland, and published climate studies, to bridge knowledge gaps on climate-related triggers for slope instability, and the implications of the current trend of climate change.

The North Sea Tunnel Valleys – Architecture, genesis and prediction (NOARG) project in the Danish North Sea aims to improve models that predict the distribution and architecture of buried tunnel valleys in former glaciated shelf areas, ultimately reducing risk for future offshore construction. Furthermore, the project will add to the scientific discussions on tunnel valley genesis, e.g. steady-state vs. catastrophic meltwater erosion and update the Quaternary geologic model of the North Sea. The SEEP (building a SEabed Environmental baseline for Platform abandonment) project investigates methane seepage from the seabed of the North Sea and establishes a baseline for natural seepage of gasses from the subsurface. It investigates how seepage has developed since the last Glacial and if the seepage is related to deeper seated faults and if offshore activities have influenced the amount of seepage.

P-22

Preliminary mapping of the 1991 surge of Skeiðarárjökull through structural glaciology and foreland geomorphology

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The 1991 surge of Skeiðarárjökull was described by a 1-kilometer advance in its western margin. The extensional stress associated with accelerated sliding caused a heavily crevassed ice surface upglacier from the 1991 ice margin. The most apparent feature that remains from the 1991 surge is a surge-end moraine, and other features that are likely linked to surging behavior, such as streamlined subglacial bedforms, crevasse-squeeze ridges, and a dead-ice moraine. Two preliminary maps of ice surface structures at the western 1991 ice margin and post-surge western forefield of Skeiðarárjökull were constructed. The maps were made to determine if any relationship exists between the 1991 ice surface structures and post-surge proglacial landforms.

P-23

Late Holocene evolution of two highly responsive debris-free glaciers: Tungnahryggsjökull (Tröllaskagi, Northern Iceland)

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The Tungnahryggsjökull, in Austurdalur and Vesturdalur valleys (central Tröllaskagi, northern Iceland), are amongst the biggest debris-free glaciers in the peninsula. Their lack of supraglacial debris cover makes them very responsive to short-lived climate oscillations, which is evidenced by great number of moraine ridges in good state of preservation. By means of a multidisciplinary approach involving geomorphological mapping, glacier reconstruction, multitemporal aerial photographs and absolute/relative dating (36Cl cosmic-ray exposure dating, lichenometric dating based on Rhizocarpon geographicm and Porpidia cf. soredizodes species), we have reconstructed the evolution of both glaciers since the culmination of their maximum ice extent. Results revealed that Tungnahryggsjökull reached their Neoglacial maximum expansion at 1.6 and 1.3 36Cl ka. During the Little Ice Age (LIA), they culminated major advances/standstills during the 15th and 17th centuries, i.e. and others of more limited scope during the 19th century (1800s, 1830s, 1840s, 1860s and 1890s). Since then, Tungnahryggsjöull have retreated accordingly with: 1) the warming trend initiated at the end of the LIA - especially exacerbated during the period 1925-1950 and more recently since 2003, with temperatures 1.5-1.9 ºC above those recorded during the late LIA -; and 2) the continuous rise of their equilibrium-line altitude (>20 m in gentle-sloping glaciers). Tungnahryggsjökulls were sensitive enough to advance in response to different short-lived cold spells occurred during the 20th, with expansions at the 1910s, 1950s and from the mid-1980s to the mid-1990s.

P-24

Debris-covered glaciers and rock glaciers response to the Neoglaciation in Tröllaskagi (northern Iceland)

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The impact of Neoglaciation is clear on the debris-free glaciers of the Tröllaskagi peninsula (northern Iceland), as in the rest of Iceland, with glaciers advancing during major cold stages in this period. However, the termini of the rock glaciers (RG) and debris-covered glaciers (DCG) of Tröllaskagi remained static. Consequently, boulders of the frontal sectors of those formations show large and coalescent lichen talus, linked to cosmic-ray exposure ages of ~6 ka and very low rebound (R-) values of the Schmidt-hammer. The upper sectors of most of these RG and DCG are currently occupied by debris-free glacial ice. The debris-covered glacier tongues are overlain by younger moraines that are located few hundred meters in front of the current debris-free glacier terminus. Intermediate depressions appear between the ice and moraines. Young moraine boulders show small lichen talus, suggesting ages of < 100 years and R-values ranging from 65 to 72. These overlapping young moraines have already been observed in RG and DCG of the Hofsdalur, Héðinsdalur, Hólardalur, Svarfaðardalur, Lambárdalur, Fremri-Grasárdalur, and Nautárdalur cirques. The existence of these younger moraines allows us to infer that the debris-free glacial ice located in upper sectors of the RG and DCG behaved as independent glaciers during the Neoglaciation; positive mass balances increased their thickness and extent, overlapping the static boulders of DCG sectors and building new moraines. In fact, the upper debris free-ice sectors and the frontal debris-covered sectors of the RG and DCG seem to have been disconnected each other during Neoglaciation.

P-25

The Impact of Tourism on Icelandic Lake Ecosystems reconstructed from Chironomidae Remains.

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Most lakes in Iceland are considered pristine ecosystems due to the low population density and low agricultural and industrial activities in the surrounding area. However, in recent decades, Iceland has seen a large spike in tourism. Which could have possibly caused an increase in catchment erosion, a decrease of plant coverage in the surrounding areas and an increased amount of waste material entering the lakes. These consequences potentially impact the water quality and nutrient budget of the lake, ultimately impacting the ecological composition.

In order to investigate the influence of tourism on lake ecosystems in Iceland, two lakes have been selected as target locations. The first lake is Hafravatn, which is located within the city limits of Reykjavík and is a well-known recreational area for locals, with fishing and kayaking occurring on the lake and hiking in its vicinity. Hafravatn also has many summer houses along its shore, most build in the last two decades. The results from Hafravatn will be compared to Graenavatn, a less accessible lake with significantly less touristic activities in its catchment, located about 35 km south-west of Reykjavík. From each lake, short sediment cores were taken, which were used to investigate the changes in the Chironomidae head capsule composition and geochemical parameters for the last 200 years. The results were compared with known changes in tourism pressure, as well as other potential drivers (e.g. nitrogen deposition and other land use changes) across both sites.

The results of this research will be part of an overarching project examining the anthropogenic impacts on lake ecosystems in Iceland and will provide reference data for future lake assessments as well as lake-ecosystem restorations.

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