ICAM-X

10th International Conference on Arctic Margins

16th to 21st of March, 2025 | Bremen, Germany

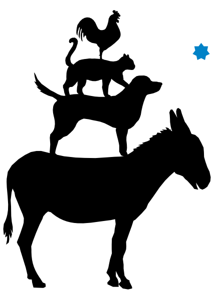
Universität Bremen

ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR-
UND MEERESFORSCHUNG

ICAM - X
Bremen 2025

CONFERENCE INFORMATION

ABSTRACT VOLUME



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SOCIAL PROGRAMME

Sunday, 16th of March, 16.30–18.00 h – Guided Tour

The guided tour through Bremen includes the highlights of the UNESCO world heritage city of Bremen. Starting point is the Roland statue at Bremen´s market place, next to the town hall. The tour ends at the Überseemuseum.

Sunday, 16th of March, 18.00 h – Icebreaker Reception

The Icebreaker Reception takes place at the Überseemuseum (Bahnhofsplatz 13, 28195 Bremen).
It is located next to the main station and can be reached by train, tram (lines 1,4,5,6,8,10) and bus (lines 20, 24, 25, 26, 27, 63).
You can pick up your conference documents and enjoy drinks along with snacks.

Wednesday, 19th of March, 19.00 h – Conference Dinner

The Conference Dinner takes place at the ***Restaurant Platzhirsch*** ↗ (Kuhgrabenweg 30, 28359 Bremen,), about 10 minutes walk from the conference venue. The dinner will be buffet-style and includes vegetarian and vegan food.

Friday, 21st of March – Post-conference Excursions

On the day after the conference, you have the opportunity to visit either the Alfred-Wegener Institute for Polar and Marine Research in Bremerhaven, or the MARUM Centre for Marine Environmental Sciences including the IODP Core Repository in Bremen. Time and Meeting points will be announced.

PUBLIC EVENING LECTURE

UNCLOS: Beyond 200 miles in the Arctic Ocean

*As part of the "10th International Conference on Arctic Margins (ICAM-X)", a public evening lecture will take place on **Tuesday, 18 March 2025 at 19:00** in the large lecture hall (HS 2010) in the lecture hall building ("Keksdose") of the University of Bremen.*

During the last decades, the Arctic has become the epicenter of climate warming and at the same time a hotspot of economic and geopolitical interests. Motivated by economic opportunities that involve commercial shipping, oil and gas development, mining, fisheries and tourism, both Arctic and global actors show increasing interest in the Arctic region - with respective need for coordination, cooperation, and regulation.

The Arctic is governed by both domestic and international laws and policies. Science plays an important role in shaping the various regulations and recommendations in treaties and soft-law. An example of how science is used for decision-making is the "Commission on the Limits of the Continental Shelf" which facilitates the implementation of the United Nations Convention on the Law of the Sea (UNCLOS), Article 76. This convention allows for States to exercise sovereignty over the seabed beyond their 200 nautical mile limit (Exclusive Economic Zone), if their continental shelf extends that far.

Five coastal States border the Arctic Ocean and because of its circular geography and extensively elevated features, their continental shelves extend towards each other creating amongst the largest overlap areas in the World. In addition, the remoteness, difficult operational conditions, financial burden and limited capability in the Arctic of any one State has led to a high degree of collaboration amongst the Arctic coastal States and with other States that have Arctic exploration interests and capabilities. This collaboration has led to immense benefits of significant new scientific understanding of the Arctic basins.

This presentation shall explain some of the complexities of article 76 in context of the Arctic, discuss the current status of continental shelf jurisdiction, and elucidate some of the rights and responsibilities of States with respect to the continental shelf.

The Invited Speaker: Prof. Dr. David Cole Mosher

Prof. Dr. David Mosher is an emeritus research scientist with the Geological Survey of Canada and Commissioner with the Commission on the Limits of the Continental Shelf at UN headquarters in New York since 2017.

CONFERENCE VENUE AND CAMPUS MAP

The conference will be held at the
Department of Geosciences,
University of Bremen,
Klagenfurter Straße 2-4.

The venue can be reached by tram (line 6) and bus (lines 21, 22, 28, 31).
Exit at the stop *"Universität/Zentralbereich"*.
There will be signposts to guide you to the conference venue.
See also Campus map below.

www.icam-x.org/home/venue-travel

IMPORTANT TELEPHONE NUMBERS IN GERMANY

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THE ICAM-X PROGRAMME – KEY

T1 – Evolution & Structure of Crust and Lithosphere in the Arctic

T2 – Digital Arctic

T3 – Deep-time Climate Archives & the Impacts on Life and the Environment

T4 – Arctic Education & Outreach

T5 – The Opening of the Arctic Ocean

T6 – Arctic Geopolitics, Governance & Society

T7 – Scientific Drilling on Arctic Margins: Past Achievements & Future Opportunities

T8 – Open Session

THE ICAM-X PROGRAMME

Sunday, 16th of March

Registration and Icebreaker Reception at the Übersee-Museum (Start 18.00 h)

Monday, 17th of March ↗

Registration (Start 08.00) Opening Ceremony (09.00) , **T1, T2,** Poster Session (09.35–19.30 h)

Tuesday, 18th of March ↗

T5, T8, T4 (08.30-19.00 h), Public evening lecture, Key Note **T6** (19.00 h)

Wednesday, 19th of March ↗

T6, T3, T8 (08.30-19.00 h), Conference Dinner (19.00 h)

Thursday, 20th of March ↗

T7, T1 (08.30-17.00 h),
Closing Ceremony, Student´s award & announcement about next ICAM (17.00–17.30 h)

Friday, 21st of March – Post-conference excursions

Alfred-Wegener Institute for Polar & Marine Research, Bremerhaven (09.00-15.00 h)
MARUM Centre for Marine Environmental Sciences, incl. the IODP Bremen core repository (10.00-12.00 h)

T1-1	**Judith Freienstein**	Assessing Geothermal Heat Flow in the Arctic
T1-2	**Christian Tegner**	High Arctic Large Igneous Province sourced from thinspots centred in the Arctic Ocean
T1-3	**Elmar Albers**	Sneak peeks into the subseafloor: studying deep-sea hydrothermal systems in the Arctic Ocean
T1-4	**Felix Genske**	Ultraslow accretion of the Arctic crust: clues from basalt and peridotite geochemistry along the Gakkel-Lena Trough ridge system
T1-5	**Wisnu Priyanto**	MCS Evidence of the Fossil Spreading Ridge Characteristic in the Canada Basin, Arctic Ocean
T1-6	**Florent Szitkar**	Oceanic core complex or not? When bathymetric structures challenge seafloor spreading models
T1-7	**Michael Schnabel**	Seismic velocities reveal tectonic deformation at the southern Nares Strait
T1-8	**Fenna Ammerlaan**	4D tectono-sedimentary evolution of the northeastern Atlantic: a multidisciplinary approach to rifted margins
T1-9	**Andrey Jakovlev**	Velocity structure of the crust beneath the Loki's Castle vent field at the Mohn-Knipovich Ridge Bend
T1-10	**Ashton Embry**	Is Crockerland a Necessary Concept in the Late Triassic? - YES IT IS!
T1-11	**Jaroslaw Majka**	Proterozoic-Paleozoic histories of North Greenland: An update on recent research activities
T1-12	**Ransom Telson**	Magma-crust interaction and alteration of Eocene dykes from Jameson Land, Greenland.
T1-13	**Alexander Minakov**	Wide-angle seismic data across the northern Svalbard continental margin
T1-14	**Kim Senger**	Crustal heterogeneity onshore central Spitsbergen: insights from new gravity and vintage geophysical data
T1-15	**Noah Riccardi**	Provenance of clastic rocks of the Inner Hornsund Trough, Svalbard: Implications for regional correlations and Devonian paleogeography
T1-16	**Karolina Kośmińska**	Early Ordovician high-pressure metamorphism on Svalbard: pressure-temperature-time evolution of the Vestgötabreen Complex
T1-17	**Matthijs Hendrik Nuus**	Thermal conductivity and heat flow modelling of petroleum exploration wells onshore Svalbard
T1-18	**Anders Dahlin**	Late syn-rift to early post-rift evolution at the western margin of the Inner Hornsund Trough, southwestern Spitsbergen, Norway
T1-19	**Alexander Minakov**	3-D electrical conductivity structure of a Miocene-Quaternary volcanic province in NW Svalbard
T1-20	**Anna Marie Sartell**	Geochemistry and geometries of the Wallenbergfjellet intrusions, a case study from the High Arctic Large Igneous Province on Svalbard
T1-21	**Christian Schiffer**	The lithospheric evolution of the Varanger Peninsula, northern Norway - Preliminary results from geophysical and geological studies

T2-1	**Henning Lorenz**	Why are Arctic data lacking in EPOS? – Time to act!
T2-2	**Björn Heincke**	A new magnetic compilation of Greenland from airborne and satellite data
T2-3	**Antonie Haas**	ESA Climate Change Initiative (CCI) – Permafrost time series WebGIS maps as Essential Climate Variable products primarily derived from satellite measuremen
T2-4	**Birgit Heim**	Validation in ESA CCI+ Permafrost - Compilation of a permafrost temperature data collection using international and national permafrost monitoring networks
T2-5	**Peter Konopatzky**	A Sustainable Spatial Data Infrastructure for the Automated Integration of Distributed Research Data
T2-6	**Aleksandra Smyrak-Sikora**	Surface to subsurface expression of a long-lived structural element: the Billefjorden Fault Zone in Svalbard
T2-7	**Estella Weigelt**	Seismic Surveys in the Arctic: Visualization on maps and link to data archive at the Alfred Wegener Institute

T3-1	**Zhengquan Yao**	Multiphase glaciation in East Siberia during the late Quaternary: Evidence from Arctic zircon U-Pb ages
T3-2	**Pingchuan Tan**	Arctic glaciation began between 20-34 Ma: Evidence from sediment deposition history of the Eurasian Basin, Arctic Ocean
T3-3	**Wolf Dummann**	Ash deposits link Oceanic Anoxic Event 2 to High Arctic volcanism
T3-4	**Xiaoxia Huang**	Where are the undiscovered hydrothermal vents in the Arctic Ocean?

T4-1	**Aleksandra Smyrak-Sikora**	Arctic Geology research-based field education in Billefjorden, Svalbard, Norway
T4-2	**Rafael Kenji Horota**	Online-based Virtual Field Learning: An Interactive Tool for Geoscience Education and Outreach
T4-3	**Cornelia Spiegel**	Building bridges between Polar Science and Society – an example from the German Society of Polar Research
T4-4	**Alexandra Zuhr**	APECS Germany - Empowering Polar and Alpine Early Career Researchers
T4-5	**Sophie Weeks**	Bridging Knowledge Gaps in Arctic Research and Education: Methods from Polar Educators International

T5-1	**Thomas Funck**	The crustal structure of Canada Basin
T5-2	**Elizabeth Miller**	Detrital zircon-based provenance of sedimentary rocks in the circum-Arctic and an update on their constraints on rifting models for the Amerasian Basin
T5-3	**Richard Lease**	Subsurface detrital zircon U/Pb affinities of pre-Mississippian basement beneath the Arctic Alaska margin: Implications for circum-Arctic evolution
T5-4	**Ashton Embry**	Latest Triassic – Early Cretaceous Sequence Boundaries and the Evolution of the Amerasia Basin
T5-5	**Yutaka Yoshimura**	Reconstruction of paleomagnetic field intensity during the Cretaceous Normal Superchron using volcanic rocks
T5-6	**Hiroshi Sato**	High-Density Systematic Rock Sampling: A Key to Understanding Intraplate Volcanism
T5-7	**Carmen Gaina**	Eocene-Miocene continental break-up and seafloor spreading in the high Arctic inferred from magnetic data
T5-8	**Amando Lasabuda**	Sedimentary source-to-sink of the northern Barents Shelf continental margin and its implication for the opening of the Nansen Basin
T5-9	**Rüdiger Lutz**	Mantle exhumation since the early formation of the Eurasia Basin, Arctic Ocean
T5-10	**Antonia Ruppel**	Revisiting the origin of the Morris Jesup Plateau: What can we learn from potential field modelling?
T5-11	**Katrin Meier**	The Eurekan in northern Greenland: Insights from low-temperature thermochronology
T5-12	**Peter Klitzke**	Evidence for Eurekan deformation within and around the Morris Jesup Plateau, Arctic Ocean
T5-13	**Wolfram Geissler**	Evidence for Eurekan deformation within and around the Yermak Plateau, Arctic Ocean
T5-14	**Nikola Koglin**	Is the Yermak Plateau a continental fragment from North America?

T6-1	**Kai Boggild**	Upcoming Canadian research expeditions in the central Arctic Ocean

T7-2	**Jens Gruetzner**	Towards a refined seismic stratigraphy for the Svyatogor Ridge (Fram Strait): Preliminary Results from Core-Log-Seismic Integration at IODP Expedition 403 Site U1620
T7-3	**Kristen St John**	Changing sedimentation rates at Svyatogor Ridge yield insights into regional paleoceanographic, paleoclimatic, and depocenter evolution: IODP Expedition 403, Site U1620
T7-4	**Sophie Kowalski**	Deglacial history at the southeastern margin of the Laurentide Ice Sheet: The sedimentary record of Lake Melville, Canada
T7-5	**Lara Perez**	NorthGreen – Northeast Greenland Glaciated Margin, IODP3 Proposal
T7-6	**Jan-Erik Rosberg**	"Riksriggen" – the research infrastructure for scientific core drilling to 2.5 km

THE ICAM-X PROGRAMME AT A GLANCE
Monday, March 17, 2025

T1 – Evolution & Structure of Crust and Lithosphere in the Arctic

T2 – Digital Arctic

08.00-09.00 *Registration*

09.00-09.35 **Opening Ceremony**
Welcome by the Bremen Senator for Environment, Climate and Science, **Kathrin Moosdorf**, and the Rector of the University of Bremen, **Jutta Günther**

09.35-10.00 **Keynote T1 – Fiona Darbyshire**
Evolution of the eastern Laurentian Arctic regions from Precambrian to present: Insights from seismic studies of lithospheric structure

10.00-10.15 **Wolfram Geissler**
SIOLA- SeIsmicity and neOtectonics of the LAptev sea region

10.15-10.30 **Vera Schlindwein**
Crustal production at the ultraslow spreading Gakkel Ridge: a review of current geophysical knowledge

10.30-10.45 **Maria Telmon**
The Seidfjellet Formation:
A Window into Miocene Volcanism and Tectonics in NW Spitsbergen

10.45-11.05 **Discussion T1**

11.05-11.35 *Coffee Break*

11.35-11.50 **Dmitri Zastrozhnov**
Quaternary Magmatism in the High Arctic: Refining the Architecture and Lava Emplacement Environment of Sverrefjellet Volcano in NW Svalbard

11.50-12.05 **Sebastian Tappe**
Dynamics of the lithosphere–asthenosphere boundary beneath Svalbard: Insights from Cenozoic volcanism and mantle-derived xenoliths

12.05-12.20 **Louisa Kanzler**
Tectonomagmatic history of meta-igneous rocks from Nordaustlandet, Svalbard, inferred from microstructural analyses and 40Ar/39Ar geochronology

12.20-12.35 **Krzysztof Michalski**
Project NEOMAGRATE – toward quantification of NE Svalbard's paleogeographic position in the Neoproterozoic

12.35-12.50 **Jaroslaw Majka**
Cryogenian to Ediacaran tectonothermal events recorded in western Svalbard

12.50-13.10 **Discussion T1**

13.10-14.20 *Lunch & Poster*

14.20-14.35 **Jörg Ebbing**
Lithospheric architecture under Greenland and its missing link to the Iceland hot-spot track

14.35-14.50 **Ransom Telson**
Carbon mobility during intrusion of Eocene Dykes in Jameson Land Basin, Greenland.

14.50-15.05 **Karsten Piepjohn**
Kinematics and age of deformation along the Trolle Land Fault System, Northeast Greenland

15.05-15.20 **Pierpaolo Guarnieri**
Strain partitioning during transpression in the Wandel Sea Basin (eastern North Greenland)

15.20-15.40 **Discussion T1**

15.40-16.10 *Coffee Break*

16.10-16.35 **Keynote T2 - Martin Jakobsson**
The Value of Mapping the Arctic Ocean Floor: Enhancing Data Availability for Scientific Progress

16.35-16.50 **Carmen Gaina**
A digital geoscience data repository for Arctic reconstructions

16.50-17.05 **Tereza Mosociova**
Svalbox: Digitizing Svalbard through Drone Photogrammetry

17.05-17.35 **Digital Poster Session T2**

17.35-18.05 **Panel Discussion T2**

18.05-19.30 ***Poster Session with drinks & nibbles***

08:00–09:00 **Registration** **–>** Geo Auditorium, Lecture Hall Building, Geo Foyer

09:00–09:35 **Opening Ceremony** **–>** Geo Auditorium

K. Moosdorf, *Senator for Environment, Climate and Science of the state of Bremen, Germany,*
J. Günther, *Rector of the University of Bremen, Bremen, Germany*

T1 – Evolution & Structure of Crust and Lithosphere in the Arctic. –> *Geo Auditorium*

09:35–11:05 **T1 – Evolution & Structure of Crust and Lithosphere in the Arctic** –> *Block 1.1*

09:35–10:00 **Evolution of the eastern Laurentian Arctic regions from Precambrian to present: Insights from seismic studies of lithospheric structure**
F. Darbyshire, *Université du Québec à Montréal, Sciences de la Terre et de l'atmosphère, Montréal, Canada*

10:00–10:15 **SIOLA- SeIsmicity and neOtectonics of the LAptev sea region**
W. Geissler[1], A. Plötz[1], A. Krylov[2, 3], S. Shibaev[4], F. Krüger[5], C. Haberland[6], B. Baranov[2], R. Tuktarov[4], N. Tsukanov[2], M. Novikov[2, 3]
[1]Alfred Wegener Institute (AWI), Helmholtz Centre for Polar and Marine Research, Bremerhaven, Germany,
[2]Shirshov Institute of Oceanology, Russian Academy of Sciences, Moscow, Russian Federation,
[3]Sirius University of Science and Technology, Sirius, Russian Federation,
[4]Yakutsk Branch Federal Research Centre Geophysical Survey Russian Academy of Sciences, Yakutsk, Russian Federation,
[5]University of Potsdam, Potsdam, Germany,
[6]Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences, Potsdam, Germany

10:15–10:30 **Crustal production at the ultraslow spreading Gakkel Ridge: a review of current geophysical knowledge**
V. Schlindwein[1, 2], M. Schmidt-Aursch[1]
[1]Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Bremerhaven, Germany, [2]University of Bremen, Department of Geosciences, Bremen, Germany

10:30–10:45 **The Seidfjellet Formation: A Window into Miocene Volcanism and Tectonics in NW Spitsbergen**
M. Telmon[1], K. Senger[2], S. A. Grundvåg[1], S. Planke[3, 4], D. Zastrozhnov[3], A. Minakov[3], R. Kenji Horota[2, 5], P. Betlem[2, 6], C. Tegner[7]
[1]The Arctic University of Norway, Geoscience, Tromsø, Norway, [2]The University Center in Svalbard, Arctic Geology, Longyearbyen, Norway, [3]Universitet i Oslo, Geoscience, Oslo, Norway, [4]VBER, Oslo, Norway, [5]Universitet i Bergen, Department of Earth Science, Bergen, Norway, [6]Norges Geotekniske Institutt, Oslo, Norway, [7]Aarhus University, Aarhus, Denmark

10:45–11:05 **Discussion**

11:05–11:35 **Coffee & Poster** **–>** Geo Auditorium, Lecture Hall Building, Geo Foyer

11:35–13:10 **T1 - Evolution & Structure of Crust and Lithosphere in the Arctic** –> *Block 1.2*

11:35–11:50 **Quaternary Magmatism in the High Arctic: Refining the Architecture and Lava Emplacement Environment of Sverrefjellet Volcano in NW Svalbard**
D. Zastrozhnov[1], S. Planke[1, 2], J. Millett[2], R. Horota[3, 4], P. Betlem[5], K. Senger[3]
[1]University of Oslo, Department of Geosciences, Oslo, Norway,
[2]Volcanic Basin Energy Research (VBER), Oslo, Norway,
[3]The University Centre in Svalbard, Department of Arctic Geology, Longyearbyen, Norway,
[4]University of Bergen, Department of Earth Science, Bergen, Norway,
[5]Norges Geotekniske Institutt, Oslo, Norway

11:50–12:05 **Dynamics of the lithosphere–asthenosphere boundary beneath Svalbard: Insights from Cenozoic volcanism and mantle-derived xenoliths**
S. Tappe[1], A. Helland-Hansen[1], A. Minakov[2], A. Stracke[3], K. Senger[4], S. Klemme[3], N. Koglin[5], A. Ishikawa[6]
[1]UiT The Arctic University of Norway, Department of Geosciences, Tromsø, Norway,
[2]University of Oslo, Department of Geosciences, Oslo, Norway,
[3]University of Münster, Institute for Mineralogy, Münster, Germany,
[4]University Centre in Svalbard, Department of Arctic Geology, Longyearbyen, Norway,
[5]BGR Hannover, Department of Polar Geology, Hannover, Germany,
[6]Tokyo University of Technology, Department of Earth and Planetary Sciences, Tokyo, Japan

12:05–12:20 **Tectonomagmatic history of meta-igneous rocks from Nordaustlandet, Svalbard, inferred from microstructural analyses and $^{40}Ar/^{39}Ar$ geochronology**
L. Kanzler[1], J. A. Pfänder[2], B. Sperner[2], K. Piepjohn[3], N. Koglin[3], S. Tappe[4], U. Riller[1]
[1]Universität Hamburg, Institut für Geologie, Hamburg, Germany,
[2]TU Bergakademie Freiberg, Institut für Geologie, Freiberg, Germany,
[3]Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), Hannover, Germany,
[4]UiT - The Arctic University of Norway, Department of Geosciences, Tromsø, Norway

12:20–12:35 **Project NEOMAGRATE – toward quantification of NE Svalbard's paleogeographic position in the Neoproterozoic**
K. Michalski[1], S. Bal[1], G. Manby[2], K. Nejbert[3], J. Domańska - Siuda[3], J. Majka[4, 5], J. V. Strauss[6], A. Hołda - Michalska[7]
[1]Institute of Geophysics Polish Academy of Sciences, Warsaw, Poland,
[2]Natural History Museum, London, United Kingdom,
[3]University of Warsaw, Department of Geology, Warsaw, Poland,
[4]Uppsala University, Department of Earth Sciences, Uppsala, Sweden,
[5]AGH University of Krakow, Faculty of Geology, Geophysics and Environmental Protection, Poland,
[6]Dartmouth College, Department of Earth Sciences, Hanover, United States of America,
[7]Institute of Paleobiology Polish Academy of Sciences, Poland, Poland

12:35–12:50 **Cryogenian to Ediacaran tectonothermal events recorded in western Svalbard**
J. Majka[1, 2]
[1]Uppsala University, Department of Earth Sciences, Uppsala, Sweden,
[2]AGH University of Krakow, Kraków, Poland

12:50–13:10 **Discussion**

13:10–14:20 **Lunch & Poster** **–>** Geo Auditorium, Lecture Hall Building, Geo Foyer

14:20–15:40 **T1 - Evolution & Structure of Crust and Lithosphere in the Arctic** –> *Block 1.3*

14:20–14:35 **Lithospheric architecture under Greenland and its missing link to the Iceland hot-spot track**
J. Ebbing[1], A. Wansing[1], J. Freienstein[1], B. Heincke[2], W. Szwillus[1]
[1]Kiel University, Geosciences, Kiel, Germany, [2]GEUS, Copenhagen, Denmark

14:35–14:50 **Carbon mobility during intrusion of Eocene Dykes in Jameson Land Basin, Greenland.**
R. Telson[1], A. Barker[1], M. Bukała[2], K. Kośmińska[3], J. Majka[1, 3], K. McCaffrey[4], C. Menzies[4], C. Schiffer[5]
[1]Uppsala University, Department of Earth Sciences; Minerology, Petrology and Tectonics, Sweden,
[2]Andalusian Earth Science Insitute, Granada, Spain,
[3]AGH University of Kraków, Department of Mineralogy, Petrography and Geochemistry, Poland,
[4]Durham University, Department of Earth Sciences, Durham, United Kingdom,
[5]Uppsala University, Department of Earth Sciences; Geophysics, Uppsala, Sweden

14:50–15:05 **Kinematics and age of deformation along the Trolle Land Fault System, Northeast Greenland**

K. Piepjohn[1], A. Ruppel[2], L. Reinhardt[2], M. Blumenberg[2], M. Jochmann[3], C. Spiegel[4]
[1]No institution, Hannover, Germany,
[2]Federal Institute for Geosciences and Natural Resources, Hannover, Germany,
[3]Store Norske Spitsbergen Kulkompani, Longyearbyen, Norway,
[4]University of Bremen, Bremen, Germany

15:05–15:20 **Strain partitioning during transpression in the Wandel Sea Basin (eastern North Greenland)**

P. Guarnieri[1], J. Bojesen-Koefoed[1], N. Keulen[2], J. Konnerup-Madsen[3], M. Olivarius[4], J. A. Rasmussen[5], T. B. Thomsen[2]
[1]Geological Survey of Denmark and Greenland GEUS, Copenhagen, Denmark,
[2]Geological Survey of Denmark and Greenland GEUS, Mapping and Mineral Resources, Copenhagen, Denmark,
[3]†Deceased 2017, University of Copenhagen, Department of Geosciences and Natural Resource Management, Copenhagen, Denmark,
[4]Geological Survey of Denmark and Greenland GEUS, Geoenergy and Storage, Copenhagen, Denmark,
[5]Museum Mors, Nykøbing Mors, Denmark

15:20–15:40 **Discussion**

15:40–16:05 **Coffee & Posters** –> Geo Auditorium, Lecture Hall Building, Geo Foyer

T2– Digital Arctic –> *Geo Auditorium*

16:10–18:05 **T2–Digital Arctic**

16:10–16:35 **The Value of Mapping the Arctic Ocean Floor: Enhancing Data Availability for Scientific Progress**

M. Jakobsson
Stockholm University, Geological Sciences, Stockholm, Sweden

16:35–16:50 **A digital geoscience data repository for Arctic reconstructions**

C. Gaina[1], A. Minakov[1], P. Gromov[2], NOR-R-AM
[1]University of Oslo, PHAB, Oslo, Norway, [2]University of Oslo, Oslo, Norway

16:50–17:05 **Svalbox: Digitizing Svalbard through Drone Photogrammetry**

T. Mosociova[1,2], N. Rodes[2], P. Betlem[3], A. Smyrak-Sikora[4], A. Sartell[2,5], A. Dahlin[1,2], R. Horota[2], K. Senger[2]
[1]University of Oslo, Department of Geosciences, Oslo, Norway,
[2]University Centre in Svalbard, Department of Arctic Geology, Longyearbyen, Norway,
[3]Norwegian Geotechnical Institute, Oslo, Norway,
[4]Norwegian University of Science and Technology, Department of Geosciences, Trondheim, Norway,
[5]University of Helsinki, Department of Geosciences and Geography, Finland

17:05–17:35 **Digital Poster Session T2**

17:35–18:05 **Panel Discussion T2**

18:05–19:30 **Poster Session with drinks & nibbles** –> Geo Auditorium, Lecture Hall Building, Geo Foyer

THE ICAM-X PROGRAMME AT A GLANCE
Tuesday, March 18, 2025

T5 – The Opening of the Arctic Ocean

T4 – Arctic Education & Outreach

T6 – Arctic Geopolitics, Governance & Society

08.30-08.55 **Keynote T5 - Grace Shephard**
Comparing and contrasting multiple phases of Arctic Ocean development; insights on tectonics and magmatism from recent numerical modelling approaches including the surface and mantle.

08.55-09.10 **Mechita Schmidt-Aursch**
New aeromagnetic and seismological data reveal insights into the transition of Gakkel Ridge to Lena Trough

09.10-09.25 **Kasia Sliwinska**
Forlandsundet Graben – a missing piece of puzzle for understanding the water exchange between the Arctic Ocean and Atlantic Ocean in the late Paleogene (Eocene to Oligocene)

09.25-09.40 **Albina Gilmullina**
Provenance insights into the Cretaceous source-to-sink system in the Greater Barents Sea Basin

09.40-09.55 **Linda Haaland**
When did the Fram Strait open? U-Pb calcite ages date the rifting process

09.55-10.10 **Marie-Andrée Dumais**
Complex seafloor spreading and crustal structure of the Fram Strait: interpretation from aeromagnetic data

10.10-10.30 **Discussion T5**

10.30-11.00 *Coffee Break*

11.00-11.15 **Yngve Kristoffersen**
Exploring the North American segment of the Lomonosov Ridge, Arctic Ocean

11.15-11.30 **Katrin Meier**
The Eurekan Deformation across North Greenland, the Morris Jesup and Yermak plateaus – a multidisciplinary perspective

11.30-11.45 **Juan Camilo Meza-Cala**
Crustal structure of the North Svalbard Margin

11.45-12.00 **Graeme Eagles**
A new relative plate motion context for post Santonian development of North Atlantic and Arctic plate boundary zones

12.00-12.15 **Jonathan Rich**
Exploring the opening of the Amerasia Basin using lithospheric numerical modelling

12.15-12.30 **Justin Strauss**
The Porcupine Fault System of Yukon and Alaska: An underappreciated piece of the Arctic Puzzle

12.30-12.50 **Discussion T5**

12.50-14.10 *Lunch & Poster*

14.10-14.25 **Jan Sverre Laberg**
Cenozoic continental margin growth off Svalbard (European Arctic) – implications for the evolution of ocean currents and ice sheets as seen from the GoNorth program and beyond

14.25-14.40 **Christoph Böttner**
Natural geological seepage offshore Northeast Greenland, Arctic Ocean

14.40-14.55 **Rune Mattingsdal**
New mud volcanoes discovered in the Arctic, Western Barents Sea

14.55-15.10 **Discussion T8**

15.10-15.40 *Coffee Break*

15.40-16.05 **Keynote T4 - Lene Liebe Delsett**
Petroleum and whale oil. How to not talk about marine vertebrates

16.05-16.20 **Franziska Warringsholz**
Polar Education in Schools in Germany

16.20-16.35 **Kim Senger**
Arctic Tectonics and Volcanism: a multi-scale, multidisciplinary educational approach

16.35-16.50 **Christophe Galerne**
Divers for Ocean Temperature (BlueDOT) - Coastal temperature database for monitoring ocean surface water past and present

16.50-17.20 **Discussion T4**

17.20-17.50 **Manuela Brocksieper**
It´s all about storytelling

19.00 **Public evening lecture**
Key Note T6 – David Mosher
UNCLOS: Beyond 200 Miles in the Arctic Ocean

T5 – The Opening of the Arctic Ocean –> *Geo Auditorium*

08:30–10:30 T5 – The Opening of the Arctic Ocean –> *Block 5.1*

08:30–08:55 **Comparing and contrasting multiple phases of Arctic Ocean development; insights on tectonics and magmatism from recent numerical modelling approaches including the surface and mantle.**
G. Shephard[1, 2]
[1]University of Oslo, Centre for Planetary Habitability, Department of Geosciences, Oslo, Norway, [2]Australian National University, Research School of Earth Sciences, Canberra, Australia

08:55–09:10 **New aeromagnetic and seismological data reveal insights into the transition of Gakkel Ridge to Lena Trough**
M. C. Schmidt-Aursch[1], G. Eagles[1], L. Driesch[2], M. Pilot[1], V. Schlindwein[1]
[1]Alfred-Wegener-Institut, Helmholtz-Zentrum für Polar- und Meeresforschung, Bremerhaven, Germany, [2]Christian-Albrechts-Universität, Kiel, Germany

09:10–09:25 **Forlandsundet Graben – a missing piece of puzzle for understanding the water exchange between the Arctic Ocean and Atlantic Ocean in the late Paleogene (Eocene to Oligocene)**
K. K. Sliwinska[1], E. Sheldon[1], J. Bojesen-Koefoed[2], S.-A. Grundvåg[3], M. Jones[4], S.-M. Knutsen[5], J. S. Laberg[3], K. Senger[6], M. Weber[3]
[1]Geological Survey of Denmark and Greenland (GEUS), Geoenergy and storage, Copenhagen, Denmark, [2]Geological Survey of Denmark and Greenland (GEUS), Copenhagen K, Denmark, [3]UIT The Arctic University of Norway, Department of Geosciences, Tromsø, Norway, [4]University of Umeå, Department of Ecology and Environmental Science (EMG), Umeå, Sweden, [5]Norwegian Offshore Directorate, Harstad, Norway, [6]The University Centre in Svalbard, Longyearbyen, Svalbard and Jan Mayen

09:25–09:40 **Provenance insights into the Cretaceous source-to-sink system in the Greater Barents Sea Basin**
A. Gilmullina[1], A. Mordasova[2], S.-A. Grundvåg[3], L.-E. Pedersen[1], M. E. Jelby[1], I. Midtkandal[4], T. O. Sømme[5], A. G. Doré[6], C. H. Eide[1]
*[1]University of Bergen, Bergen, Norway,
[2]Lomonosov Moscow State University, Moscow, Russian Federation,
[3]UiT the Arctic University of Norway, Tromsø, Norway,
[4]University of Oslo, Oslo, Norway, [5]Equinor ASA, Oslo, Norway, [6]Retired, London, United Kingdom*

09:40–09:55 **When did the Fram Strait open? U-Pb calcite ages date the rifting process**
L. Haaland[1], T. Slagstad[2], P. T. Osmundsen[1], T. Redfield[2]
[1]Norwegian University of Science and Technology, Department of Geosciences, Trondheim, Norway, [2]Geological Survey of Norway, Trondheim, Norway

09:55–10:10 **Complex seafloor spreading and crustal structure of the Fram Strait: interpretation from aeromagnetic data**
M.-A. Dumais[1], L. Gernigon[1], O. Olesen[1], A. Lim[2], S. E. Johansen[3], M. Brönner[1]
*[1]Geological Survey of Norway, Trondheim, Norway, [2]Argeo, Oslo, Norway,
[3]Norwegian University of Science and Technology, Trondheim, Norway*

10:10–10:30 **Discussion**

08:30–19:00 Poster Session 1–7 –> Geo Foyer

10:30–11:00 Coffee & Posters –> Geo Auditorium, Lecture Hall Building, Geo Foyer

TUESDAY, MARCH 18, 2025

11:00–12:50 T5 – The Opening of the Arctic Ocean –> *Block 5.2*

11:00–11:15 **Exploring the North American segment of the Lomonosov Ridge, Arctic Ocean**
Y. Kristoffersen[1], J. K. Hall[2], E. Harris Nilsen[3]
[1](retired) University of Bergen, Geoscience, Bergen, Norway, [2](retired) Geological Survey of Israel, Jerusalem, Israel, [3]AKER BP ASA, Oslo, Norway

11:15–11:30 **The Eurekan Deformation across North Greenland, the Morris Jesup and Yermak plateaus – a multidisciplinary perspective**
K. Meier[1], W. Geissler[2], P. Klitzke[3], G. Eagles[2], A. Ruppel[3], N. Koglin[3], L. Reinhardt[3], S. Estrada[4], K. Piepjohn[5]
[1]University of Bremen, Bremen, Germany,
[2]Alfred Wegener Institute Helmholtz-Centre for Polar and Marine Research, Bremerhaven, Germany,
[3]Federal Institute for Geosciences and Natural Resources (BGR), Hannover, Germany,
[4]retired from Federal Institute for Geosciences and Natural Resources (BGR), present address Thieshof 10, Hannover, Germany,
[5]retired from Federal Institute for Geosciences and Natural Resources (BGR), present address Jacobistraße 34, Hannover, Germany

11:30–11:45 **Crustal structure of the North Svalbard Margin**
J. C. Meza-Cala[1], J. I. Faleide[2], A. Minakov[2], M. M. Abdelmalak[2], G. E. Shephard[2], W. H. Geissler[3], P. Klitzke[4], C. Gaina[2]
[1]University of Oslo, Geosciences, Oslo, Norway, [2]University of Oslo, Oslo, Norway,
[3]Alfred Wegener Institute, Bremen, Germany,
[4]Federal Institute for Geosciences and Natural Resources, Hannover, Germany

11:45–12:00 **A new relative plate motion context for post Santonian development of North Atlantic and Arctic plate boundary zones**
G. Eagles[1], J. Adam[2], L. Pérez Díaz[3], W. Geissler[1], P. Klitzke[4], A. Ruppel[4], A. Causer[2]
[1]Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany,
[2]Royal Holloway, University of London, Earth Sciences, London, United Kingdom,
[3]Halliburton, Oxford, United Kingdom,
[4]Federal Institute for Geosciences and Natural Resources (BGR), Hannover, Germany

12:00–12:15 **Exploring the opening of the Amerasia Basin using lithospheric numerical modelling**
J. E. Rich[1], G. E. Shephard[2,3], P. J. Heron[1,4]
[1]University of Toronto, Earth Sciences, Toronto, ON, Canada,
[2]University of Oslo, Centre for Planetary Habitability (PHAB), Oslo, Norway,
[3]Australian National University, Research School of Earth Sciences, Canberra, ACT, Australia,
[4]University of Toronto Scarborough, Physical and Environmental Sciences, Toronto, ON, Canada

12:15–12:30 **The Porcupine Fault System of Yukon and Alaska: An underappreciated piece of the Arctic Puzzle**
J. V. Strauss[1], K. Faehnrich[2], W. C. McClelland[3], M. L. Odlum[4], E. E. Donaghy[1], E. T. Rasbury[5], M. Colpron[6]
[1]Dartmouth College, Department of Earth Sciences, Hanover, United States of America,
[2]University of Adelaide, School of Biological Sciences, Adelaide, Australia,
[3]University of Iowa, Department of Earth and Environmental Sciences, Iowa City, United States of America,
[4]Scripps Institution of Oceanography, Geosciences Research Division, San Diego, United States of America,
[5]Stony Brook University, Department of Geosciences, Stony Brook, United States of America,
[6]Yukon Geological Survey, Whitehorse, Canada

12:30–12:50 **Discussion**

12:50–14:10 Lunch & Poster –> Geo Auditorium, Lecture Hall Building, Geo Foyer

TUESDAY, MARCH 18, 2025

T8 – Open session –> *Geo Auditorium*

14:10–15:10 T8 – Open Session –> ***Block 8.1***

14:10–14:25 **Cenozoic continental margin growth off Svalbard (European Arctic) – implications for the evolution of ocean currents and ice sheets as seen from the GoNorth program and beyond**

J. S. Laberg[1], O. Martinez[1], M. Weber[1], C. T. Kollsgård[1], F. W. Jakobsen[1], A. P. E. Lasabuda[2], A. Minakov[2], T. A. Rydningen[1], S.-A. Grundvåg[1], M. Winsborrow[1], A. Plaza-Faverola[1], M. Forwick[1]
[1]UiT The Arctic University of Norway, Department of Geosciences, Tromsø, Norway,
[2]University of Oslo, Oslo, Norway

14:25–14:40 **Natural geological seepage offshore Northeast Greenland, Arctic Ocean**

C. Böttner[1], F. W. Jakobsen[2], S. Gupta[3, 4], M. Winsborrow[2], T. Nielsen[5], K. J. Andresen[1], O. J. S. Millinge[6], M. R. Asif[6], M. B. W. Fyhn[5], J. Hopper[5, 7], S. Planke[8, 9], R. Myklebust[10], M.-S. Seidenkrantz[1]
[1]Aarhus University, Department of Geoscience, Aarhus, Denmark,
[2]UiT The Arctic University of Norway, iC3: Centre for ice, Cryosphere, Carbon and Climate, Department of Geosciences, Tromsø, Norway,
[3]University of Malta, Marine Geology and Seafloor Surveying, Msida, Malta,
[4]GEOMAR Helmholtz Centre for Ocean Research Kiel, Kiel, Germany,
[5]Geological Survey of Denmark and Greenland (GEUS), Copenhagen, Denmark,
[6]Aarhus University, Department of Electrical and Computer Engineering, Aarhus, Denmark,
[7]University of Copenhagen, Department of Geosciences and Natural Resources, Denmark,
[8]Volcanic Basin Energy Research (VBER), Oslo, Norway,
[9]University of Oslo, Department of Geoscience, Oslo, Norway,
[10]TGS, Oslo, Norway

14:40–14:55 **New mud volcanoes discovered in the Arctic, Western Barents Sea**

R. Mattingsdal[1], C. Argentino[2], G. Panieri[2]
[1]Norwegian Offshore Directorate, Harstad, Norway,
[2]UiT The Arctic University of Norway, Tromsø, Norway

14:55–15:10 **Discussion**

15:10–15:40 Coffee & Posters –> Geo Auditorium, Lecture Hall Building, Geo Foyer

T4 – Arctic Education & Outreach –> *Geo Auditorium*

15:40–17:50 T4 – Arctic Education & Outreach

15:40–16:05 **Petroleum and whale oil. How to not talk about marine vertebrates**

L. Liebe Delsett
University of Oslo, Natural History Museum, Oslo, Norway

16:05–16:20 **Polar Education in Schools in Germany**

F. Warringsholz, R. Lehmann
Europa-Universität Flensburg, Interdisziplinäres Institut für Umwelt-, Sozial- und Humanwissenschaften, Flensburg, Germany

16:20–16:35 **Arctic Tectonics and Volcanism: a multi-scale, multidisciplinary educational approach**

K. Senger[1], G. Shephard[2], F. Ammerlaan[3], O. Anfinson[4], P. Audet[5], B. Coakley[6], V. Ershova[7], J. I. Faleide[2], S.-A. Grundvåg[8], R. Horota[9], K. Iyer[10], J. Janocha[8], M. Jones[11], A. Minakov[2], M. Odlum[12], A. Sartell[13], A. Schaeffer[14], D. Stockli[15], M. Vander Kloet[16], C. Gaina[2]

[1]The University Centre in Svalbard, Department of Arctic Geology, Longyearbyen, Norway,
[2]University of Oslo, Norway,
[3]Utrecht University, Utrecht, Netherlands,
[4]Sonoma State University, Sonoma, United States of America,
[5]University of Ottawa, Canada,
[6]University of Alaska, Fairbanks, Fairbanks, United States of America,
[7]St Petersburg State University, St Petersburg, Russian Federation,
[8]UiT - the Arctic University of Norway, Tromsø, Norway,
[9]The University Centre in Svalbard, Longyearbyen, Norway,
[10]Geomodsol, Hamburg, Germany,
[11]University of Umeå, Umeå, Sweden,
[12]University of California San Diego, San Diego, United States of America,
[13]University of Helsinki, Helsinki, Finland,
[14]National Resources Canada, Sidney, Canada,
[15]University of Texas, Austin, United States of America,
[16]University of Bergen, Bergen, Norway

16:35–16:50 **Divers for Ocean Temperature (BlueDOT) - Coastal temperature database for monitoring ocean surface water past and present**

C. Galerne[1], R. Zitoun[2], A. Kopf[3], A. Schwab[4]
[1]MARUM Center for Marine Environmental Sciences, Bremen, Germany,
[2]GEOMAR Helmholtz Centre for Ocean Research Kiel, Kiel, Germany,
[3]MARUM Center for Marine Environmental Science, Bremen, Germany,
[4]Schwab Research Technology (SchwaRTech), Achim, Germany

16:50–17:20 **Discussion**

17:20–17:50 **It´s all about storytelling**

M. Brocksieper
University of Bremen, FB 5 Geosciences, Bremen, Germany

T6 – Arctic Geopolitics, Governance & Society. –> *Lecture Hall Building*

19:00–20:00 T6 – Keynote: Arctic Geopolitics, Governance & Society

UNCLOS: Beyond 200 M in the Arctic Ocean

D. Mosher
Natural Resources Canada, Geological Survey of Canada, Dartmouth, Canada

THE ICAM-X PROGRAMME AT A GLANCE
Wednesday, March 19, 2025

T6 – Arctic Geopolitics, Governance & Society

T3 – Deep-time Climate Archives & the Impacts on Life and the Environment

T8 – Open Session

08.30-08.45 Stephen Grasby
Energy sovereignty of remote Arctic communities - assessing the potential for geothermal energy in northern Canada

08.45-09.00 Marie-Claude Williamson
Navigating the complex world of ESG in the Canadian Arctic: Insights from a collaborative research project on the Ni-Cu-PGE potential of the Mackenzie LIP, Nunavut

09.00-09.15 Flemming Getreuer Christiansen
Greenland mineral policy – change from investor-friendly to nationalistic and protectionistic

09.15-09.30 Marcus Przybyl
Studies on Sámi Shamanism - Indigenous Knowledge about the Arctic Ecosystem in the Context of Global Climate Change

09.30-09.50 Discussion T6

09.50-10.15 Keynote T3 - Stephen Grasby
The long-term impact of Cretaceous volcanism on the Arctic environment.

10.15-10.45 Coffee Break

10.45-11.00 Ashton Embry
Episodic Global Tectonics as the Fundamental Driver of Mass Extinctions: Examples from the Arctic

11.00-11.15 Morgan Jones
Volcanic and environmental proxies from the northern Pangean margin across the end-Permian mass extinction: Evidence of pulsed Siberian Traps activity

11.15-11.30 Mónica Alejandra Gómez-Correa
The first record of ostracods from Svalbard in the aftermath of the end-Permian mass extinction

11.30-11.45 Anja Frank
Anoxia – Trigger or Companion of end-Permian shallow marine extinctions?

11.45-12.00 Stella Zora Buchwald
The lipid biomarker record across the Permian/Triassic boundary in Svalbard

12.00-12.15 William Foster
Response of marine organisms to the Permian-Triassic Climate Crisis based on new findings from Spitsbergen, Svalbard

12.15-12.35 Discussion T3

12.35-14.00 Lunch & Poster

14.00-14.15 Richard Lease
OAE2 carbon cycle dynamics along a deepwater-to-shelf transect across the Arctic Alaska margin

14.15-14.30 William Craddock
A high-resolution stratigraphic record of the Paleocene margin of Arctic Alaska: Implications for regional sequence stratigraphic framework

14.30-14.45 John Counts
Oligocene-Miocene Glendonites as Paleoclimatic Archives in Arctic Alaska, USA

14.45-15.00 Gabriel Akoko Juma
Autochthonous organic carbon supports Arctic nearshore food webs even in degrading permafrost coasts

15.00-15.20 Discussion T3

15.20-15.50 Coffee Break

15.50-16.05 John Hopper
Geologic Controls on Marine Terminating Glaciers

16.05-16.20 Nora Nieminski
Assessing coastal hazard impacts in Arctic Alaska

16.20-16.35 Martina Dolezych
Fossil woods of Larix Miller from Paleogene fossil plant Lagerstätten of the Canadian Arctic Archipelago – insights into high latitude paleoenvironment

16.35-16.50 Horst Kämpf
Tracing thermal fluid systems at Woodforden area, Svalbard, Norway: a hydro- and gas isotope study

16.50-17.10 Discussion T8

19.00 Conference Dinner ↗

T6 - Arctic Geopolitics, Governance & Society –> *Geo Auditorium*

08:30–09:50 T6 – Arctic Geopolitics, Governance & Society

08:30–08:45 **Energy sovereignty of remote arctic communities - assessing the potential for geothermal energy in northern Canada**
S. Grasby
Geological Survey of Canada, Calgary, Canada

08:45–09:00 **Navigating the complex world of ESG in the Canadian Arctic: Insights from a collaborative research project on the Ni-Cu-PGE potential of the Mackenzie LIP, Nunavut**
M.-C. Williamson
Geological Survey of Canada, Natural Resources Canada, Ottawa, Canada

09:00–09:15 **Greenland mineral policy – change from investor-friendly to nationalistic and protectionistic**
F. G. Christiansen
flemmingGC, Vanløse, Denmark

09:15–09:30 **Studies on Sámi Shamanism - Indigenous Knowledge about the Arctic Ecosystem in the Context of Global Climate Change**
M. Przybyl
University of Lapland, Rovaniemi, Finland

09:30–09:50 **Discussion**

08:30–19:00 Poster Session 1-7 –> Geo Foyer

T3 - Deep-time Climate Archives & the Impacts on Life and the Environment

–> *Geo Auditorium*

09:50–10:15 T3 – Deep-time Climate Archives & the Impacts on Life and the Environment

–> *Block 3.1*

09:50–10:15 **The long-term impact of Cretaceous volcanism on the arctic environment.**
S. Grasby
Geological Survey of Canada, Calgary, Canada

10:15–10:45 Coffee & Posters –> Geo Auditorium, Lecture Hall Building, Geo Foyer

10:45–12:35 T3 – Deep-time Climate Archives & the Impacts on Life and the Environment

–> *Block 3.2*

10:45–11:00 **Episodic Global Tectonics as the Fundamental Driver of Mass Extinctions: Examples from the Arctic**
A. Embrym, *Retired, Toronto, Canada*

11:00–11:15 **Volcanic and environmental proxies from the northern Pangean margin across the end-Permian mass extinction: Evidence of pulsed Siberian Traps activity**

M. Jones[1, 2], A. Rooney[3], V. Zuchuat[4], J. Frieling[5], L. E. Augland[2], A. Sleveland[2], H. Svensen[2], J. I. Faleide[2], H. Turner[6], Ø. Hammer[6], K. Senger[7], P. Betlem[7], A. Sartell[8], S. Planke[2, 9]
[1]Umeå University, Ecology and Environmental Science, Umeå, Sweden,
[2]University of Oslo, Oslo, Norway,
[3]Yale University, New Haven, United States of America,
[4]Commonwealth Scientific and Industrial Research Organisation, Kensington, Australia,
[5]Oxford University, Oxford, United Kingdom, [6]Natural History Museum, Oslo, Norway,
[7]University Centre in Svalbard (UNIS), Longyearbyen, Norway,
[8]University of Helsinki, Helsinki, Finland,
[9]Volcanic Basin Energy Research (VBER) AS, Oslo, Norway

11:15–11:30 **The first record of ostracods from Svalbard in the aftermath of the end-Permian mass extinction**

M. A. Gómez Correa[1], C. Suchau[1], A. Ernst[1], S. Buchwald[1], T. Mosociova[2], V. Zuchuat[3, 4], A. Frank[1], K. Senger[5], W. Foster[1]
[1]Universität Hamburg, Hamburg, Germany, [2]University of Oslo, Oslo, Norway,
[3]CSIRO Mineral Resources, Perth, Australia, [4]RWTH Aachen University, Aachen, Germany,
[5]University Centre in Svalbard, Svalbard, Norway

11:30–11:45 **Anoxia – Trigger or Companion of end-Permian shallow marine extinctions?**

A. B. Frank[1], S. W. Poulton[2], S. Grasby[3], Y. Xiong[2], V. Zuchuat[4, 5], F. Scholz[1], S. Buchwald[1], M. A. Gomez Correa[1], W. Foster[1]
[1]Universität Hamburg, Institute for Geology, Hamburg, Germany,
[2]University of Leeds, School of Earth and Environment, Leeds, United Kingdom,
[3]Geological Survey of Canada – Calgary, Calgary, Canada,
[4]RWTH Aachen, Geological Institute, Aachen, Germany,
[5]CSIRO Mineral Resources, Perth, Australia

11:45–12:00 **The lipid biomarker record across the Permian/Triassic boundary in Svalbard**

S. Z. Buchwald[1], D. Birgel[1], Y. Pei[2], A. Frank[1], M. A. Gómez Correa[1], T. Mosociova[3], K. Senger[4], J. Peckmann[1], W. J. Foster[1]
[1]University of Hamburg, Department of Earth System Sciences, Hamburg, Germany,
[2]China University of Geosciences, State Key Laboratory of Biogeology and Environmental Geology, Wuhan, China, People's Republic of, [3]University of Oslo, Department of Geosciences, Oslo, Norway,
[4]The University Centre in Svalbard, Department of Arctic Geology, Longyearbyen, Norway

12:00–12:15 **Response of marine organisms to the Permian-Triassic Climate Crisis based on new findings from Spitsbergen, Svalbard**

W. J. Foster[1], G. Asatryan[2], S. Rauzi[3], J. Botting[4], S. Buchwald[1], D. Lazarus[2], T. Isson[3], J. Renaudie[2], W. Kiessling[5]
[1]Universität Hamburg, Department of Earth System Sciences, Hamburg, Germany,
[2]Museum für Naturkunde, Berlin, Germany,
[3]University of Wakaito, Hamilton, New Zealand,
[4]National Museum Wales, Cardiff, United Kingdom,
[5]Friedrich-Alexander Universität, Erlangen, Germany

12:15–12:35 **Discussion**

12:35–14:00 **Lunch & Poster –>** Geo Auditorium, Lecture Hall Building, Geo Foyer

14:00–15:20 **T3 – Deep-time Climate Archives & the Impacts on Life and the Environment**

–> *Block 3.3*

14:00–14:15 **OAE2 carbon cycle dynamics along a deepwater-to-shelf transect across the Arctic Alaska margin**

R. Lease[1], M. Jones[2], K. Whidden[3], N. Griffis[3], J. Gooley[1]
[1]U.S. Geological Survey, Anchorage, United States of America, [2]U.S. Geological Survey, Reston, United States of America, [3]U.S. Geological Survey, Denver, United States of America

14:15–14:30 **A high-resolution stratigraphic record of the Paleocene margin of Arctic Alaska: Implications for regional sequence stratigraphic framework**
W. Craddock[1], R. Lease[2], J. Wycech[3], D. Roberts[3], M. Dreier[3], J. Gooley[2]
[1]U.S. Geological Survey, Reston, VA, United States of America, [2]U.S. Geological Survey, Anchorage, AK, United States of America, [3]U.S. Geological Survey, Denver, CO, United States of America

14:30–14:45 **Oligocene-Miocene Glendonites as Paleoclimatic Archives in Arctic Alaska, USA**
J. Counts[1], M. Vickers[2], R. Stokes[1], M. Jones[1], S. Bernasconi[3], M. Jaggi[3]
[1]U.S. Geological Survey, Geology, Energy & Mineral Science Center, Reston, United States of America, [2]Umeå universitet, Department of Ecology and Environmental Science, Umeå, Sweden, [3]ETH Zürich, Department of Earth and Planetary Sciences, Zürich, Switzerland

14:45–15:00 **Autochthonous organic carbon supports Arctic nearshore food webs even in degrading permafrost coasts**
G. A. Juma[1], H. Grotheer[2], C. Meunier[1], G. Mollenhauer[2], M. Boersma[1]
[1]Alfred Wegener Institut Helmholtz Zentrum für Polar- und Meeresforschung, Shelf Sea System Ecology, Helgoland, Germany, [2]Alfred Wegener Institut Helmholtz Zentrum für Polar- und Meeresforschung, Bremerhaven, Germany

15:00–15:20 **Discussion**

15:20–15:50 Coffee & Posters

T8 - Open session –> *Geo Auditorium*

15:50–17:10 T8 – Open Session –> *Block 8.2*

15:50–16:05 **Geologic Controls on Marine Terminating Glaciers**
J. R. Hopper[1], M. Jakobsson[2], K. Faehnrich[3], E. V. Sørensen[4], J. R. Ineson[4], M. O'Regan[2], L. Mayer[5]
[1]GEUS, Univ. of Copenhagen, Copenhagen, Denmark,
[2]University of Stockholm, Stockholm, Sweden,
[3]University of Adelaide, Adelaide, Australia,
[4]GEUS, Copenhagen, Denmark,
[5]University of New Hampshire, Durham, NH, United States of America

16:05–16:20 **Assessing coastal hazard impacts in Arctic Alaska**
N. Nieminski[1], K. Horen[1], J. Christian[2]
[1]Alaska Division of Geological & Geophysical Surveys, Anchorage, Alaska, United States of America, [2]Alaska Division of Geological & Geophysical Surveys, Fairbanks, Alaska, United States of America

16:20–16:35 **Fossil woods of Larix Miller from Paleogene fossil plant Lagerstätten of the Canadian Arctic Archipelago – insights into high latitude paleoenvironment**
M. Dolezych
Senckenberg Natural History Collections Dresden, Palaeobotany, Dresden, Germany

16:35–16:50 **Tracing thermal fluid systems at Woodforden area, Svalbard, Norway: a hydro- and gas isotope study**
H. Kämpf[1], S. Niedermann[2], K. Senger[3]
[1]GFZ German Research Centre for Geosciences, 3.2, Potsdam, Germany,
[2]GFZ German Research Centre for Geosciences, 3.1, Potsdam, Germany,
[3]The University Centre in Svalbard, Department of Arctic Geology, Longyearbyen, Norway

16:50–17:10 **Discussion**

19:00–23:59 Conference Dinner –> Restaurant Platzhirsch ↗

THE ICAM-X PROGRAMME AT A GLANCE
Thursday, March 20, 2025

T7 – Scientific Drilling on Arctic Margins: Past Achievements & Future Opportunities

T1 – Evolution & Structure of Crust and Lithosphere in the Arctic

08.30-08.55 **Keynote T7 Judith Schicks**
Natural gas hydrates: the hidden climate risk factor in the polar regions - why we should care

08.55-09.10 **Ewa Burwicz-Galerne**
Identifying meta-stable gas hydrate hot-spots in the Arctic:
natural gas hydrate cyclicity vs. climate change-related triggers

09.10-09.25 **Jochen Knies**
A prolific Tertiary source rock of terrestrial origin in the eastern Nordic Seas

09.25-09.40 **Catalina Gebhardt**
Recurrent physical-properties patterns for three post Mid-Brunhes interglacials off Western Svalbard

09.40-09.55 **Bernard Coakley**
Scientific Ocean Drilling on the Chukchi Borderland What are we waiting for?

09.55-10.15 **Discussion T7**

10.15-10.45 *Coffee Break*

10.45-11.00 **Denise Kulhanek**
High-resolution coring of Svalbard's sedimentary record of the onset of glaciations at the Eocene–Oligocene Transition (ICDP application SVALCLIME-Hot2Cold)

11.00-11.15 **Aleksandra Smyrak-Sikora**
Deep-time Arctic climate archives: High-resolution coring of Svalbard's Permian to Paleogene sedimentary record (ICDP application SVALCLIME-P2P)

11.15-11.30 **Renata Lucchi**
The paleoclimatic record of IODP Exp-403, Eastern Fram Strait
Paleo-Archive

11.30-11.50 **Discussion T7**

11.50-13.20 *Lunch & Poster*

13.20-13.35 **Andrew Schaeffer**
Tectonics of the Beaufort Sea margin, western Canadian Arctic and Northern Canadian Cordillera

13.35-13.50 **Margo Odlum**
Regional and fault rock geo- and thermochronological evidence for polyphase deformation along the Porcupine Fault System of Yukon and Alaska

13.50-14.05 **Elizabeth Miller**
Age and correlation of rock sequences in the Nome Complex, Seward Peninsula, Alaska

14.05-14.20 **Jared Gooley**
Regional provenance changes during the initiation and evolution of the Early Cretaceous Arctic Alaska Colville Foreland Basin

14.20-14.35 **Christopher Connors**
Subsurface constraints on Paleozoic deformation in Arctic Alaska and the adjacent offshore region

14.35-14.50 **George Geier**
Evidence for Middle–Late Devonian assembly of the Arctic Alaska terrane, northeastern Brooks Range, Alaska

14.50-15.10 **Discussion T1**

15.10-15.40 *Coffee Break*

15.40-15.55 **Snorre Olaussen**
The Middle Jurassic-Early Cretaceous First Order Sequence of the High Arctic - the Calm before the Storm

15.55-16.10 **Benoit Beauchamp**
Serpukhovian (Early Carboniferous) Rifting in the Sverdrup Basin, Arctic Canada

16.10-16.25 **Luke Beranek**
Silurian arc volcanism in northern Axel Heiberg Island, Nunavut, Arctic Canada

16.25-16.40 **William McClelland**
Field relations and displacement of the Pearya terrane, Ellesmere Island, and its role in the tectonic evolution of the Arctic margin of North America

16.40-17.00 **Discussion T1**

17.00-17.30 **Closing Ceremony,**
Student´s award & announcement about next ICAM

T7 – Scientific Drilling on Arctic Margins: Past Achievements & future Opportunities

–> Geo Auditorium

08:30–10:15 T7 – Scientific Drilling on Arctic Margins: Past Achievements & future Opportunities

–> Block 7.1

08:30–08:55 **Natural gas hydrates: the hidden climate risk factor in the polar regions – why we should care**

J. M. Schicks
GFZ German Research Centre for Geosciences, Potsdam, Germany

08:55–09:10 **Identifying meta-stable gas hydrate hot-spots in the Arctic: natural gas hydrate cyclicity vs. climate change-related triggers**

E. Burwicz-Galerne[1], S. Gupta[2, 3]
[1]MARUM - Center for Marine Environmental Sciences, University of Bremen, Bremen, Germany,
[2]GEOMAR Helmholtz Centre for Ocean Research Kiel, Kiel, Germany,
[3]University of Malta, Msida, Malta

09:10–09:25 **A prolific Tertiary source rock of terrestrial origin in the eastern Nordic Seas**

J. Knies[1], R. Mattingsdal[2], T. Brekke[3], K. Sliwinska[4], K. Grøsfjeld[1], S. Planke[5]
[1]Geological Survey of Norway (NGU), Trondheim, Norway,
[2]Norwegian Offshore Directorate, Harstad, Norway, [3]Brekke CHEMO, Førde, Norway,
[4]Geological Survey of Denmark and Greenland (GEUS), Copenhagen, Denmark,
[5]Department of Geosciences, University of Oslo, Oslo, Norway

09:25–09:40 **Recurrent physical-properties patterns for three post Mid-Brunhe interglacials off Western Svalbard**

C. Gebhardt[1], S. De Schepper[2], S. Adukkam Veedu[3], G. Goss[4], N. Greco[5], A. K. I. U. Kapuge[6], L. Adriane[7], O. Libman-Roshal[8], L. Monito[9], Y. Sakai[10], Y. Suganuma[11], R. G. Lucchi[12], K. St John[13], T. Ronge[14], M. A. Barcena[15], L. Duxbury[16], A. Gonzalez-Lanchas[17], J. Grützner[1], L. Haygood[18], K. Husum[19], M. Iizuka[20], Y. Liu[21], B. Reilly[22], Y. Rosenthal[23], Y. Zhong[24], and the JOIDES Resolution Exp403 technical support team
[1]Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Geosciences, Bremerhaven, Germany,
[2]NORCE Norwegian Research Centre & Bjerknes Centre for Climate Research, Bergen, Norway,
[3]Central University of Kerala, Department of Geology, Kasaragod, India,
[4]Yale University, New Haven, United States of America,
[5]National Center for Ecological Analysis and Synthesis, Santa Barbara, United States of America,
[6]University of Delaware, Department of Earth Sciences, Newark, United States of America,
[7]Binghamton University, Binghamton, United States of America,
[8]Montclair State University, Department of Earth and Environmental Studies, Montclair, United States of America,
[9]University of Florida, Department of Geological Sciences, Gainesville, United States of America,
[10]Kyoto University, Department of Urban Management, Kyoto, Japan,
[11]Institute of Polar Research, Tokyo, Japan,
[12]National Institute of Oceanography and Applied Geophysics - OGS, Trieste, Italy,
[13]James Madison University, Harrisonburg, United States of America,
[14]Texas A&M University, Integrated Ocean Drilling Program, College Station, United States of America,
[15]University of Salamanca, Geology, Salamanca, Spain,
[16]Institute for Marine and Antarctic Studies, Battery Point, Australia,
[17]University of Oxford, Oxford, United Kingdom,
[18]Oklahoma State University, Stillwater, United States of America,
[19]Norwegian Polar Institute, Tromsø, Norway,
[20]The National Institute of Advanced Industrial Science and Technology (AIST), Higashi, Japan,
[21]The First Institute of Oceanography, State Oceanic Administration, Qingdao, China,
[22]Lamont-Doherty Earth Observatory, Palisades, United States of America,
[23]Rutgers University, Department of Marine and Coastal Sciences, New Brunswick, United States of America, [24]Southern University of Science and Technology, Shenzhen, China

09:40–09:55 **Scientific Ocean Drilling on the Chukchi Borderland; What are we waiting for?**

B. Coakley[1], C. Gebhardt[2]
[1]University of Alaska, Geophysical Institute, Fairbanks, United States of America,
[2]Alfred Wegener Institute, Geophysics, Bremerhaven, Germany

09:55–10:15 **Discussion**

08:30–17:30 Poster Session 1-7

10:15–10:45 Coffee & Posters

10:45–11:50 T7 – Scientific Drilling on Arctic Margins: Past Achievements & future Opportunities

–> *Block 7.2*

10:45–11:00 **High-resolution coring of Svalbard's sedimentary record of the onset of glaciations at the Eocene–Oligocene Transition (ICDP application SVALCLIME-Hot2Cold)**

D. K. Kulhanek[1], S.-A. Grundvåg[2], M. E. Jelby[3], M. T. Jones[4,5], A. Lasabuda[6,7], H. Lorenz[8], S. Planke[5,9], K. Senger[10], G. Shephard[6,11], M. Sinnesael[12], K. K. Sliwinska[13], A. Smyrak-Sikora[14], M. L. Vickers[4], V. Zuchuat[15], SVALCLIME extended science team
[1]Kiel University, Institute of Geosciences, Kiel, Germany,
[2]UiT the Arctic University of Norway, Department of Geosciences, Tromsø, Norway,
[3]University of Bergen, Department of Earth Science, Bergen, Norway,
[4]Umeå University, Department of Ecology and Environmental Science (EMG), Umeå, Sweden,
[5]University of Oslo, Department of Geosciences, Oslo, Norway,
[6]Centre for Planetary Habitability (PHAB), University of Oslo, Department of Geosciences, Norway,
[7]The University of Sydney, School of Geosciences, Sydney, Australia,
[8]Uppsala University, Department of Earth Sciences, Uppsala, Sweden,
[9]Volcanic Basin Energy Research (VBER), Oslo, Norway,
[10]The University Centre in Svalbard (UNIS), Department of Arctic Geology, Longyearbyen, Norway,
[11]The Australian National University, Research School of Earth Sciences, Canberra, Australia,
[12]Trinity College Dublin, The University of Dublin, Department of Geology, Dublin, Ireland,
[13]Geological Survey of Denmark and Greenland (GEUS), Geo-energy and -storage, Copenhagen, Denmark, [14]Norwegian University of Science and Technology, Department of Geoscience and Petroleum, Trondheim, Norway,
[15]Commonwealth Scientific and Industrial Research Organisation (CSIRO), Kensington, Australia

11:00–11:15 **Deep-time Arctic climate archives: High-resolution coring of Svalbard's Permian to Paleogene sedimentary record (ICDP application SVALCLIME-P2P)**

M. Jones[1,2], J. Barta[3], S. Danise[4], W. J. Foster[5], S.-A. Grundvåg[6], D. K. Kulhanek[7], H. Lorenz[8], S. Planke[2,9], K. Senger[10], K. K. Sliwinska[11], A. Smyrak-Sikora[12], L. Tarhan[13], M. L. Vickers[1], W. Xu[14], V. Zuchuat[15], SVALCLIME extended science team
[1]Umeå University, Ecology and Environmental Science, Umeå, Sweden,
[2]University of Oslo, Oslo, Norway, [3]University of South Bohemia, Centre of Polar Ecology/Department of Ecosystem Biology, Ceske Budejovice, Czech Republic,
[4]Università degli Studi di Firenze, Dipartimento di Scienze della Terra, Firenze, Italy,
[5]University of Hamburg, Institute for Geology, Hamburg, Germany,
[6]UiT the Arctic University of Norway, Department of Geosciences, Tromsø, Norway,
[7]Christian-Albrechts-University of Kiel, Institute of Geosciences, Kiel, Germany,
[8]Uppsala University, Department of Earth Sciences, Uppsala, Sweden,
[9]Volcanic Basin Energy Research (VBER) AS, Oslo, Norway,
[10]University Centre in Svalbard (UNIS), Longyearbyen, Norway,
[11]Geological Survey of Denmark and Greenland (GEUS), Geoenergy and -storage, København,
[12]Norwegian University of Science and Technology, Department of Geoscience and Petroleum, Trondheim, Norway,
[13]Yale University, Department of Earth and Planetary Sciences, New Haven, Connecticut, United States of America,
[14]University College Dublin, School of Earth Sciences, Dublin, Ireland,
[15]Commonwealth Scientific and Industrial Research Organisation, Kensington, Australia

11:15–11:30 **The paleoclimatic record of IODP Exp-403, Eastern Fram Strait Paleo-Archive**

R. G. Lucchi[1], K. St. John[2], T. Ronge[3], M. A. Barcena[4], S. De Schepper[5], L. Duxbury[6], C. Gebhardt,[7], A. Gonzalez-Lanchas[8], G. Goss[9], N. Greco[10], J. Gruetzner[11], L. Haygood[12], H. Katrine[13], M. Iizuka[14], I. Kapuge[15], O. Libman-Roshal[16], Y. Liu[17], B. Reilly[18], Y. Rosenthal[19], Y. S. Sakai[20], S. Kumar A. V.[21], Y. Zhong[22], the JOIDES Resolution Exp403 technical support team
[1]National Institute of Oceanography and Applied Geophysics - OGS, Sgonico -Trieste, Italy,
[2]James Madison University, Harrisonburg, United States of America,
[3]Texas A&M University, Integrated Ocean DrillingProgram, College Station, United States of America, [4]University of Salamanca, Salamanca, Spain,
[5]NORCE Norwegian Research Centre,Climate & Environment, Bergen, Norway,
[6]Institute for Marine andAntarctic Studies, Battery Point, Australia,
[7]Alfred Wegener Institut - AWI, Bremerhaven,, Germany,
[8]University of Oxford, Oxford, United Kingdom,
[9]Yale University, New Haven, United States of America,
[10]National Center for Ecological Analysis and Synthesis, Santa Barbara, United States of America,
[11]Alfred Wegener Institut - AWI, Bremerhaven, Germany,
[12]Oklahoma State University, Stillwater, United States of America,
[13]NorwegianPolar Institute, Tromsø, Norway,
[4]The National Institute of AdvancedIndustrial Science and Technology (AIST), Higashi, Japan,
[15]Universityof Delaware, Newark, United States of America,
[16]Montclair State University, Montclair, NJ, United States of America,
[17]the First Institute of Oceanography, State Oceanic Administration (FIOA), Qingdao, China,
[18]Lamont-Doherty Earth Observatory, Palisades, United States of America,
[19]Rutgers University, New Brunswick, NJ, United States of America,
[20]Kyoto University, Kyoto, Japan, [21]Central University of Kerala, Kasaragod, India,
[22]Southern University of Science and Technology, Shen Zhen, China

11:30–11:50 **Discussion**

11:50–13:20 Lunch & Poster

T1 - Evolution & Structure of Crust and Lithosphere in the Arctic

–> Geo Auditorium

13:20–15:10 T1 – Evolution & Structure of Crust and Lithosphere in the Arctic

–> Block 1.4

13:20–13:35 **Tectonics of the Beaufort Sea margin, western Canadian Arctic and Northern Canadian Cordillera**

A. Schaeffer[1], P. Audet[2], S. Cairns[3], B. Elliott[3], M. Colpron[4], C. Esteve[5], J. Gosselin[1], J. Emberley[4], R. Dave[1]
[1]Natural Resources Canada, Geological Survey of Canada - Pacific Division, Sidney, Canada, [2]University of Ottawa, Ottawa, Canada, [3]Northwest Territories Geological Survey, Yellowknife, Canada, [4]Yukon Geological Survey, Whitehorse, Canada, [5]University of Vienna, Vienna, Austria

13:35–13:50 **Regional and fault rock geo- and thermochronological evidence for polyphase deformation along the Porcupine Fault System of Yukon and Alaska**

M. Odlum[1], J. Strauss[2], K. Faehnrich[3], E. Donaghy[2, 4], B. McClelland[5], E. T. Rasbury[6], M. Colpron[7]
[1]University of California San Diego, Scripps Institution of Oceanography, La Jolla, CA, United States of America,
[2]Dartmouth University, Hanover, NH, United States of America,
[3]University of Adelaide, Adelaide, Australia,
[4]University of Nevada, Las Vegas, Las Vegas, United States of America,
[5]University of Iowa, Iowa City, IA, United States of America,
[6]Stony Brook University, Stony Brook, NY, United States of America,
[7]Yukon Geological Survey, Whitehorse, Yukon, Canada

13:50–14:05 **Age and correlation of rock sequences in the Nome Complex, Seward Peninsula, Alaska**

E. Miller[1], J. M. Amato[2], J. Toro[3], J. Craig[4]
[1]*Stanford University, Earth and Planetary Sciences, Stanford, United States of America,*
[2]*University of New Mexico, Geological Sciences, Las Cruces, United States of America,*
[3]*West Virginia University USA, Dept. Geology and Geography, Morgantown, WV, United States of America,*
[4]*Stanford University, Earth and Planetary Sciences, Stanford, CA, United States of America*

14:05–14:20 **Regional provenance changes during the initiation and evolution of the Early Cretaceous Arctic Alaska Colville Foreland Basin**

J. Gooley[1], R. Lease[1], D. Houseknecht[2], J. Counts[2]
[1]*United States Geological Survey, Alaska Science Center, Anchorage, Alaska, United States of America,*
[2]*United States Geological Survey, Geology, Energy & Minerals Science Center, Reston, Virgina, United States of America*

14:20–14:35 **Subsurface constraints on Paleozoic deformation in Arctic Alaska and the adjacent offshore region**

C. Connors[1, 2], R. Lease[3], J. Dumoulin[3], W. McClelland[4], J. Strauss[5], W. Craddock[2], D. Houseknecht[2]
[1]*Washington and Lee University, Earth and Environmental Geoscience, Lexington, United States of America,* [2]*U.S. Geological Survey, Reston, United States of America,*
[3]*U.S. Geological Survey, Anchorage, United States of America,*
[4]*University of Iowa, Iowa City, United States of America,*
[5]*Dartmouth College, Hanover, United States of America*

14:35–14:50 **Evidence for Middle–Late Devonian assembly of the Arctic Alaska terrane, northeastern Brooks Range, Alaska**

G. Geier[1], A. Lockett[2], S. Sehra[3], E. Kroeger[4], W. McClelland[5], C. Connors[6], J. Crowley[7], J. Strauss[1]
[1]*Dartmouth College, Department of Earth Sciences, Hanover, NH, United States of America,*
[2]*WSP, Earth and Environment Pacific Northwest, Redmond, WA, United States of America,*
[3]*Massachusetts Institute of Technology, Department of Earth, Atmospheric, and Planetary Sciences, Cambridge, MA, United States of America,* [4]*Clemson University, Department of Environmental Engineering and Earth Sciences, Anderson, SC, United States of America,*
[5]*University of Iowa, Department of Earth and Environmental Sciences, Iowa City, IA, United States of America,*
[6]*Washington and Lee University, Department of Earth and Environmental Geoscience, Lexington, VA, United States of America,*
[7]*Boise State University, Department of Geosciences, Boise, ID, United States of America*

14:50–15:10 **Discussion**

15:10–15:40 Coffee & Posters

15:40–17:00 T1 – Evolution & Structure of Crust and Lithosphere in the Arctic

–> Block 1.5

15:40–15:55 **The Middle Jurassic-Early Cretaceous First Order Sequence of the High Arctic - the Calm before the Storm**

S. Olaussen[1], A. Embry[2], S.-A. Grundvåg[3], M. E. Jelby[4], K. Senger[5], M. Smelror[6]
[1]*UNIS, Stavanger, Norway,* [2]*Geological Survey of Canada, Toronto, Canada,*
[3]*UiT The Arctic University of Norway, Department of Geosciences, y,, N-9037 Tromsø, Norway,*
[4]*University in Bergen, Department of Earth Science, Bergen, Norway,*
[5]*Unis, Longyearbyen, Svalbard, Norway,* [6]*Norway Geological Survey, Trondheim, Norway*

15:55–16:10 **Serpukhovian (Early Carboniferous) Rifting in the Sverdrup Basin, Arctic Canada**

B. Beauchamp
University of Calgary, Earth, Energy and Environment, Calgary, Canada

THURSDAY, MARCH 20, 2025

16:10–16:25 **Silurian arc volcanism in northern Axel Heiberg Island, Nunavut, Arctic Canada**

L. Beranek[1], V. Pease[2], W. McClelland[3], J. Strauss[4]
[1]Memorial University of Newfoundland, Department of Earth Sciences, St. John's, Canada,
[2]Stockholm University, Department of Geological Sciences, Stockholm, Sweden,
[3]University of Iowa, Department of Earth and Environmental Sciences, Iowa City, United States of America,
[4]Dartmouth College, Department of Earth Sciences, Hanover, United States of America

16:25–16:40 **Field relations and displacement of the Pearya terrane, Ellesmere Island, and its role in the tectonic evolution of the Arctic margin of North America**

W. McClelland[1], M. Koch[2], K. Faehnrich[3], K. Kośmińska[4], J. Gilotti[1], J. Strauss[5], L. Beranek[6], M. Colpron[7]
[1]University of Iowa, Earth & Environmental Sciences, Iowa City, United States of America,
[2]Syracuse University, Department of Earth and Environmental Sciences, Syracuse, United States of America,
[3]Adelaide University, Faculty of Sciences, Engineering and Technology, Adelaide, Australia,
[4]AGH University of Kraków, Faculty of Geology, Geophysics and Environmental Protection, Poland,
[5]Dartmouth College, Department of Earth Sciences, Hanover, United States of America,
[6]Memorial University of Newfoundland, Department of Earth Sciences, St. John's, Canada,
[7]Yukon Geological Survey, Whitehorse, Canada

16:40–16:55 **Discussion**

17:00–17:30 Closing Ceremony, Student´s award & announcement about next ICAM

FRIDAY, MARCH 21, 2025

09:00–15:00 Post-Conference Excursions

Alfred-Wegener Institute for Polar & Marine Research, Bremerhaven

10:00–12:00 Post-Conference Excursions

MARUM Centre for Marine Environmental Sciences, incl. the IODP Bremen Core Repository

Disclaimer*: Participation in the excursions is at your own risk. The organiser assumes no liability for any damage incurred in connection with the excursions.*

Topical Session 1– Talks

Evolution & Structure of Crust and Lithosphere in the Arctic

Evolution of the eastern Laurentian Arctic regions from Precambrian to present: Insights from seismic studies of lithospheric structure

F. Darbyshire

Université du Québec à Montréal, Sciences de la Terre et de l'atmosphère, Montréal, Canada

The tectonic history of northeast Laurentia (present-day Canada and Greenland) has been shaped by Archean craton formation and Proterozoic orogenesis. Since the continent was assembled, it has been affected by multiple Wilson cycles including episodes of rifting and mountain building, and interaction with the Iceland hotspot in conjunction with North Atlantic breakup.
Seismic studies of crust and upper-mantle structure across northern Canada, Greenland and their surroundings are key to understanding the complex geological history of the region. Variations in seismic wave speed help to identify the relationships between Archean cratons, Proterozoic mobile belts, Phanerozoic orogenic belts, rift structures and potential magmatic alteration of the lithosphere. Fast-polarization orientations of seismic anisotropy record 'fossil' lithospheric deformation and active sub-lithospheric mantle flow patterns.
I present an overview of recent lithospheric-scale seismic studies spanning a region from northeast Canada through Greenland to the northern North Atlantic, using a variety of methods including receiver function analysis, surface wave tomography and shear wave splitting.
In northeast Canada, Archean crust shows a relatively simple crustal structure and a sharp Moho at ~33-46 km depth. Proterozoic crust is more complex, with a high-velocity lower crust and a deeper, more gradual Moho. The lithosphere is thick, generally >180 km, with high seismic wave speeds and internal variations that correlate with known tectonic boundaries. Multi-layered anisotropy preserves a record of lithospheric deformation associated with Proterozoic orogenesis and continental assembly.
Beneath Greenland, the relationship between deep seismic structure and surface geology remains more enigmatic due to the presence of the inland ice sheet. Crustal thickness varies from ~30 to ~55 km onshore, with significant internal heterogeneity. A thick, seismically fast, continental keel is preserved beneath much of Precambrian Greenland, but it appears eroded beneath regions associated with hotspot magmatism. Anisotropic fabrics correlate with some known tectonic subdivisions but suggest decoupling between the crust and lithospheric mantle, and thin-skinned tectonics beneath the onshore traces of Phanerozoic orogens. Low seismic wave speeds and strong anisotropy at depth likely represent hotspot-related mantle flow beneath the landmass.

SIOLA – Seismicity and neOtectonics of the LAptev sea region

W. Geissler[1], A. Plötz[1], A. Krylov[2,3], S. Shibaev[4], F. Krüger[5], C. Haberland[6], B. Baranov[2], R. Tuktarov[4], N. Tsukanov[2], M. Novikov[2,3]

[1]*Alfred Wegener Institute (AWI), Helmholtz Centre for Polar and Marine Research, Bremerhaven, Germany,* [2]*Shirshov Institute of Oceanology, Russian Academy of Sciences, Moscow, Russian Federation,* [3]*Sirius University of Science and Technology, Sirius, Russian Federation,* [4]*Yakutsk Branch Federal Research Centre Geophysical Survey Russian Academy of Sciences, Yakutsk, Russian Federation,* [5]*University of Potsdam, Potsdam, Germany,* [6]*Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences, Potsdam, Germany*

The Laptev Sea region in Northeast Siberia is one out of very few examples for possible initiation of continental breakup. In the North seismicity concentrates clearly on the Gakkel Ridge separating the oceanic parts of the North American and Eurasian plates. Earthquake epicenters are more diffuse on the Laptev Sea Shelf and further inland, where in 1927 two M6.7 earthquakes occurred just 200 km to the south of the seaport of Tiksi. Suspicious hypocenter depths of up to 80 km have been reported from short temporary deployments near the coast. This was the motivation to start new regional seismological investigations within the German-Russian SIOLA project.
Following reconnaissance investigations in 2015 we installed one detection array near the city of Tiksi consisting of 13 3-component sensors in summer 2016. The array was in operation until 2020.

In addition, temporary networks of 3-component stations were deployed by ship along the Lena river to the west of Tiksi (Lena Delta), and along the shore of Buor Khaya Bay over the course of the four years (2016-2020). We will give an introduction into the tectonic setting, the SIOLA project and associated field work, and we will present results from the data recorded in the first year of the deployments with a focus to the seismicity in the Lena Delta region.

Crustal production at the ultraslow spreading Gakkel Ridge: a review of current geophysical knowledge

V. Schlindwein[1,2], M. Schmidt-Aursch[1]

[1]*Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Bremerhaven, Germany,*
[2]*University of Bremen, Department of Geosciences, Bremen, Germany*

It is almost 25 years, since the scientific community became aware that seafloor spreading at Gakkel Ridge is not just a slower version of spreading processes at the Mid-Atlantic ridge. The groundbreaking discoveries of the Arctic Mid-Ocean Ridge Expedition 2001 established Gakkel Ridge as the key representative of the distinct class of "ultraslow" spreading ridges. A characteristic feature of ultraslow spreading is highly discontinuous magmatic crustal production at discrete volcanic centres.
In recent years, the use of ocean bottom seismometers for active and passive seismic surveys has become possible and several volcanic centres of Gakkel Ridge have been studied, adding considerably to our knowledge of the functioning of crustal accretion, which is reviewed in this presentation.
The volcanic centres of Gakkel Ridge can be identified in bathymetric maps by their long chains of off-axis highs extending in spreading direction. At the rift axis, sidescan sonar images show a marked contrast between the high-reflectivity basaltic seafloor of the volcanic centres compared to the less reflective areas inbetween. Volcanic centres are additionally connected with lows in mantle Bouguer anomalies, positive magnetic anomalies and increased seismic moment release, often in seismic clusters.
New microearthquake data from a volcanic centre at Gakkel Ridge Deep show a circular area devoid of seismic activity that coincides with a magnetic anomaly. Spatially focused earthquake swarms directed outward of this potentially hot area may indicate ongoing magmatism. Recent seismic refraction studies conducted as part of the Chinese Jasmine expeditions show a thickening of the crust by a factor of 2 in the volcanic centres of eastern Gakkel Ridge relative to area inbetween where earthquake depths drop and the crust thins. 2D modelling of accretion processes indicates that mantle heterogeneity may play an important role to locally change temperature and viscosity and thereby melt production. Crustal thickness at the volcanic centres of Gakkel ridge may thus reach up to 7 km whereas average crustal thickness is rather of the order of 3-5 km. The spatially highly variable crustal production at Gakkel Ridge has been ongoing for extended time periods, since off-axis seismic profiles reveal similar variations of thickness and composition in much older crust.

The Seidfjellet Formation: A Window into Miocene Volcanism and Tectonics in NW Spitsbergen

M. Telmon[1], K. Senger[2], S. A. Grundvåg[1], S. Planke[3,4], D. Zastrozhnov[3], A. Minakov[3], R. Kenji Horota[2,5], P. Betlem[2,6], C. Tegner[7]

[1]*The Arctic University of Norway, Geoscience, Tromsø, Norway,* [2]*The University Center in Svalbard, Arctic Geology, Longyearbyen, Norway,* [3]*Universitet i Oslo, Geoscience, Oslo, Norway,* [4]*VBER, Oslo, Norway,*
[5]*Universitet i Bergen, Department of Earth Science, Bergen, Norway,* [6]*Norges Geotekniske Institutt, Oslo, Norway,*
[7]*Aarhus University, Aarhus, Denmark*

Miocene basaltic lava flows overlying Devonian sedimentary rocks crop out on numerous mountain tops in Andrée Land in north-western Spitsbergen and are collectively referred to as the Seidfjellet Formation. The study aims to understand the nature and formation of this relatively young and poorly studied High-Arctic igneous province within a regional tectonomagmatic context. The Seidfjellet Formation extends for over 40 km from south to north and nearly 50 km from west to east. In the summer of 2023, we systematically mapped and sampled well-exposed outcrops along Woodfjorden, documenting several stratigraphic profiles and logging basaltic lava flows from an elevation of approximately 600 to over 1000 m above sea level. Additionally, we acquired a high number of photospheres and photographs using unmanned aerial vehicles (UAVs). To enhance the consistency of our dataset, 13 legacy samples from a helicopter-based expedition in

2014 have been analyzed for standard geochemical characterization, including major and trace element concentrations, isotopic ratios, and $^{40}Ar/^{39}Ar$ age determination. Photographs were processed to obtain high-resolution georeferenced digital outcrop models (DOMs) for systematic mapping of the Seidfjellet Formation and its relationship with the paleosurface. The mapped lava flow sequences have variable thickness with maximums reaching up to 400 m locally. We also observed a massive 50 m thick olivine-rich sheet-slow unit in the lower part of the formation. A distinctive hyaloclastic body is locally mapped at the base of the sequence, suggesting a subaqueous lava emplacement environment, while clear evidence of subaerial emplacement as pahoehoe lava flow features are documented in the upper section. The interpretation of DOMs and the distribution of the lava flows suggest that the igneous province extends more widely than what is evident from the existing remnant outcrops. Geochemical analysis of the sequence reveals both silica-saturated ‚tholeiitic' and silica-undersaturated ‚alkaline' magmas, with isotopic signatures of crustal-contaminated mantle. This reflects a complex geological setting. The magmatic rocks of Seidfjellet formation and structural relations with host sedimentary rocks serves as a valuable resource for investigating the Miocene evolution in Svalbard and its surroundings, including the characterization of regional vertical motion history and the evolution of large-scale volcanism at play during the Miocene in Svalbard.

Quaternary Magmatism in the High Arctic: Refining the Architecture and Lava Emplacement Environment of Sverrefjellet Volcano in NW Svalbard

D. Zastrozhnov[1], S. Planke[1,2], J. Millett[2], R. Horota[3,4], P. Betlem[5], K. Senger[3]

[1]*University of Oslo, Department of Geosciences, Oslo, Norway,* [2]*Volcanic Basin Energy Research (VBER), Oslo, Norway,*
[3]*The University Centre in Svalbard, Department of Arctic Geology, Longyearbyen, Norway,*
[4]*University of Bergen, Department of Earth Science, Bergen, Norway,* [5]*Norges Geotekniske Institutt, Oslo, Norway*

Sverrefjellet, an extinct alkali basaltic volcano in NW Svalbard, represents a distinct phase of recent volcanism in the High Arctic. Volcanism occurred during Quaternary glaciations, although the precise timing and nature of volcanic activity remains unclear. Sverrefjellet is known for abundant mantle xenoliths in lavas and dykes, a focus of most studies, while its volcanic architecture has been underexplored since initial mapping in the 1980s.

In July 2023, field mapping and sampling of volcanic units along Sverrefjellet were performed to study igneous emplacement processes. Drones were used to capture high-resolution 3D models of the entire volcano and the best-exposed outcrops. AI-assisted mapping with trainable image segmentation estimated xenolith volumes and morphologies. 20 rock samples were selected for petrographic, SEM, and EPMA analyses.

Mantle xenoliths were present in all volcanic units, including pillow lavas, basaltic flows, volcanogenic sediments, and dykes. Xenoliths averaged 20% of the total lava volume, reaching up to 55% locally. Contrary to previous interpretations, which suggested xenoliths primarily accumulate at flow bases due to gravity settling, we observed a more uniform distribution in the studied flow. Pillow lavas were found only at elevations of 200-300 meters above sea level.

Distinctive textural zones were identified in the lava flows and dykes, featuring platy tops and bottoms with associated flattened xenolith nodules. Some dyke interiors displayed curved, concentric platy fractures. Xenoliths and basalts revealed no significant crystal alignment in the platy zones corresponding to fracture orientation.

Our results support a subglacial origin for Sverrefjellet eruptions. This is evidenced by the occurrence of pillow lavas at high elevation along the volcano, which makes interaction of lava with seawater highly unlikely. Moreover, the curved and platy fractures observed in the dykes are similar to textures in lavas from other glaciated regions, which are interpreted as evidence of magma-ice interaction. The formation of the platy zones is likely linked to contraction from rapid cooling and freeze-thaw processes. However, the presence of flattened nodules within these zones suggests that shearing during magma flow could induce foliation, contributing to the formation of platy fragments.

Dynamics of the lithosphere–asthenosphere boundary beneath Svalbard: Insights from Cenozoic volcanism and mantle-derived xenoliths

S. Tappe[1], A. Helland-Hansen[1], A. Minakov[2], A. Stracke[3], K. Senger[4], S. Klemme[3], N. Koglin[5], A. Ishikawa[6]

[1]*UiT The Arctic University of Norway, Department of Geosciences, Tromsø, Norway,* [2]*University of Oslo, Department of Geosciences, Oslo, Norway,* [3]*University of Münster, Institute for Mineralogy, Münster, Germany,* [4]*University Centre in Svalbard, Department of Arctic Geology, Longyearbyen, Norway,* [5]*BGR Hannover, Department of Polar Geology, Hannover, Germany,* [6]*Tokyo University of Technology, Department of Earth and Planetary Sciences, Tokyo, Japan*

The Cenozoic geodynamic evolution of the High Arctic is critical for our understanding of continental breakup mechanisms and opening of marine gateways, which in turn control ocean currents and climate patterns. The ongoing opening of the Fram Strait between Greenland and Svalbard started at ca. 20 Ma, and the region provides a natural laboratory to investigate geological processes at a continent–ocean transition. Magmatic processes are of particular importance because their volcanic products record the time–temperature and compositional evolution of Earth's upper mantle beneath the developing rift branches, information that is impossible to obtain from geophysical measurements at time-zero. Recent elemental and isotopic analyses of basalts and their source rocks from mid-ocean ridge segments of the Lena Trough revealed geochemically enriched signatures that suggest the presence of remnant continental lithosphere beneath the Fram Strait. This implies that continent–ocean transitions are structurally much more complex than widely assumed. Enigmatic volcanic centers in NW Svalbard, such as the ca. 1 Ma Bockfjorden Volcanic Complex and the ca. 10 Ma Seidfjellet Formation, have been interpreted previously as expressions of 'oceanic' volcanism on thinned continental lithosphere. In this contribution, we present pressure–temperature estimates for newly collected mantle-derived peridotite xenoliths from NW Svalbard. These data, in combination with pressure–temperature estimates for the Cenozoic lavas as well as lithospheric thickness estimates from seismic surveys, help to constrain the Cenozoic evolution of the lithosphere–asthenosphere boundary beneath this tectonically active continent–ocean transition. We also present Re-Os isotope data for the peridotite xenoliths, which suggest the presence of Paleoproterozoic mantle lithosphere beneath NW Svalbard. Ubiquitous mantle heterogeneity within these peridotite xenoliths, recorded by websteritic and pyroxenitic veins, was mainly created during Paleoproterozoic melting processes, without evidence for strong magmatic overprinting during the Mesozoic–Cenozoic. This suggests that the shallow lithospheric mantle near the dynamic lithosphere–asthenosphere boundary behaved rather passively during Cenozoic tectonic activity, with concomitant mantle-derived magmatism being focussed along spatially confined deep-rooted conduits and plumbing systems in NW Svalbard and adjoining offshore areas.

Tectonomagmatic history of meta-igneous rocks from Nordaustlandet, Svalbard, inferred from microstructural analyses and $^{40}Ar/^{39}Ar$ geochronology

L. Kanzler[1], J. A. Pfänder[2], B. Sperner[2], K. Piepjohn[3], N. Koglin[3], S. Tappe[4], U. Riller[1]

[1]*Universität Hamburg, Institut für Geologie, Hamburg, Germany,* [2]*TU Bergakademie Freiberg, Institut für Geologie, Freiberg, Germany,* [3]*Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), Hannover, Germany,* [4]*UiT - The Arctic University of Norway, Department of Geosciences, Tromsø, Norway*

Due to its remoteness in the High Arctic, the island of Nordaustlandet is one of the least understood geological terranes on Earth regarding Precambrian and Paleozoic geodynamic processes. Such knowledge is, however, essential to reconstruct the geological evolution of the Arctic Oceans' surrounding continental shelf areas and landmasses. To elucidate the age of metamorphism and deformation, 18 separates of foliation-forming mineral phases from 11 samples of meta-igneous rocks from northern Nordaustlandet were dated by $^{40}Ar/^{39}Ar$ geochronology. The geochronological study was complemented by a regional compilation of planar metamorphic fabrics and a microstructural analysis. Collectively, the structural observations allowed us to constrain the mechanisms, intensities and shortening directions of deformation. The geochronology data and the orientation of planar magmatic mineral fabrics reveal that deformation imparted to the metagranitoids is mostly Late Caledonian and may have followed immediately the emplacement of respective magmatic bodies as large subhorizontal sheets. Interestingly, the rocks deformed at medium-grade metamorphism in a rather narrow time interval between 420.1 ± 2.3 Ma and 399.9 ± 1.7 Ma. This time interval corresponds to the

Scandian phase of the Caledonian orogeny. Notable departures in $^{40}Ar/^{39}Ar$ ages from the Scandian phase include ages of 147.2 ± 1.46 Ma and 147.1 ± 1.1 Ma for biotite and muscovite from a granite on Laponiahalvøya, possibly as a consequence of reheating by the intrusion of a nearby dolerite. Except for the latter ages, our results point to the construction and subsequent deformation of a Caledonian magmatic arc within a well-defined time window between the Late Silurian to Early Devonian. Our study calls into question the popular hypothesis that Nordaustlandet is largely made up of Grenvillian meta-igneous rocks.

Project NEOMAGRATE – toward quantification of NE Svalbard's paleogeographic position in the Neoproterozoic

K. Michalski[1], S. Bal[1], G. Manby[2], K. Nejbert[3], J. Domańska - Siuda[3], J. Majka[4,5], J. V. Strauss[6], A. Hołda - Michalska[7]

[1]*Institute of Geophysics Polish Academy of Sciences, Warsaw, Poland,*

[2]*Natural History Museum, London, United Kingdom,*

[3]*University of Warsaw, Department of Geology, Warsaw, Poland,* [4]*Uppsala University, Department of Earth Sciences, Uppsala, Sweden,*

[5]*AGH University of Krakow, Faculty of Geology, Geophysics and Environmental Protection, Krakow, Poland,*

[6]*Dartmouth College, Department of Earth Sciences, Hanover, United States of America,*

[7]*Institute of Paleobiology Polish Academy of Sciences, Poland, Poland*

The project NEOMAGRATE aims to recognise the palaeomagnetic record of one of the Earth's most complete Neoproterozoic sections that crop out in NE Svalbard. Targeted Neoproterozoic sections around Hinlopenstretet were not subjected to Caledonian metamorphism and potentially preserve their primary magnetization. This creates a unique opportunity to reconstruct the paleogeographic position of the Eastern Terrane/ Northeastern Basement Province of Svalbard, revise the models for the evolution of Rodinia and verify the models for True Polar Wander events in the Neoproterozoic (Maloof *et al.* 2006, Michalski *et al.* 2023)

During the palaeomagnetic expeditions to NE Svalbard (2022, 2023), the NEOMAGRATE team collected 400 independently oriented Neoproterozoic palaeomagnetic samples from 58 sites around Hinlopenstretet. The samples represent the Tonian Kapp Hansteen volcanics, the Veteranen Group siliciclastics, the Akademikerbreen Group carbonates and the Cryogenian carbonates and tillites of the Polarisbreen Group. Preliminary thermal demagnetisation results of the first 120 samples of the Akademikerbreen and Polarisbreen Groups revealed a significant high-inclination component, potentially related to the Mesozoic High Arctic Large Igneous Province remagnetisation. Low-inclination components above 250°C were identified in selected sites, which may represent a Caledonian thermal resetting and a pre-Caledonian (primary?) palaeomagnetic record. Further integrated palaeomagnetic, rock-magnetic, AMS, structural and geochronological investigations of the samples are in progress.

This study is part of the NEOMAGRATE project 2022–2025: "Rate of tectonic plates movement in Neoproterozoic – verification of Neoproterozoic True Polar Wander hypothesis", funded by the Polish National Science Centre (NSC); grant number: 2021/41/B/ST10/02390.

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Cryogenian to Ediacaran tectonothermal events recorded in western Svalbard

J. Majka[1,2]

[1]*Uppsala University, Department of Earth Sciences, Uppsala, Sweden,* [2]*AGH University of Krakow, Kraków, Poland*

The very first geochronological data on Late Neoproterozoic tectonothermal activity in Svalbard was provided by a pioneering work of Gayer et al. (1966, NorskPolarSkrift), who noticed c. 600 Ma K-Ar ages in southwestern Svalbard. Since that time numerous authors provided evidence for both igneous and metamorphic events affecting Svalbard in Cryogenian to Ediacaran times. In northwestern Svalbard, metagabbros and eclogites from Raudfjorden yield protolith ages of c. 670-650 Ma (interpreted by some authors as an age of high pressure metamorphism). A c. 632 Ma zircon upper intercept was reported from a lower crustal xenolith in the Quaternary Sverrefjellet volcano located in Bockfjorden. In Wedel Jarlsberg Land of southwestern Svalbard, amphibolite facies metapelites and orthogneisses yielded zircon and monazite ages of c. 643 and c. 635 Ma, respectively. Associated pegmatites provided slightly older zircon and monazite ages in range of c. 665-651 Ma. These ages are interpreted to be connected to the Timanides. Voluminous mafic magmatism coeval with Marinoan glacial deposits (i.e. c. 635 Ma) can be traced from Wedel Jarlsberg Land northward. The youngest Neoproterozoic igneous rock reported so far is a (meta)gabbro from Oscar II Land yielding c. 560 Ma baddeleyite age. The latter is interpreted to be connected to the Central Iapetus magmatic Province (Gumsley et al. 2020, PrecamRes). The wealth of Cryogenian to Ediacaran ages from igneous and metamorphic rocks occurring in western Svalbard has a profound importance for understanding Neoproterozoic history of Svalbard and the High Arctic in general. Yet, no attempt to summarize and provide a coherent evolutionary model for this tectonothermal activity has been made. Are all these aforementioned events connected to each other or not? What is the relation of these Cryogenian to Ediacaran igneous and metamorphic rocks to other rocks of similar age in remaining regions of the High Arctic? To answer these questions a tentative provisional model explaining close spatial and temporal existence of both convergence- and extension-related rock complexes will be presented.

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Lithospheric architecture under Greenland and its missing link to the Iceland hot-spot track

J. Ebbing[1], A. Wansing[1], J. Freienstein[1], B. Heincke[2], W. Szwillus[1]

[1]*Kiel University, Geosciences, Kiel, Germany,* [2]*GEUS, Copenhagen, Denmark*

Greenland's ice mass loss has been one of the largest contributors to global sea level rise since the early 2000s. However, the mechanisms driving the mass loss are not fully understood, and particularly large uncertainties are associated with the solid earth conditions under the ice. For example, a number of geothermal heat flow models exist, that contradict each other, but like to relate increased heat flow to the Iceland hot-spot track. However, only one heat flow observation in Central Greenland indicates unusual high heat flow.

We present a new lithospheric scale model, which is based on a wealth of data from satellite gravity to seismic velocity models and depth estimates, showing that the mantle contribution to heat flow is moderate. The lithospheric scale model shows a very thick cratonic lithosphere for most of Greenland, except the coastal areas. For one, that might relate to an imprint of the Caledonian orogeny, but in the area of adjacent to Iceland, that might relate to an imprint of the hot-spot track.

This model agrees with recent lithospheric-scale models based on slightly different techniques and different data sets, which provides some confidence that the results are robust. This in turn implies, that the unusual high heat flow observation in Central Greenland might be of local origin and relate to sub-glacial geology, only. However, data coverage is not yet adequate to provide an explanation.

Carbon mobility during intrusion of Eocene Dykes in Jameson Land Basin, Greenland.

R. Telson[1], A. Barker[1], M. Bukała[2], K. Kośmińska[3], J. Majka[1,3], K. McCaffrey[4], C. Menzies[4], C. Schiffer[5]
[1]*Uppsala University, Department of Earth Sciences; Minerology, Petrology and Tectonics, Uppsala, Sweden,* [2]*Andalusian Earth Science Insitute, Granada, Spain,* [3]*AGH University of Kraków, Department of Mineralogy, Petrography and Geochemistry, Kraków, Poland,* [4]*Durham University, Department of Earth Sciences, Durham, United Kingdom,* [5]*Uppsala University, Department of Earth Sciences; Geophysics, Uppsala, Sweden*

The Jameson Land sedimentary basin is an extensional basin comprised of mostly fluvial, lacustrine, shallow marine shale and sandstone deposits along Greenland's eastern coast. The basin developed between the Devonian and late Jurassic. Flood basalts and intrusions, now interspersed throughout the basin, are related to the opening and subsequent spreading of the Ægir ridge 55 Ma and the separation of Greenland from Europe. This study investigates the potential mobilisation of climate-forcing compounds such as CO_2 in the sedimentary basin caused by the Eocene intrusions. We develop models to explain the geochemistry of samples from two sites that expose contacts between dykes and sedimentary rocks. From the southernmost site, chemical profiles show steady increases in carbon, calcium, fluid-mobile elements, and hydrothermal alteration from the interior of the dykes to their contacts. Sandstone in the contact aureole shows inverse elemental distributions, attributed to the loss of dolomite-rich cement near (<1 m) the intrusion. Raman spectrometry analysis of the graphitization of organic material reveals peak metamorphic temperatures between 500 and 600°C. The northernmost site records similar element distributions. The increase in carbon and calcium is associated with calcite-filled vesicles in the outermost samples of the dyke, as well as calcite-epidote-type alteration. Models integrating the textures, mineralogy and geochemistry of the contacts between the dykes and sedimentary rock suggest that CO_2 is dominantly derived from carbonate lithologies and cement from the contact aureoles. Dissolution and transportation of sequestered CO_2 likely causes some amount of CO_2(aq) to be degassed as CO_2(g) before reacting with basaltic dykes and forming calcite.
This study shows that interactions between the dykes and sediment may have been sources of atmospheric CO_2 over geological timescales. This has important implications for our understanding of CO_2 sources and the role of intrusion complexes in past and future climate systems.

Kinematics and age of deformation along the Trolle Land Fault System, Northeast Greenland

K. Piepjohn[1], A. Ruppel[2], L. Reinhardt[2], M. Blumenberg[2], M. Jochmann[3], C. Spiegel[4]
[1]*No institution, Hannover, Germany,* [2]*Federal Institute for Geosciences and Natural Resources, Hannover, Germany,* [3]*Store Norske Spitsbergen Kulkompani, Longyearbyen, Norway,* [4]*University of Bremen, Bremen, Germany*

The geology of the Wandel Sea Basin in Northeast-Greenland is dominated by a number of NW-SE striking faults of the Trolle Land Fault System as part of the Wandel Hav Strike-Slip Mobile Belt. It is still a matter of debate if the deformation in this area was controlled by NE-SW contraction of a NW-SE trending fold-and-thrust belt and/or by NW-SE trending dextral strike-slip tectonics. However, the timing of the deformation was unclear until now, because only Carboniferous to Late Cretaceous sedimentary rocks of the Wandel Sea Basin were involved in this deformation. As the known Cenozoic exposures in Kronprins Christian Land and on Thyra Ø were reported as being undeformed, an assignement to the Eurekan deformation was unclear. Therefore, the possibility was suggested that the area was affected by the Kronprins Christian Orogeny before the Cretaceous-Paleogene boundary. On the other hand, the base of the Paleogene deposits in Northeast Greenland is unkown, and an unconformity of undeformed, horizontal Paleogene strata on top of deformed Cretaceous and older rocks of the Wandel Sea Basin is nowhere exposed. During fieldwork in 2018 we discovered new outcrops of consolidated sandstones and siltstones of the Paleocene Thyra Ø Formation in the northeastern part of Thyra Ø, which are folded and affected by small-scale NW-SE contraction. The deformed Paleocene deposits is the first evidence in Northeast Greenland, that the movements along the Trolle Land Fault System might be younger and were affected by a post-Paleocene deformation possibly related to the Eocene Eurekan deformation. Although the outcrop area is very small, and tectonic measurements are not enough to support real statistic interpretations, we suggest that the deformation of these sediments is possibly related to dextral strike-slip deformation comparable to the Eurekan stage 2 along the large fault zones at the corresponding continental margin of Svalbard. NW-SE striking, classical fold-and-thrust belt structures, comparable to the West Spitsbergen Fold-and-Thrust Belt of Eurekan stage 1, are not developed in Northeast Greenland. Except for the local deformation on NE Thyra Ø, the Paleogene deposits in Northeast Greenland are undeformed.

Strain partitioning during transpression in the Wandel Sea Basin (eastern North Greenland)

P. Guarnieri[1], J. Bojesen-Koefoed[1], N. Keulen[2], J. Konnerup-Madsen[3], M. Olivarius[4], J. A. Rasmussen[5], T. B. Thomsen[2]

[1]*Geological Survey of Denmark and Greenland GEUS, Copenhagen, Denmark,* [2]*Geological Survey of Denmark and Greenland GEUS, Mapping and Mineral Resources, Copenhagen, Denmark,* [3]*†Deceased 2017, University of Copenhagen, Department of Geosciences and Natural Resource Management, Copenhagen, Denmark,* [4]*Geological Survey of Denmark and Greenland GEUS, Geoenergy and Storage, Copenhagen, Denmark,* [5]*Museum Mors, Nykøbing Mors, Denmark*

Sedimentary rocks in the Wandel Sea Basin (eastern North Greenland) are overprinted by Eurekan deformation that, according to plate tectonics reconstructions, is associated with major convergence in the Paleocene, followed by strike-slip tectonics in the Eocene. Analogue sand-box models suggest strain partitioning during transpression along the De Geer shear zone, to account for the deformation in the West Spitsbergen fold belt and a compressional retro-wedge corresponding to the Wandel Sea area in eastern North Greenland.

In this study, based on fieldwork in North Greenland in 2012 and 2013, structural mapping and kinematic data along major faults are implemented with a new dataset of fluid inclusions, vitrinite reflectance, conodont colour alteration index, petrographic analysis and U-Pb geochronology from detrital zircons. A more detailed investigation of the thermal overprint from the new dataset better explains the strong thermal heating affecting the Upper Cretaceous sediments of the Wandel Sea Basin, indicated by previous studies. The paleotemperature maps show how maximum temperatures and the distribution of metamorphic rocks follow major normal fault trends that were reactivated as thrust faults during basin inversion. The Middle Paleocene-Early Eocene age of the sedimentary rocks affected by compressive structures indicates that the tectonic inversion was contemporaneous with the activity along the De Geer shear zone, which was initiated in the Early Eocene. This evidence indicates that strain partitioning during transpression rather than pure strike-slip, better explains the tectonic setting of this area with strike-slip movements along the Fram Strait and thrusting in North Greenland and West Spitsbergen until the Early Eocene.

In summary, the main outcomes of this study are:

1-Late Cretaceous-Early Paleocene extension with a WNW-ESE rift is interpreted to have developed between North Greenland and the western Barents Sea, sourced by volcaniclastics and sediments with tuffaceous levels from the Kap Washington rift.

2-Middle Paleocene-Early Eocene compression with SSW to SW-ward directed thrusts and basin inversion.

3-Eocene strike-slip tectonics with NW-SE trending faults locally offsetting compressive structures.

Tectonics of the Beaufort Sea margin, western Canadian Arctic and Northern Canadian Cordillera

A. Schaeffer[1], P. Audet[2], S. Cairns[3], B. Elliott[3], M. Colpron[4], C. Esteve[5], J. Gosselin[1], J. Emberley[4], R. Dave[1]

[1]*Natural Resources Canada, Geological Survey of Canada - Pacific Division, Sidney, Canada,* [2]*University of Ottawa, Ottawa, Canada,* [3]*Northwest Territories Geological Survey, Yellowknife, Canada,* [4]*Yukon Geological Survey, Whitehorse, Canada,* [5]*University of Vienna, Vienna, Austria*

The formation and development of the western Canadian Arctic Archipelago has long been a complex tectonic enigma. In the eastern Beaufort Sea, the young Arctic Ocean lies adjacent to the ancient Paleo-Proterozoic Canadian Shield. Offshore seismic data from controlled sources indicate that Banks Island marks the western boundary of the rifted margin formed during the opening of the Arctic Ocean. This rifting likely caused the island to subside, leading to the accumulation of petroleum-rich sediments. On the other hand, surface-wave velocity models across North America reveal that velocities at depths of 100-150 km beneath Banks Island are similar to those found beneath Canada's diamond-rich central Slave craton. This suggests that the Banks Island basement may be part of the Canadian Shield, making any kimberlite formations potential diamond sources. Additionally, the southern Beaufort Sea's Mackenzie Delta margin, which features a fold and thrust belt less than 65 million years old, has only recently been recognized as potentially active. This belt may accommodate either slow thrusting of continental crust over oceanic crust or the early stages of subduction of oceanic crust beneath the margin.

We utilize data from newly established land seismic networks to study the crustal structure and seismic activity of the Beaufort Sea region and its surroundings. A central issue is understanding how the mantle structure, typical of the Canadian Shield, can be reconciled with the crust of a rifted passive margin. In particular, the presence of thick, craton-like lithosphere beneath Banks Island seems inconsistent with the tectonically disrupted and thinned margin of the Canada Basin. Initial findings from dispersion analysis, 1D inversion, and receiver function studies reveal a Moho depth of approximately 30 km beneath the Beaufort Sea and Banks Island, with a slight thinning trend towards Prince Patrick and Melville Islands to the north. Mantle velocities remain high, suggesting a cooler lithosphere. Anisotropy orientations derived from SKS splitting show fabrics aligned parallel to the margin, which contrasts with what would be expected for an extended tectonic margin; however, the depths at which these fabrics originate are still uncertain.

Regional and fault rock geo- and thermochronological evidence for polyphase deformation along the Porcupine Fault System of Yukon and Alaska

M. Odlum[1], J. Strauss[2], K. Faehnrich[3], E. Donaghy[2,4], B. McClelland[5], E. T. Rasbury[6], M. Colpron[7]

[1]*University of California San Diego, Scripps Institution of Oceanography, La Jolla, CA, United States of America,* [2]*Dartmouth University, Hanover, NH, United States of America,* [3]*University of Adelaide, Adelaide, Australia,* [4]*University of Nevada, Las Vegas, Las Vegas, United States of America,* [5]*University of Iowa, Iowa City, IA, United States of America,* [6]*Stony Brook University, Stony Brook, NY, United States of America,* [7]*Yukon Geological Survey, Whitehorse, Yukon, Canada*

The Porcupine Fault System (PFS) of northern Yukon and Alaska is a major craton-bounding fault zone that accommodated Paleozoic terrane translation. The Mesozoic-Cenozoic history of the PFS remains poorly understood due to a lack of coupled structural and geo- and thermochronological datasets, but this chronology is critical for kinematic and paleogeographic models for the circum-Arctic, northern Pacific, and northern Cordillera. Faults within the PFS exhibit normal, thrust, and strike-slip kinematics and are commonly coated by hematite, epidote, and/or calcite which are amenable to (U-Th)/He and U-Pb thermochronology. Field and microstructural observations support synkinematic growth and deformation of these minerals, allowing us to target them to date kinematically characterized deformation within the PFS. Preliminary calcite U-Pb dates from conjugate vein sets are ~120 Ma. Regional apatite (U-Th)/He analysis from samples across and within the PFS yield dates between ~140–70 Ma, with a significant component at ca. 70-60 Ma. A thin tuff interbedded within nonmarine strata exposed along the PFS yielded an age of ~61 Ma, overlapping with regional cooling dates and highlighting the presence of previously unrecognized early Cenozoic synorogenic deposits. Our field observations and structural data integrated with preliminary regional and fault rock geo- and thermochronology support reactivation of the PFS during the Cretaceous and Paleogene, suggesting it played a role in the opening of the Arctic Ocean.

Age and correlation of rock sequences in the Nome Complex, Seward Peninsula, Alaska

E. Miller[1], J. M. Amato[2], J. Toro[3], J. Craig[4]

[1]*Stanford University, Earth and Planetary Sciences, Stanford, United States of America,* [2]*University of New Mexico, Geological Sciences, Las Cruces, United States of America,* [3]*West Virginia University USA, Dept. Geology and Geography, Morgantown, WV, United States of America,* [4]*Stanford University, Earth and Planetary Sciences, Stanford, CA, United States of America*

Seward Peninsula, AK, lies within a zone of Mesozoic convergent margin deformation, overprinted by high-strain extensional fabrics coeval with magmatism, crustal flow and rise of sillimanite gneiss complexes in the mid-Cretaceous. Greenschist and relict blueschist facies rocks of the Nome Complex flank gneiss complexes; metamorphism and extreme deformation makes deciphering their origin difficult. Geologic mapping and U-Pb dating of detrital zircon (DZ) suites allow insight into their stratigraphic age and match to units in the Brooks Range and the circum-Arctic.
The oldest Mount Distin assemblage represents a shelf depositional environment. DZ populations have a few .9-1Ga, many 1-1.5Ga, lesser 1.5-2Ga. and a few 2.5-3Ga zircons. It is host to felsic orthogneiss bodies (600-700 Ma) and small mafic intrusions. The Casadepaga Schist is a Neoproterozoic mafic metavolcanic and mafic to calcareous metasedimentary assemblage. Its DZ population has abundant 550-750 Ma, lesser 1-2Ga, and few

2-3Ga zircons. Contacts with older rocks are sharp and interpreted as faults that pre-date the youngest extensional deformation. Lower grade strata overlie these units along an inferred unconformity, normal fault or faulted unconformity south of the village of Teller. DZ maximum depositional ages (MDAs) are 530 Ma and younger, with older populations like those of underlying units. Gabbro dikes are 539±11Ma. Fossil-bearing Ordovician, Silurian and Early Devonian carbonates of the York Mountains overlie these strata along a low-angle normal fault system that may represent a faulted stratigraphic contact. Coeval carbonates form part of the metamorphosed Nome Complex elsewhere. The above-described packages of rocks and their equivalents in the Brooks Range are similar to those in the Polar Ural region of Russia, suggesting their restoration to the Barents Shelf/Lomonosov Ridge when the Eurasian Basin is closed.
Other rock packages in the Nome Complex include a meta-clastic unit with DZ populations rich in 400-500 Ma zircons, over half .9-2Ga, and a few 2.5+Ga zircons. Ordovician to Devonian zircons suggest Caledonian sources. A unit originally named the Solomon Schist yields zircon populations that are Carboniferous and older and correlates with the widespread greywacke-phyllite belt and Hunt Fork Shale of the Brooks Range.
These new data, combined with previous work, help evaluate opening models for the Amerasian Basin as detailed in the accompanying poster presentation.

Regional provenance changes during the initiation and evolution of the Early Cretaceous Arctic Alaska Colville Foreland Basin

J. Gooley[1], R. Lease[1], D. Houseknecht[2], J. Counts[2]

[1]*United States Geological Survey, Alaska Science Center, Anchorage, Alaska, United States of America,*

[2]*United States Geological Survey, Geology, Energy & Minerals Science Center, Reston, Virgina, United States of America*

The Colville Foreland Basin of Arctic Alaska is a product of collision of the Jurassic Koyukuk arc and Arctic Alaska continental margin during the assembly of the northern Cordillera of North America. In this study, we synthesize detrital zircon U-Pb (DZ) data from published and ~100 new samples of Colville Foreland Basin Lower Cretaceous strata across the Alaska North Slope. We use mixture modeling to interpret sediment sources from the Brooks Range orogen and arc-related rocks to the south, Russian Chukotka orogen to the west, and rifted continental margin to the north.

Results show that the northward retrograding transgressive system, comprising the Hauterivian Kemik Sandstone and informal pebble shale unit, is dominated by Paleozoic–Neoproterozoic ages interpreted to have been shed southward from the Arctic Alaska rifted margin. To the southwest, Neocomian Okpikruak Formation (Fm.) flysch and mélange record the initial sediment shed northward into the ancestral foredeep. The Okpikruak Fm. was transported northward in allochthons dominated by either Jurassic or Permian–Triassic DZ ages attributed to Angayucham-Koyukuk provenance or Chukotka Triassic clastic strata, respectively. The Aptian–Cenomanian wedgetop facies of the Fortress Mountain Fm., deep-basin facies of the lower Torok Fm., and the northern extent of the Nanushuk-Torok Clinothem (NTC) are dominated by Permian–Early Cretaceous DZ ages that indicate Chukotka provenance. Conversely, the southern ~70–90 km of the NTC are dominated by Paleozoic and older DZ ages that suggest central Brooks Range sediment was sequestered in the proximal foredeep and not broadly distributed to the north. Stratigraphic transects show an upsection decrease of Chukotka sediment and near absence in upper Nanushuk Fm. non-marine topsets. This spatiotemporal transition delineates the northeastward propagation of the foredeep axis during progradation of the NTC. East of the Nanushuk ultimate shelf margin, sand-rich terminal lowstand deposits reflect central Brooks Range provenance and are overlain by a sediment-starved interval in the eastern foredeep. The subsequent ~95 Ma transgressive Ninuluk Sandstone marks a return of minor quantities of Chukotka sediment, possibly indicating that transgressive systems both rework older strata and efficiently mix shelfal sediment. Ongoing DZ work in the Colville Basin will explore provenance shifts in younger Upper Cretaceous–Cenozoic clinothems and wedgetop basin development.

Subsurface constraints on Paleozoic deformation in Arctic Alaska and the adjacent offshore region

C. Connors[1,2], R. Lease[3], J. Dumoulin[3], W. McClelland[4], J. Strauss[5], W. Craddock[2], D. Houseknecht[2]
[1]*Washington and Lee University, Earth and Environmental Geoscience, Lexington, United States of America,* [2]*U.S. Geological Survey, Reston, United States of America,* [3]*U.S. Geological Survey, Anchorage, United States of America,* [4]*University of Iowa, Iowa City, United States of America,* [5]*Dartmouth College, Hanover, United States of America*

We present regional reflection seismic interpretation and multifaceted analyses from well cores and cuttings that provide new constraints on Paleozoic deformation in Arctic Alaska and the adjacent offshore region. Seismic interpretation shows that in Arctic Alaska and the Beaufort Sea shelf pre-Mississippian strata are imbricated in widespread east-west-trending fold-and-thrust belts. A belt of south-directed structures underlies the North Slope east of the Colville River, the western Beaufort Sea shelf, and nearshore Point Barrow (Nuvuk) area. West of the Colville River, in the central National Petroleum Reserve in Alaska (NPR-A), north-directed contractional structures predominate. A complex superposed zone marks the boundary between these different structural belts.

Detrital zircon (DZ) U/Pb LA-ICP-MS age spectra in pre-Mississippian strata from 20 wells on the North Slope and Beaufort shelf, along with associated petrography, define distinct domains that correspond with these different major structural transport directions. Quartz- and feldspar-rich sandstones with Proterozoic DZ ages are present in south-directed belts, whereas chert-rich sandstones dominated by Silurian–Devonian maximum depositional ages (MDAs) are present in the north-directed belts, suggesting differences in provenance. A third domain of potentially mixed signature corresponds to the boundary between the belts. CA-TIMS analysis on young zircon from selected wells shows the estimated MDA from carefully filtered LA-ICP-MS datasets are robust.

Though south-directed belts were active and deeply exhumed in the Devonian, constraints provided by seismic interpretation of growth strata and unconformities indicate that the north-directed belts were both active in the Devonian and reactivated in the Mississippian and probably Pennsylvanian. Farther north in NPR-A, this north-directed thrust belt impinged on older south-directed structures, likely in Pennsylvanian–Permian time. The north-directed belt in part overlaps spatially with an area of Mississippian–Permian zircon fission track central ages in older Paleozoic strata. Contrary to prior assumptions, late Paleozoic crustal extension on the North Slope is limited. This is in contrast to previously documented Mississippian extension in the Chukchi Sea shelf that reactivated pre-Mississippian east-directed thrusts.

Evidence for Middle–Late Devonian assembly of the Arctic Alaska terrane, northeastern Brooks Range, Alaska

G. Geier[1], A. Lockett[2], S. Sehra[3], E. Kroeger[4], W. McClelland[5], C. Connors[6], J. Crowley[7], J. Strauss[1]
[1]*Dartmouth College, Department of Earth Sciences, Hanover, NH, United States of America,* [2]*WSP, Earth and Environment Pacific Northwest, Redmond, WA, United States of America,* [3]*Massachusetts Institute of Technology, Department of Earth, Atmospheric, and Planetary Sciences, Cambridge, MA, United States of America,* [4]*Clemson University, Department of Environmental Engineering and Earth Sciences, Anderson, SC, United States of America,* [5]*University of Iowa, Department of Earth and Environmental Sciences, Iowa City, IA, United States of America,* [6]*Washington and Lee University, Department of Earth and Environmental Geoscience, Lexington, VA, United States of America,* [7]*Boise State University, Department of Geosciences, Boise, ID, United States of America*

Middle Paleozoic strata of the Arctic Alaska terrane record tectonic events that profoundly shaped the northwestern margin of North America. This record is uniquely preserved in rocks exposed in the northeastern Brooks Range of Alaska, including the Middle–Upper(?) Devonian Ulungarat Formation, the Upper Devonian–Mississippian Endicott Group, and a previously unnamed succession of Middle–Upper Devonian sedimentary, volcanic, and volcaniclastic rocks referred to herein as the Double Mountain Formation. In the first ICAM meeting, Anderson and colleagues (1994) hypothesized that the Ulungarat Formation reflects an abrupt Middle Devonian transition from regional contraction to extension, distinguishing this event from the Ellesmerian orogeny of the adjacent Canadian Arctic Islands and eventually leading to the introduction of the “Romanzof orogeny” of Arctic Alaska. In order to explore this purported discrepancy between Arctic Alaska and the adjacent Laurentian margin, we conducted detailed geologic mapping of the continental divide

region of the northeastern Brooks Range and argue that the proposed rift to passive margin setting of the Ulungarat Formation and overlying Endicott Group is untenable. Within a revised stratigraphic and structural framework, we integrate biostratigraphy, major and trace element geochemistry, and zircon U-Pb geochronology and Hf isotope geochemistry to determine the age, provenance, and tectonic setting of these Middle Devonian–Carboniferous rocks. Our results suggest that this region records multiphase tectonic convergence throughout the Middle to Late Devonian and perhaps even up into the Early Carboniferous, implying that the "Romanzof orogeny" is likely a phase of the more widespread Ellesmerian orogen. This more closely matches the timing of middle Paleozoic orogenesis recorded in the Canadian Arctic Islands and is therefore more consistent with other regional geological relationships preserved along North America's northern margin.

Anderson, A.V., Wallace, W.K., and Mull, C.G., 1994, Depositional record of a major tectonic transition in northern Alaska: Middle Devonian to Mississippian rift-basin margin deposits, upper Kongakut River region, eastern Brooks Range, Alaska, in Thurston, D.K. and Fujita, K., eds., Proceedings of the 1992 International Conference on Arctic Margins: Anchorage, Alaska, U.S. Department of the Interior, Minerals Management Service, Outer Continental Shelf Report MMS 94-0040, p. 71–76.

The Middle Jurassic-Early Cretaceous First Order Sequence of the High Arctic - the Calm before the Storm

S. Olaussen[1], A. Embry[2], S.-A. Grundvåg[3], M. E. Jelby[4], K. Senger[5], M. Smelror[6]

[1]*UNIS, Stavanger, Norway,* [2]*Geological Survey of Canada, Toronto, Canada,*

[3]*UiT The Arctic University of Norway, Department of Geosciences, y,, N-9037 Tromsø,, Norway,*

[4]*University in Bergen, Department of Earth Science, Bergen, Norway,*

[5]*Unis, Longyearbyen, Svalbard, Norway,*

[6]*Norway Geological Survey, Trondheim, Norway*

A Middle Jurassic-Early Cretaceous first-order sequence has been recognized in Svalbard and the Sverdrup Basin and is bound by prominent subaerial unconformities dated as base Bajocian below and base Barremian above. In Svalbard, the sequence is dominated by argillaceous lithologies of marine shelf origin with subordinate sandstone units of Kimmeridgian and Hauterivian age derived most likely from an uplift to the north and west. In the Sverdrup Basin, argillaceous strata are also dominant and include thick Kimmeridgian and Hauterivian sandstone units sourced from shield areas to the south and east. Notably, the boundaries coincide with major tectonic changes in the rift phase of the Amerasia Basin. Rifting was initiated in the latest Triassic whereby the base Bajocian sequence boundary coincides with a marked expansion of rifting. The capping, base Barremian sequence boundary coincides with the end of the rift phase in the Amerasia Basin and the onset start of sea floor spreading emplacement of the High Arctic Large Igneous Province (HALIP). Both Svalbard and the Sverdrup Basin were separated from the evolving Amerasia Basin by uplifted terrains which supplied only small amounts of sediments.

The first-order sequence spans about 45 Myr and encompasses five second-order sequences with sequence boundaries dated to the early – mid Oxfordian, near-base Tithonian, near-base Valanginian and near-base Hauterivian. All the 5 sequence bounding surfaces was tectonically generated and marks changes in the tectonic and depositional regimes of the two basins. The Bajocian-Callovian sequence is characterized by very low subsidence rates and condensed sedimentation. Subsidence and sedimentation rates increased for both the Oxfordian-Kimmeridgian and Tithonian-Berriasian sequences. The highest subsidence and sedimentation rates occurred in the Valanginian and Hauterivian sequences. Deposition of the following Barremian–Albian sequence was characterized by higher subsidence rates accompanied by increased sediment influx of paralic and shallow shelf deposits across the region. Locally, these deposits intercalate with basalts that was sourced from a mantle plume. Extensive basin margin uplift took place during these times, thus marking a dramatic change in tectonic style. Thus, the entire Middle Jurassic – Early Cretaceous first-order sequence in the High Arctic reflects a relatively quiet tectonic interval that can be characterized as 'the calm before the storm'.

Serpukhovian (Early Carboniferous) Rifting in the Sverdrup Basin, Arctic Canada

B. Beauchamp

University of Calgary, Earth, Energy and Environment, Calgary, Canada

The Sverdrup Basin is a successor basin that formed through Carboniferous crustal extension and collapse of the latest Devonian Ellesmerian Orogen. Four episodes of rifting occurred in the Viséan, Serpukhovian, Bashkirian and Early Moscovian. The Serpukhovian episode was by far the most significant: it led to a widespread interconnected network of mostly terrestrial half-grabens, the record of which is preserved in the Borup Fiord Formation on northern Axel Heiberg and northern Ellesmere islands. This unit ranges from zero to >1500 m in thickness over short distances (<10 km), reflecting the tapering geometry of individual grabens. It comprises a complex mosaic of red-weathering conglomerate, sandstone and shale, with subordinate carbonate (limestone and dolostone); evaporite and volcanic rocks also occur locally. Lithofacies assemblages and depositional environments include: i) Meandering river/flood plain clastic, ii) Braided river/alluvial fan clastic, iii) Fan delta breccia, iv) Open marine carbonate, v) Restricted marine carbonate and evaporite, and vi) Terrestrial volcanic flows. The vertical and lateral distribution of these assemblages reflects the shedding of coarse clastic material eroded from hangingwall and footwall highs bordering individual grabens. This material entered the grabens via alluvial fans and braided rivers at high angle to the graben axis where they met a meandering river snaking about within a variably wide flood plain. Marine incursions along the graben axis led to ephemeral open marine conditions, shown by fossil-rich limestone, followed by episodes of desiccation that led to evaporite and microbial dolostone accumulation. Volcanic basaltic flows of continental (within plate) alkali composition were poured into some of the grabens from nearby fissures and volcanoes (cf. Audhild Bay volcanics). The top of the Borup Fiord Formation is a major locally angular unconformity indicating uplift and deep-seated erosion of rotated graben fills occurred prior to the widespread Bashkirian marine transgression that followed. Four higher-order sequences are nested within the Serpukhovian sequence, each interpreted as resulting from episodic tectonic disturbance and quiescence. Seismic profiles on Ellef Ringnes, Melville and Prince Patrick islands indicates the Sverdrup rift system was linked to contemporaneous rift systems in Hannah Trough of the Chukchi Shelf to the west (pre-Alaska rotation) and Svalbard-Barents Sea to the east.

Silurian arc volcanism in northern Axel Heiberg Island, Nunavut, Arctic Canada

L. Beranek[1], V. Pease[2], W. McClelland[3], J. Strauss[4]

[1]*Memorial University of Newfoundland, Department of Earth Sciences, St. John's, Canada,* [2]*Stockholm University, Department of Geological Sciences, Stockholm, Sweden,* [3]*University of Iowa, Department of Earth and Environmental Sciences, Iowa City, United States of America,* [4]*Dartmouth College, Department of Earth Sciences, Hanover, United States of America*

The passive to convergent margin transition along northern Laurentia was driven by a sinistral transform system that promoted Ordovician arc accretion and Silurian-Devonian translation and final collision of the Pearya against the Franklinian basin. A key problem in Canadian Arctic paleogeography includes the uncertain origin of Silurian arc successions, which are notably absent in Pearya but required by ca. 440–420 Ma detrital zircon occurrences in Silurian flysch units exposed along northern Laurentia. In this study, we report new results from the Svartevaeg Formation in northern Axel Heiberg Island to identify Silurian magmatism in Arctic Canada and provide a framework to better understand its relationship to the sinistral transform system.

The Svartevaeg Formation is ~1600 m-thick and mostly consists of lava flows, volcaniclastic rocks, and lithic sandstone units that record >10 Myr of arc-related magmatism. Aphanitic to feldspar porphyry lavas and comagmatic dikes comprise the exposed base of the Svartevaeg Formation. Geochemically they define arc-related, calc-alkaline basaltic andesites with enriched LREE (10x N-MORB) and flat (N-MORB-like) HREE. Sandstone matrix from a monomict volcanic conglomerate interbedded with basal lavas yields Silurian (Llandovery-Wenlock) and Ordovician (Tremadocian-Katian) detrital zircon grains; the Silurian ages are consistent with graptolite and macrofossil collections by the GSC from the 1960s. Svartevaeg Formation turbiditic sandstone units that overlie the basal lavas are dominated by chert, limestone, and volcanic rock fragments and yield a Wenlock detrital zircon U-Pb age peak. The Silurian detrital zircon grains have juvenile Hf isotope compositions that indicate mantle origins for the Svartevaeg lavas with little to no crustal contamination. Ordovician detrital zircon grains have more evolved Hf isotope compositions and imply that an older, pre-Silurian arc system was built on Neoproterozoic juvenile crust. Working hypotheses for the cause of Svartevaeg Formation arc magmatism include: (1) induced nucleation of subduction by continued convergence along northern Laurentia after initial Pearya accretion; and (2) spontaneous nucleation of subduction generated by lithospheric collapse along the sinistral transform system. Ongoing detrital zircon studies are evaluating the provenance of Silurian flysch and resolving the sediment contributions of Svartevaeg Formation, Pearya, and other regions into strike-slip basins.

Field relations and displacement of the Pearya terrane, Ellesmere Island, and its role in the tectonic evolution of the Arctic margin of North America

W. McClelland[1], M. Koch[2], K. Faehnrich[3], K. Kośmińska[4], J. Gilotti[1], J. Strauss[5], L. Beranek[6], M. Colpron[7]

[1]*University of Iowa, Earth & Environmental Sciences, Iowa City, United States of America,* [2]*Syracuse University, Department of Earth and Environmental Sciences, Syracuse, United States of America,* [3]*Adelaide University, Faculty of Sciences, Engineering and Technology, Adelaide, Australia,* [4]*AGH University of Kraków, Faculty of Geology, Geophysics and Environmental Protection, Kraków, Poland,* [5]*Dartmouth College, Department of Earth Sciences, Hanover, United States of America,* [6]*Memorial University of Newfoundland, Department of Earth Sciences, St. John's, Canada,* [7]*Yukon Geological Survey, Whitehorse, Canada*

Tectonic models for the Pearya terrane are largely based on pioneering work by Trettin and his colleagues. Field programs in 2008 and 2017 provided unique opportunities to couple new observations with geochronologic, isotopic, geochemical, and paleontologic data and advance our understanding of the Pearya terrane-Laurentian margin boundary. Ediacaran mafic volcanic rocks of the Yelverton Formation record rifting along the Laurentian margin and onset of deep-water sedimentation on the Franklinian passive margin. This rifting likely generated isolated crustal fragments along the length of the margin, such as the North Slope subterrane of the composite Arctic Alaska terrane. Numerous early Paleozoic strike-slip faults transected the passive margin and disrupted the stratigraphic architecture of the Franklinian basin, while accommodating translation of outboard crustal fragments. Displacement on these faults severely limits stratigraphy-based tectonic models. For example, the Fire Bay assemblage, originally correlated with Laurentian passive margin units, is now best interpreted as a juvenile Ordovician forearc succession juxtaposed with Silurian clastic units deposited in a strike-slip environment. Ordovician arc-related rocks in the Fire Bay and Kulutingwak units and Peary terrane represent different segments of an arc system that collapsed against the Laurentian margin and experienced Silurian and younger translation. Paleozoic displacement of the Pearya terrane is best preserved along the Petersen Bay fault zone. L-S, L>S and L tectonites in the fault zone were largely derived from Tonian orthogneiss of the Pearya terrane to the north and blocks of Ordovician-Silurian igneous and clastic units to the south. The Pearya orthogneiss defines a complex kinematic history of coaxial deformation, non-coaxial deformation about L and triclinic shear. Devonian ductile deformation at amphibolite to upper greenschist facies conditions produced steep planar fabrics and a range of shallow to steep lineations in oblique transpression. Mesozoic(?)–Cenozoic brittle faults developed thick cataclasites, caused vertical-axis block rotations and excised large sections along the Petersen Bay fault. The ductile deformation is consistent with translation and accretion of the Pearya terrane to the Laurentian margin in the Devonian along the Canadian Arctic Transform System (CATS). Younger motion reactivated the structure resulting in a complex history of brittle deformation.

Topical Session 1 – Poster
Evolution & Structure of Crust and Lithosphere in the Arctic

T1-1
Assessing Geothermal Heat Flow in the Arctic

J. Freienstein[1], W. Szwillus[1], M. Zimmer[1], B. Heincke[2], J. Ebbing[1]
[1]*Kiel University, Kiel, Germany,* [2]*GEUS, Copenhagen, Denmark*

This study presents methods to better understand the regional and local variations of geothermal heat flow (GHF) in the Arctic, where the scarcity of observations makes it difficult to assess heat flow. Our approach focuses on continental heat flow.
Data-driven methods (such as machine learning) estimate regional GHF, but isolated observations can have an undue influence on the derived GHF models. For example, using the high heat flow value from the North Greenland Ice Core Project site causes predictions of large heat flow anomalies that are incompatible with geophysical and glaciological constraints.
To determine if the GHF observations align with regional assumptions, we apply statistical analysis based on 1-D steady-state temperature modelling and lithospheric models (LithoREF18, ArcCrust). Discrepancies between observed and modelled GHF often are attributed to local effects or measurement errors, so these observations should be excluded from regional studies. However, the lithospheric models may also introduce inconsistencies. For example, while the lithosphere-asthenosphere boundary (LAB) generally correlates well with large-scale GHF, in some areas (e.g. northern Scandinavia) there are systematic differences suggesting possible issues with the LAB of LithoREF18.
In lithospheric temperature modelling, radiogenic heat production (RHP) plays a crucial role, but it is difficult to constrain. Rock samples from Greenland's coast give us RHP estimates and reveal significant spatial variability. Interpolating these values into interior Greenland is challenging, so we propose to rely on tectonic age units to guide RHP interpolation and GHF modelling. We validate and test this idea using a uniquely dense RHP rock sample data base available for Finland from which we transfer the geostatistical properties to Greenland. A recently proposed subdivision of Greenland into tectonic age units is then used to transfer the information on RHP from the coasts to the interior. Conditional simulation based on the units and statistical parameters of the RHP shows high spatial variability of GHF.
Finally, we explore the impact of 3-D temperature modelling, incorporating topographic information from radar data and ice temperature data from the SMOS (Soil Moisture and Ocean Salinity) satellite data to improve the GHF map.
Since geothermal heat flow is a crucial input parameter for ice sheet dynamics, the resulting consistent model will improve predictions in ice sheet modelling.

T1-2
High Arctic Large Igneous Province sourced from thinspots centred in the Arctic Ocean

C. Tegner[1], C. Schiffer[2], E. L. Brown[1], J. H. Bédard[3], V. Pease[4], N. Stolbov[5], K. Brumley[6], S. E. Grasby[7], K. Piepjohn[8], K. Senger[9], S. Planke[10]
[1]*Aarhus University, Aarhus, Denmark,* [2]*Uppsala University, Uppsala, Sweden,* [3]*Geological Survey of Canada, Québec, Canada,* [4]*Stockholm University, Stockholm, Sweden,* [5]*All-Russian Research Institute for Geology and Mineral Resources of the World Ocean, St, Petersburg, Russian Federation,* [6]*University of Houston, Houston, United States of America,* [7]*Geological Survey of Canada, Calgary, Canada,* [8]*Federal Institute for Geosciences and Natural Resources, Hannover, Germany,* [9]*The University Centre in Svalbard, Longyearbyen, Norway,* [10]*Volcanic Basin Energy Research AS, Oslo, Norway*

Large melt volumes (up to millions of km^3) of large igneous provinces (LIPs) are often ascribed to melting of convecting, asthenospheric mantle below thinned lithosphere (thinspots), but lateral magma transport via crustal dyke and sill complexes means that volcanism can be offset from melt generation. The Cretaceous High Arctic LIP (HALIP) shows a spectacularly widespread magmatic footprint in the form of dykes, sills and flood basalts outcropping in the borderlands of the Arctic Ocean (Russia, Svalbard, Greenland and Canada) and volcanic rocks imaged geophysically below the seafloor (Alpha-Mendeleev Ridge). We combine a geophysical assessment of past lithospheric thickness (depth of the lithosphere-asthenosphere boundary, LAB) with petrological constraints on the melting depths of asthenospheric mantle to identify suitable thinspots corresponding to mantle melting maxima. The LAB depths (Cretaceous times) of the borderlands range from >125 km (Franz Josef Land, Kong Karls Land and Arctic Canada) to >82 km (Western Svalbard, Bennett Island). The shallowest LAB depths identified are 50-60 km (Canada Basin, Chukchi Borderland) whereas c. 80 km is estimated for the Cretaceous LAB of the Alpha-Mendeleev Ridge. In contrast, the geochemical modelling of a large, compiled dataset for HALIP basalts indicates that the tops of the melting regions in the asthenospheric mantle were generally at 45-80 km depth, but may have been as shallow as 27 km. We therefore conclude that most of the HALIP magmas must have formed in thinspots that are today located in the central part of the Arctic Ocean such as the Canada Basin, Chukchi Borderland and perhaps portions of the Alpha-Mendeleev Ridge. This implies that the magmas that formed the HALIP rocks in the borderlands of the Arctic Ocean migrated hundreds of km laterally into the surrounding, thick continental margins via radiating dyke and sill complexes.

T1-3

Sneak peeks into the subseafloor: studying deep-sea hydrothermal systems in the Arctic Ocean

E. Albers, C. R. German

Woods Hole Oceanographic Institution, Department of Geology & Geophysics, Woods Hole, United States of America

The nature of the oceanic crust is thought to be particularly diverse at ultraslow-spreading mid-ocean ridges, due to combined magmatic and tectonic accretion that can produce magmatic crust, cause the uplift of deeper crustal rocks, or mixtures thereof. The structure and composition of the ultraslow-spreading Arctic Ocean crust are particularly poorly understood, especially in the *sub*seafloor, because investigations are complicated by the Arctic's remoteness and the presence of perennial sea ice.
Hydrothermal fluids reacting with rocks along the flow trajectory of their hydrothermal cells absorb chemical characteristics representative of the different lithologies present. To further our understanding of subseafloor geologic processes, we investigated the fluid chemistry of three distinct hydrothermal systems along the Arctic ridges: *Aurora*, *Polaris*, and *Lucky B*. These are the first three vent sites that have been traced to the seafloor in the high Arctic. The *Aurora* hydrothermal field, at the westernmost end of the Gakkel Ridge, is located on basaltic crust at the margin of a magmatically robust area. Black smoker fluids vent at ~370°C among extensive areas of lower-temperature flow. Extraordinarily H_2-rich endmember vent fluids suggest subseafloor serpentinization of ultramafic rocks at this site. The *Polaris* site lies further east at the northernmost limit of the global mid-ocean ridge system, at 87°N, on a basaltic axial volcanic ridge. Buoyant hydrothermal plume samples exhibit elevated H_2 and CH_4 but low Fe and Mn concentrations, indicative of venting of metal-poor (intermediate-temperature?) fluids, following reaction with ultramafic lithologies beneath the seabed. *Lucky B* is a high-temperature black smoker field located on an ultramafic ridge in the Lena Trough, at 81°N. Its non-buoyant plume waters show strong enrichments in H_2 and CH_4, consistent with active serpentinization in the root zone and much higher CH_4/Mn ratios than other ultramafic-influenced black smoker systems. Each of these vent sites fall outside the previously known range of geological diversity in styles of hydrothermal venting, globally. Our results imply the presence of ultramafic lithologies shallow in the subseafloor, i.e., within reach for hydrothermal fluids, even at sites where the seafloor is composed entirely of volcanic products. Yet, all three systems differ from each other, emphasizing the crust's complex structure along the ultraslow-spreading Arctic ridges.

T1-4

Ultraslow accretion of the Arctic crust: clues from basalt and peridotite geochemistry along the Gakkel-Lena Trough ridge system

F. Genske[1], E. Albers[2], E. Hellebrand[3]

[1]*Universität Münster, Institut für Mineralogie, Münster, Germany,* [2]*Woods Hole Oceanographic Institution, Department of Geology and Geophysics, Falmouth, United States of America,* [3]*Utrecht University, Geosciences, GeoLab, Utrecht, Netherlands*

Mid-ocean ridges spreading at ≤20 mm/year represent an ultraslow-spreading endmember of crustal accretion, defining their own class of divergent plate boundary. These ridges are characterized by deep rift valleys, typically exceeding 4 km water depth, and exhibit abundant extensional faulting and isolated focused magmatism. Ultraslow-spreading ridges in general but particularly the ones in the Arctic Ocean, namely the Lena Trough and the Gakkel Ridge, are disproportionately underinvestigated owing to their remoteness and inaccessibility. As a result, processes of crust formation remain poorly understood.

In this contribution, we present a comprehensive compilation of both existing and new geochemical data of mafic and ultramafic rocks sampled along the Gakkel Ridge and Lena Trough and discuss key geochemical observations, also in the light of geophysical data. The longevity and length of the Gakkel-Lena Trough ridge system allow detailed investigations of crustal architecture in time and space. Large-scale along-axis variations in crustal accretion are depicted by chiefly ultramafic seafloor in the Lena Trough, robust magmatism in Gakkel's Western Volcanic Zone, the ~300 km long Sparsely Magmatic Zone in the central Gakkel Ridge, and volcanic seafloor along with distinct volcanic centers in the Eastern Volcanic Zone. The spreading rate, water depth, and geophysical parameters (magnetic anomalies, earthquake patterns) vary between and along these different zones, as do the major and trace element compositions of the mafic and ultramafic lithologies. Each zone shows unique geochemical trends related to varying mantle source composition, melt extraction as well as metasomatic overprint. Combined basalt and peridotite geochemistry suggests that the Arctic mantle is, on average, more depleted in the east than in the west. In contrast, the strongest signals of metasomatic overprinting are observed in the central Gakkel Ridge and the Lena Trough. The overall enrichment of the mantle towards the western part of the spreading system is related to either larger amounts of recycled oceanic lithosphere or remnants of subcontinental material from Svalbard/Greenland.

We show that the dispersal of mantle heterogeneity plays an important role in crust formation, and that spreading dynamics also influence the extraction and emplacement of mantle-derived melts. We integrate our observations into a comprehensive model of ocean crust accretion at ultraslow spreading rates.

T1-5

MCS Evidence of the Fossil Spreading Ridge Characteristic in the Canada Basin, Arctic Ocean

W. Priyanto[1], **B. Coakley**[2], T. Funck[3]

[1]*Univeristy of Alaska, Geophysical Institute, Fairbanks, United States of America,* [2]*University of Alaska, Geophysical Institute, Fairbanks, United States of America,* [3]*Geological Survey of Denmark and Greenland, Department of Geophysics and Sedimentary Basins, Copenhagen, Denmark*

A fossil spreading ridge has been interpreted due to a gravity low and weakly paired magnetic anomalies in the center of the Canada Basin. The magnetic and gravity anomaly maps indicate that the fossil ridge is unsegmented and may best be interpreted as a slow or ultra-slow spreading ridge. This is consistent with the tectonic setting, which is similar to the ultra-slow spreading Gakkel Ridge.

The most accepted theory is that the spreading ridge was responsible for some of 66˚ counterclockwise rotation of Arctic Alaska away from the Canadian Arctic Archipelago. A sonobuoy study shows velocity models and simple structure beneath the Canada Basin and spreading ridge. These 1-D velocity models are consistent with mid-ocean ridge velocity stratification across an approximately 300-km-wide zone in the central basin.

In 2021, we collected 4514 km multichannel seismic reflection (MCS) data and ocean bottom seismometer (OBS) data on board R/V *Sikuliaq* across the Chukchi Borderland and Canada Basin. The OBS data were acquired in two arrays; one in the centre of Canada Basin close to the extinct spreading ridge; the other off the identified oceanic crust. The MCS acquisition used a 200-m-long streamer (32 channels) and two 520 cubic inches GI air guns. We combine the 2021 MCS data with MCS data collected from CCGS *Louis S. St-Laurent* between 2007 and 2011 to compile a basement surface map of the spreading ridge using a 1 km grid spacing. The seismic profiles show a distinct basement low, associated with the gravity low. This basement low, recognized as the fossil spreading axis, has a depth of up to 1 s TWT and is 35 to 50 km wide. The seismic profiles parallel to the fossil spreading ridge display the unbroken basement. The basement map exposes a linear feature as a fossil spreading ridge. The velocity model shows crustal thinning close to the spreading ridge and the velocity model on the lower crust shows a velocity high coincident with extrusive magnetism. The age of the fossil spreading ridge has been widely debated. If the zone of oceanic crust is 300 km across and the existed study mentioned that the fossil spreading ridge developed ~17 Ma, then it will require spreading rate about 1.76 cm/yr. We conclude, based on the understanding of the behavior of the tectonic and magmatic structures, and spreading rates, that the linear feature in the center of the Canada Basin is an ultra-slow spreading ridge.

T1-6

Oceanic Core Complex or not? When bathymetric structures challenge seafloor spreading models

F. Szitkar[1], L. Gernigon[1], A. Lim[2], M. Brönner[1]

[1]*The Geological Survey of Norway, Department of Geophysics, Trondheim, Norway,* [2]*Argeo Survey AS, Hvalstad,, Norway*

We use regional magnetic and local multibeam bathymetric data to investigate the geological nature of a prominent high located off-axis near the junction between the Mohns and the Knipovich ridges, in the Norwegian-Greenland Sea. Given the location of this hill, near the bend marking the junction between these two ultraslow spreading centers and the bathymetric asymmetry on both sides of the ridge, an Oceanic Core Complex, corresponding to the outcropping part of an underlying detachment, was proposed as a possible interpretation. Nevertheless, the magnetization distribution over this hill is compatible with a basaltic environment and magnetic gradients are also identical to those existing in basaltic contexts, pointing towards a similar geology. Finally, a combined plate and magnetic reconstruction reveals that this hill has a conjugate structure and that
regional magnetic anomalies are symmetric. These observations rule out the Oceanic Core Complex hypothesis, as detachment surfaces are often associated with a marked spreading asymmetry. We therefore propose that this protruding bathymetric feature should rather be seen as a basaltic hill and the depth asymmetry likely results from seafloor subsidence triggered by the massive accumulation of sediments from the Bear Island Fan, on the eastern flank of the ridge axis.

T1-7

Seismic velocities reveal tectonic deformation at the southern Nares Strait

M. Schnabel

Federal Institute for Geosciences and Natural Resources, Hannover, Germany

Within hard-rock environments, the seismic reflection method delivers sometimes only poor results due to missing sub-horizontal impedance contrasts. In these cases, the interpretation of the seismic velocity may help to assess the structures in the subsurface. This presentation shows results from a 200 km long seismic line at the norther margin of the Baffin Bay. The transect (profiles BGR10-314 and BGR10-315) is roughly trending N-S along 75°E with a mean water depth of about 500 m. The active length of the seismic recording cable (3600 m) allowed for the identification of refracted phases within the shot gathers. These traveltimes have been converted to seismic velocities by the application of tomography. The resulting model shows an area of high seismic velocity (up to 5.5 km/s near the seafloor) between Makinson Inlet and Steensby Land. Here, previous works have interpreted Proterozoic strata. The undulating shape of the velocity field most probable results from the folded nature of the material. The area of high velocities extends for about 50 km in North-South direction, and is bounded by abrupt transitions, which may relate to faults. North of this belt, sedimentary structures with velocities near the seafloor of around 2.6 and 3.0 km/s are found. South of the belt, the sediments are even slower (around 2.2 and 2.4 km/s), with the Carey Basin showing up as a pronounced low velocity anomaly (velocities below 2.0 km/s).

T1-8

4D tectono-sedimentary evolution of the northeastern Atlantic: a multidisciplinary approach to rifted margins

F. Ammerlaan, G. Peron-Pinvidic

Norwegian University of Science and Technology (NTNU), Department of Geosciences, Trondheim, Norway

Rifted margins architecture and extensional processes shaping it are key to the structural and tectonic evolution of a region. The last two decades, significant steps were undertaken to improve an understanding of these complex tectonic systems. However, knowledge gaps remain regarding the temporal and spatial evolution of the crustal tectonic history, specifically concerning relatively unexplored frontier regions, such as the northeastern Atlantic. In this research, we address these gaps focusing specifically on the North Sea rift and the Møre-Vøring rifted margin, along with their Jan Mayen and East Greenland conjugates.

We present an extensive 4D model of tectono-sedimentary tectonic evolution of the northeastern Atlantic with focus on crustal architecture and depositional thickness analysis. This multi-disciplinary approach allows for integrating diverse datasets and compiling constraints from both geological and geophysical data sources, including depositional record of megasequences, Moho depth and top basement mapping. Specific focus is on the time frame related to major geological events, such as the post-Caledonian orogeny collapse, Permian-Triassic early rifting to Jurassic – Early Cretaceous crustal necking.

This work forms the foundation for building a fragmented tectonic plate model which will be utilised in a deformable tectonic plate model (GPlates) that is planned in the next step. Deformable plate models will enable capturing of inherited structures and internal deformation of the plate and margin segments that will lead to quantification of rift deformation in time and better understanding of tectonic inheritance. Combining deformable plate models with the geological and geophysical constraints from the 4D crustal architecture and thickness analysis, provides an innovative method for characterising the spatial and temporal evolution of rifts and rifted margins. The more realistic crustal context can help constrain basin formation in this sub-Arctic region and can be incorporated into various other disciplines.

T1-9

Velocity structure of the crust beneath the Loki's Castle vent field at the Mohn-Knipovich Ridge Bend

A. Jakovlev[1], V. Schlindwein[1,2], M. Pilot[1,2]

[1]*Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Geophysics, Bremerhaven, Germany,*

[2]*University of Bremen, Faculty of Geosciences, Bremen, Germany*

Loki's Castle high temperature vent field is located on the summit of an Axial volcanic Ridge near the corner point where Mohns Ridge joins the north-trending Knipovich Ridge. A network of eight OBS stations recorded seismicity in 2019-2020 in an area of approximately 10 by 10 km. More than 3500 local earthquakes were detected, selected and localised. In total, more than 50000 P- and S-wave arrivals were manually picked. Here we present models of the P- and S-wave velocity anomalies distribution and the Vp/Vs ratio obtained after a local travel-time tomographic inversion of the Loki's Castle dataset using the LOTOS algorithm. Seismicity observed along a major active fault zone and an area of elevated Vp/Vs ratio, potentially indicating melt are spatially separated. A rooting of the detachment in a melt zone is not obvious. The Vp/Vs ratio model along the cross-rift profile is to some extent consistent with the interpretation of the inversion results of the combined controlled source electromagnetic and magnetotelluric data along the same profile presented in Johansen et al. (2019, Deep electrical imaging of the ultraslow-spreading Mohns Ridge. Nature, 567(7748), 379-383, https://doi.org/10.1038/s41586-019-1010-0). In particular, an anomaly with elevated Vp/Vs values at depths greater than 7 km below sea level, located below the rift axis, coincides with the uplift of the lithosphere-asthenosphere boundary derived from the deep electrical imaging. However, seismicity and thus brittle faulting extend into an area that Johansen et al. propose to have temperatures in excess of 1000°C, far too hot for brittle faulting. The tomographic model shows that the near-surface structure of the rift valley and its flanks is significantly asymmetric, with a pronounced elevated Vp/Vs anomaly on the eastern flank, where the Loki's Castle black smoker is located, and no such anomaly on the western flank. While this is consistent with the asymmetric fluid flow interpreted by Johansen et al., ray paths are strongly bundled in the study area due to clustered seismicity, such that the problem of vertical smearing persists.

T1-10

Is Crockerland a Necessary Concept in the Late Triassic? - YES IT IS!

A. Embry

Retired, Toronto, Canada

Facies studies of Carnian (Late Triassic) strata of the Sverdrup Basin indicated that the main source area was a landmass to the north of the basin. Given the large volume of Carnian sediment and its fine-grained nature, the landmass, named Crockerland, was interpreted to be low lying and extensive. Studies also indicated that it supplied notable sediment to the Sverdrup in the Late Permian, Early Triassic, and Norian (Late Triassic). Detrital zircon analysis revealed that most of the Crockerland-derived, Carnian strata contain zircons no younger than Devonian with Precambrian zircons being dominant. This fit well with a Crockerland source which was interpreted to be covered by Devonian siliciclastics. Importantly, the Carnian strata of the northeastern Sverdrup also contained Carboniferous to Triassic zircons, and the only reasonable source area of such zircons was the northern Urals. Consequently, it was interpreted that rivers, with headwaters in the Urals, flowed across Crockerland to the northeast Sverdrup Basin.

Norwegian researchers recently asked "Is Crockerland a necessary concept in the Triassic?" and their answer was "the Crockerland concept should be abandoned". To support this recommendation, they interpreted that "sediment was transported from the Uralo-Siberian source across the Barents Sea over Svalbard throughout the Late Triassic in a direction trending directly towards where the Sverdrup Basin was located" and "there is no need for" a Crockerland source. The researchers appealed to mass balance estimates of Carnian sediments from the Uralo-Siberian source area to support their interpretation that major amounts of sediment bypassed the Barents area and were transported westward across the Sverdrup Basin.

Their interpretation is falsified by the fact that most of the Carnian sediment of the Sverdrup Basin does not contain zircons younger than Devonian. Furthermore, Carnian strata on Spitsbergen are mainly marine shelf in origin and the interpretation, that the Carnian shallow shelf sands of the NE Sverdrup were transported 500 km down dip from a shallow shelf, is untenable. The only reasonable way to transport sediment from a Uralo-Siberian source to the Sverdrup Basin is across Crockerland and this pathway also satisfies mass balance calculations for the Carnian.

In conclusion, the scientific database solidly supports the concept of Crockerland and readily falsifies the concept of Barents sediment overflow to the Sverdrup in the Carnian.

T1-11

Proterozoic-Paleozoic histories of North Greenland: An update on recent research activities

J. Majka[1,2], C. Schiffer[3], K. Faehnrich[4], G. Geier[5], L. Beranek[6], W. McClelland[7], V. Pease[8], J. V. Strauss[5]

[1]*Uppsala University, Department of Earth Sciences, Uppsala, Sweden,* [2]*AGH University of Krakow, Kraków, Poland,* [3]*Uppsala University, Uppsala, Sweden,* [4]*University of Adelaide, Adelaide, Australia,* [5]*Dartmouth College, Hanover, United States of America,* [6]*Memorial University of Newfoundland, St. John's, Canada,* [7]*The University of Iowa, Iowa City, United States of America,* [8]*Stockholm University, Stockholm, Sweden*

In the spring 2024, we launched the research project titled: "Proterozoic-Paleozoic histories of North Greenland: Pivotal windows for deciphering the High Arctic tectonic puzzle." The project is hosted at Uppsala University and funded by the Swedish Research Council. The main aim of this multi-disciplinary project is to test the hypothesis that a major continental suture exists in North Greenland, recording the middle Paleozoic accretion of an exotic terrane to Laurentia's northern margin. The east-west trending Harder Fjord Fault Zone (HFFZ is a compelling candidate for the location of the hypothesized suture. To the south of the HFFZ, relatively unmetamorphosed Silurian turbidites overlie the Neoproterozoic–Silurian Franklinian passive margin. In contrast, north of the HFFZ, rocks of broadly similar age to the Franklinian margin are highly deformed and metamorphosed to greenschist and amphibolite facies. It is currently unknown if metamorphosed rocks north of the HFFZ are exotic to Laurentia, and if so, what relationship exists between these rocks and other Arctic terranes exposed on adjacent Ellesmere Island and Svalbard.

During the summer of 2024, members of our team joined a research cruise on the Swedish Icebreaker Oden to North Greenland. There, we collected an initial suite of rock samples, primarily from south of the HFFZ, and installed 6 broadband seismometers in a transect crossing the inferred location of the HFFZ. We will revisit the study area in 2025 to collect the deployed seismometers and focus on sampling the succession north of the HFFZ. We will conduct detrital mineral provenance analysis on samples from the Silurian turbidite succession to determine the source of sediments deposited in this synorogenic basin, and to identify any metamorphic signature. Petrochronological and geochemical analysis of rocks north of the HFFZ will help clarify the metamorphic history of this hypothesised displaced terrane and determine the timing of its accretion to Laurentia. Finally, analysis of the recorded earthquake data from the broadband seismometers will reveal the lithospheric structure across the HFFZ, and whether it forms a boundary between different lithospheric blocks. In addition to testing the presence of a displaced crustal fragment in North Greenland, our results will likely yield information about potential Timanian, Ellesmerian, Eurekan, and other tectonic events in North Greenland.

T1-12

Magma-crust interaction and alteration of Eocene dykes from Jameson Land, Greenland.

R. Telson[1], A. Barker[1], M. Bukała[2], K. Kośmińska[3], J. Majka[1,3], K. McCaffrey[4], C. Menzies[4], C. Schiffer[5]
[1]*Uppsala University, Department of Earth Sciences; Minerology, Petrology and Tectonics, Uppsala, Sweden,*
[2]*Andalusian Earth Science Insitute, Granada, Spain,*
[3]*AGH University of Kraków, Department of Mineralogy, Petrography and Geochemistry, Kraków, Poland,*
[4]*Durham University, Department of Earth Sciences, Durham, United Kingdom,*
[5]*Uppsala University, Department of Earth Sciences; Geophysics, Uppsala, Sweden*

The sedimentary sequence in Jameson Land, Greenland, began developing during the Devonian and continued to the late Jurassic, after which it was intruded by basaltic dykes during the Eocene. Coeval flood basalts are observed across East Greenland, notably in the Gieke Plateau and Milne Land Formation. This study investigates ten samples of two basaltic dykes separated by 55 km to determine the effects of hydrothermal alteration and magma-crust interactions during dyke emplacement in the sedimentary Jameson Land Basin. The dykes exhibit varying degrees of alteration, increasing from the core of the dykes toward their contact with the surrounding sedimentary rocks. Primary phases of olivine and pyroxene show distinctive carbonisation textures that increase with the extent of alteration. High values for the Carbonate-Chlorite-Pyrite Index (CCPI) and low Alteration Index (AI) suggest a high degree of calcite-epidote-type hydrothermal alteration, and vesicles are filled with calcite. Careful petrographical observations reveal secondary carbonate minerals of predominantly calcite across the lithological boundaries of sandstones and basalts. Alkali-feldspar and quartz xenocrysts suggest crustal contamination during ascent and emplacement in the upper crust, sampling detrital sandstones lower in the stratigraphy. Contamination also likely occurred in the lower crust, as trace element analyses indicate an enriched mantle source with trace element compositions characteristic of the lower crust. The observed carbonisation and calcite crystallisation suggest hydrothermal fluids were rich in dissolved carbonates, likely sourced from limestone and dolomite-rich sandstone cement in the contact aureole. Furthermore, multigenerational fluid phases evidenced by carbonate-filled vesicles suggest post-emplacement fluid interaction.
The consistency between these two sites suggests that the alteration type and melt evolution recorded from the samples could be extrapolated to fit the greater Jameson Land intrusion complex.

T1-13

3-D electrical conductivity structure of a Miocene-Quaternary volcanic province in NW Svalbard

A. Minakov[1], M. Smirnov[2], D. Varılsuha[3], M. Neukirch[4], K. Senger[5]

[1]*University of Oslo, Department of Geosciences, Oslo, Norway,* [2]*Luleå University of Technology, Department of Civil, Environmental and Natural Resources Engineering, Luleå, Sweden,* [3]*Istanbul Technical University, Istanbul, Turkey,* [4]*Marine Science Institute, Barcelona, Spain,* [5]*The University Centre in Svalbard, Department of Arctic Geology, Longyearbyen, Norway*

The Woodfjorden-Bockfjorden area in northwestern Svalbard hosts thermal springs, extinct Quaternary volcanoes and late Miocene lava flows that overlie an uplifted Devonian sedimentary basin. Here, we present processing results of the first three-dimensional magnetotelluric (MT) survey acquired in this volcanic area in July 2023.

Data were collected with two broadband instruments at 9 sites positioned within the Devonian sedimentary basin, and 3 sites within the Mesoproterozoic basement near the Sverrefjellet volcano covering an area of about 20x20 km. At each site, we obtained on average 20 hr of data with a sampling rate of 20 Hz and, additionally, 2 hr of data with 1 kHz sampling which started at midnight. The MT data processing included transforming time series into the spectral domain and the estimation of the impedance transfer functions using robust regression.

In addition to the 12 MT sites, we used one-second magnetic field data from 3 observatories in Longyearbyen, Ny-Ålesund, and Hornsund. Observatory data improved the quality of the transfer functions significantly for all periods from 10 to 1000 s. The non-stationary processing algorithm in combination with the various observatory data allowed us to retrieve transfer functions for very long periods at more than a 1000 s for many sites.

To obtain the subsurface electrical resistivity distribution in the vicinity of the Quaternary eruptive center, we invert the acquired MT data using two different methods. The well-tested ModEM finite-difference code which, however, has limitations in implementing surface topography and a hybrid finite-element code (DEVA3DMT) which includes the topography and allows including galvanic distortion as inversion parameters. The forward modeling and the comparison of the two methods explore the sensitivity of the model including the effect of bathymetry/topography and effect of galvanic distortion.

The model reveals a pathway of deep magmatic fluids interpreted as an active upper crustal hydrothermal system associated with the Bockfjord volcanic complex. We spatially integrate the MT data with regional cross-sections to decipher the regional significance of the conductivity anomalies. The obtained electrical resistivity model aids the characterization of the Late Cenozoic mantle-derived basaltic volcanism in this area.

T1-14

Crustal heterogeneity onshore central Spitsbergen: insights from new gravity and vintage geophysical data

K. Senger[1], F. Ammerlaan[2], SVALGRAV team

[1]*The University Centre in Svalbard, Department of Arctic Geology, Longyearbyen, Norway,*

[2]*Utrecht University, Utrecht, Netherlands*

Gravity data provide constraints on lateral subsurface density variations and thus provides crucial insights into the geological evolution of the region. Previously, gravity data from the Norwegian Arctic archipelago of Svalbard comprised an onshore regional gravity database with coarse station spacing of 2-20 km, offshore gravity profiles acquired in some fjords, airborne gravity, and satellite altimetry. The sparse regional point-based onshore coverage hampered the direct integration of gravity data with seismic profiles acquired onshore Svalbard in the late 1980s and early 1990s. In April 2022, we acquired gravity data at 260 new stations along seven profiles from western to eastern Spitsbergen, with a cumulative length of 329 km. The profiles were acquired directly along selected seismic profiles and provide much closer station spacing (0.5-2 km) compared to the regional inland grid (2-20 km) acquired in the late 1980s (total number of onshore stations: 1037). Having processed the data, we compare the first-order density trends of our new data with the legacy regional grid. The new gravity data are consistent with the regional data, imaging a gravity low in the western part of the area underlying a foreland basin and a gravity high in the northwestern part of the area likely associated with a basement high or denser basement. We compare the new and vintage gravity using maps and profiles, linked to the known major tectonic features such as major basinal axes and fault zones, as well as other geophysical datasets including seismics and magnetics. We conclude that the new gravity data which is made publicly available in this contribution provides a significant improvement to onshore gravity station coverage (from 1037 to 1297), and is especially useful for constraining seismic interpretation.

T1-15

Provenance of clastic rocks of the Inner Hornsund Trough, Svalbard: Implications for regional correlations and Devonian paleogeography

N. Riccardi[1], A. Chapman[1], O. Anfinson[2], E. Figueroa[2], O. McKeon[2], A. Smyrak-Sikora[3], M. Odlum[4], T. Capaldi[4]

[1]*Macalester College, Geology, Saint Paul, United States of America,* [2]*Sonoma State University, Geology, Rohnert Park, United States of America,* [3]*Norwegian University of Science and Technology, Geoscience, Trondheim, Norway,* [4]*University of California, San Diego, Geosciences Research Division, La Jolla, United States of America*

Late Paleozoic clastic sedimentary rocks in the Inner Hornsund Trough (southern Svalbard) represent an archive of regional tectonic events and are key to accurate paleogeographic reconstructions of the Arctic. To tap this archive, ~600 detrital zircon grains were separated and analyzed from samples of the Marietoppen (Devonian) and Adriabukta (Devonian and/or Carboniferous) formations. Preliminary detrital zircon U-Pb age spectra from both units are similar, with the majority of analyzed grains falling in the 1.0-2.0 Ga range and exhibiting distinct peaks at ca. 1.7, 1.45, 1.1, and 1.9 Ga. Relatively small populations also occur at ca. 2.7 and 3.2 Ga. These ages are comparable to those derived from Neoproterozoic metasedimentary rocks of the Southwestern Basement Province that nonconformably underlie Paleozoic and younger rocks of the Inner Hornsund Trough, as well as the Northwestern Basement Province of more northerly Svalbard. This relationship suggests that studied samples of Marietoppen and Adriabukta formations likely represent reworked locally- and/or regionally-derived material. These results from the Marietoppen and Adriabukta formations are distinct from previously published age spectra from the Andrée Land Basin of northern Svalbard. The zircon ages obtained are also distinct from more distal potential sources in the Arctic (e.g., northern Greenland and the Canadian Arctic). Our new results, though limited, invite two possible interpretations. One explanation is that late Paleozoic strata of the Inner Hornsund Trough and the Andrée Land Basin were geographically separated, perhaps because the Southwest and Northern basement provinces were not yet juxtaposed. Alternatively, each of these basins may have been locally sourced and disconnected from each other, but otherwise in a relative arrangement similar to today.

T1-16

Early Ordovician high-pressure metamorphism on Svalbard: pressure-temperature-time evolution of the Vestgötabreen Complex

K. Kośmińska[1], J. Majka[1,2], W. C. McClelland[3]

[1]*AGH University of Krakow, Faculty of Geology, Geophysics and Environmental Protection, Kraków, Poland,* [2]*Uppsala University, Department of Earth Sciences, Uppsala, Sweden,* [3]*University of Iowa, Department of Earth and Environmental Sciences, Iowa, United States of America*

The Vestgötabreen Complex located in southwestern Svalbard comprises high-pressure low-temperature (HP-LT) metamorphic rocks. The Lower unit includes garnet-bearing schists, phyllites, magnesites and serpentinites, whereas the Upper unit consists of garnet-bearing schists, eclogites, blueschists and metacarbonates. We studied eclogite and blueschist from the Upper unit using geothermobarometry combined with Lu-Hf garnet dating and U-Pb zircon, monazite and allanite dating. Conventional geothermobarometry, QuiG barometry and Zr-in-rutile thermometry constrain three stages of eclogite evolution: M1 (prograde stage, 1.6 ± 0.3 GPa at 460 ± 60 °C), M2 (peak-pressure, 2.3 ± 0.3 GPa at 507 ± 60 °C) and M3 (peak-temperature, 2.1 ± 0.3 GPa at 553 ± 60 °C). U-Pb dating of zircon yielded 482 ± 10 Ma which is interpreted as zircon growth during M1 prograde metamorphism. Monazite could have formed between M2

peak-pressure and M3 peak-temperature conditions at 471 ± 6 Ma. Monazite from blueschist yield the age of prograde metamorphism at 486 ± 6 Ma. Lu-Hf garnet dating suggests a peak-metamorphism age at 471.1 ± 4 Ma under conditions of 2.0 ± 0.03 GPa and 500 ± 30 °C. The age of the exhumation and juxtaposition of the Lower and Upper unit rocks is constrained as the Middle Ordovician (454 ± 6 Ma) using Ar-Ar white mica dating (Barnes et al. 2020). The results provide further evidence for early Ordovician subduction in proximity of the Baltica margin. In addition, this study supports models showing a mixed Baltican and Laurentian provenance of southwestern Svalbard (i.e. Wala et al. 2021).
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T1-17

Thermal conductivity and heat flow modelling of petroleum exploration wells onshore Svalbard

M. H. Nuus[1,2], S. Fuchs[3], A. Smyrak-Sikora[4], T. Kubutat[5], K. Senger[6]
[1]*ETH Zürich, Zürich, Switzerland,*
[2]*The University Centre in Svalbard, Arctic Geology, Longyearbyen, Svalbard and Jan Mayen,*
[3]*GFZ German Research Centre for Geosciences, Potsdam, Germany,*
[4]*Norwegian University of Science and Technology, Trondheim, Norway,*
[5]*TU Bergakademie Freiberg, Freiberg, Germany,*
[6]*University Centre in Svalbard, Arctic Geology, Longyearbyen, Svalbard and Jan Mayen*

Thermal properties such as radiogenic heat production, thermal conductivity and thermal diffusivity are crucial to provide reliable heat flow estimates, with direct implications on, for instance, geothermal exploration. Such parameters can be derived from laboratory analyses on drill core samples or estimated from standard wireline logs. Onshore the Arctic archipelago of Svalbard, geothermal energy is being actively considered as an alternative to the diesel-fueled present-day energy supply. However, reliable thermal conductivity estimates are only available from fully cored research boreholes covering Paleogene to Late Triassic sedimentary succession. Adequate temperatures for geothermal district heating (~80 °C) are only reached at ca. 2 km depth beneath Longyearbyen, Svalbard's largest settlement. At such depths, the thermal properties of the subsurface are unconstrained. In this contribution, we use petroleum exploration boreholes drilled to depths down to 3.3 km onshore Svalbard to derive thermal properties from wireline logs. We focus primarily on the Mid Triassic to Carboniferous succession where such properties are unknown. Our analyses suggest variable thermal conductivity from 0.4 to 4.2 W/mK, controlled largely by lithology. In the shallower subsurface, where fully cored research boreholes are available, we compared the calculated thermal properties with the observed data from these boreholes. We observed similar trends between lithology and the calculated thermal conductivity; however, the calculated values are generally slightly lower than the observed ones. Subsequently, we use the regional thermal properties as input to 1D heat flow modelling of 9 boreholes and a hypothetical deep geothermal exploration borehole beneath Longyearbyen. The calculated heat flow values span from 52 to 125 mW/m2, with the highest values obtained from the Tromsøbreen-II borehole. By calculating thermal properties from wireline logs, we allow for more accurate heat flow models, providing valuable insights into the spatial distribution of heat flow across Svalbard and its thermal state. This work is particularly relevant for potential geothermal exploration and drilling in the Longyearbyen area.

T1-18

Late syn-rift to early post-rift evolution at the western margin of the Inner Hornsund Trough, southwestern Spitsbergen, Norway

A. Dahlin[1,2], K. H. Blinkenberg[3], A. Braathen[2], S. Olaussen[1], K. Senger[1], A. Smyrak-Sikora[4], L. Stemmerik[1,3]

[1]*The University Centre in Svalbard, Arctic Geology Department, Longyearbyen, Norway,* [2]*University of Oslo, Department of Geosciences, Oslo, Norway,* [3]*Geological Survey of Denmark and Greenland, Copenhagen, Denmark,* [4]*Norwegian University of Science and Technology, Department of Geoscience, Trondheim, Norway*

The upper Carboniferous – lower Permian strata on Spitsbergen generally constitute the infills of several north-south trending Carboniferous to early Permian rift basins. Our case study of the Late Palaeozoic Inner Hornsund Trough targets the late syn-rift strata of the Pennsylvanian – lower Permian Treskelodden Formation. This infill represents a mixed siliciclastic-carbonate paralic succession deposited in semi-arid climate when Svalbard was in lower latitudes of ca. 25-30°N. New geological field studies and analysis have improved our insight into the depositional and tectonic evolution, however the importance of glacio-eustatic sea-level changes at this time is challenging to decipher from the tectonic influence.

In this contribution we outline the depositional evolution on a fault block banked to the Sørkapp-Hornsund High and the structural evolution of the Inner Hornsund Fault Zone. Our multidisciplinary study incorporated sedimentary logs, micro-facies analysis, and high-resolution digital outcrop models in addition to data from petroleum exploration boreholes.

We document local scale (<10 km) facies variability, sequence stratigraphy, and evolution of the succession during the late syn-rift stage. Similar to the contemporary rift basins in central Spitsbergen (e.g., the Billefjorden Trough), deposition in the Inner Hornsund Trough was characterized mainly by early siliciclastic input from the adjacent actively uplifting basement high, medial mixed siliciclastic-carbonate sedimentation to fully marine carbonate sedimentation late in the rifting phase. During the transition towards rift termination glacio-eustatic sea-level changes and overall regional flooding became a more prominent forcing factor controlling sedimentation.

We conclude that the internal sediment cyclicity of the succession mainly reflects autogenic processes, particularly the changing rate of sediment input from the source area. On a larger scale, the importance of glacio-eustatic sea-level changes, driven by waxing and waning of ice caps in the southern hemisphere (Gondwana), increased as the rift-related tectonics decreased. The sequence stratigraphic analysis of the upper Carboniferous – lower Permian Treskelodden Formation reveals a considerable hiatus between the lower and upper part of the formation, spanning the Late Pennsylvanian – early Asselian, as well as an erosional angular unconformity to the overlying late Permian strata, spanning the ?early Sakmarian – ?late Asselian.

T1-19

Wide-angle seismic data across the northern Svalbard continental margin

A. Minakov[1], T. Funck[2], J. Meza-Cala[1], J. I. Faleide[1], C. Gaina[1]

[1]*University of Oslo, Department of Geosciences, Oslo, Norway,* [2]*Geological Survey of Denmark and Greenland, Copenhagen, Denmark*

The northern Barents Sea-Svalbard continental margin is a unique laboratory for studying a complex pattern of lithospheric deformation during early Cenozoic continental fragmentation. Recent studies postulated that corridors of exhumed mantle imaged by seismic reflection data in the Nansen Basin were formed in the Eurasia Basin since its inception. Now, new deep seismic data have been acquired to test the existing hypotheses of the margin's geological evolution and to explore the links between the present-day segmentation of the ultraslow Gakkel Ridge and the pre-existing crustal structure of the passive margin.

During GoNorth-2022 expedition, controlled-source wide-angle seismic data were acquired using 24 ocean bottom seismometers operated from the Norwegian research icebreaker Kronprins Haakon. A part of data was acquired in ice-covered water using a remotely operated vehicle. The new deep seismic refraction data provide control on seismic velocities, that combined with seismic reflection, gravity and magnetic data are used to determine the crustal and upper mantle structure of the northern Svalbard continental margin and the character of the continent-ocean transition zone.

T1-20

Geochemistry and geometries of the Wallenbergfjellet intrusions, a case study from the High Arctic Large Igneous Province on Svalbard

A. M. R. Sartell[1,2], C. Beier[1], K. Senger[2], G. E. Shephard[3,4], T. Mosočiová[2,3], K. Mäkinen[5], N. Rodes[2]

[1]*University of Helsinki, Department of Geosciences and Geography, Helsinki, Finland,* [2]*University Centre in Svalbard, Department of Arctic Geology, Longyearbyen, Svalbard and Jan Mayen,* [3]*University of Oslo, Department of Geosciences, Oslo, Norway,* [4]*Australian National University, Research School of Earth Sciences, Canberra, Australia,* [5]*Aalto University, Department of Built Environment, Espoo, Finland*

The High Arctic Large Igneous Province (HALIP) encompasses large-scale volcanism and magmatism emplaced in the circum-Arctic during the Early Cretaceous. In the Svalbard archipelago, the HALIP is formally classified as the Diabasodden Suite, and here the magma was mainly emplaced as sills and dikes.

Wallenbergfjellet, a mountain in central Spitsbergen, was investigated in detail during two weeks in July 2022. The site offers a laterally continuous intrusion (for at least 5 km) with variable geometries, including a 50 m thick main sill and various transgressive segments feeding shallower sills. This study site was chosen to test how large the compositional variation within a HALIP outcrop locality is, specifically to see how many samples are needed to get a representative dataset for an intrusion of this size (ca. 5 x 5 km). On Svalbard, boat-based summer campaigns are most common and because of constraining factors, e.g. weather, wildlife, and limited time, usually only a handful of samples can be collected at each site. At Wallenbergfjellet, over 100 samples were systematically collected, with good coverage both laterally and over the full thickness of the main sill. These samples are used for whole-rock geochemical analysis, to examine in detail the geochemical variability. In addition to traditional geological fieldwork, this igneous complex was documented through the acquisition of high-resolution UAV images to create digital outcrop models (DOMs). The DOMs allow for the geochemical dataset to be visualized three-dimensionally to see where each data point originates from and for a thorough interpretation of the structures within the intrusion.

Here we present the whole-rock geochemical data and DOMs from Wallenbergfjellet, and discuss the compositional variability found within these intrusions.

T1-21

The lithospheric evolution of the Varanger Peninsula, northern Norway - Preliminary results from geophysical and geological studies

C. Schiffer[1], M. Bergsjö[1], R. Callegari[1,2], K. Faehnrich[3], K. Komminaho[4], T. Luhta[5], J. Majka[1,2]

[1]*Uppsala University, Earth Sciences, Uppsala, Sweden,* [2]*AGH University of Krakow, Krakow, Poland,* [3]*University of Adelaide, Adelaide, Australia,* [4]*University of Helsinki, Helsinki, Finland,* [5]*Geological Survey of Finland (GTK), Espoo, Finland*

The Varanger Peninsula in northern Norway is the only part of Scandinavia affected by the Neoproterozoic Timanian Orogen, the main location of which is found in the northwestern Russian Arctic. Furthermore, Timanian-aged events were identified in the Barents Sea, Svalbard, the central Russian Arctic, North Greenland and Ellesmere Island. From 2022 to 2024, Uppsala University conducted three geological-geophysical surveys to the Varanger Peninsula. A broad geological campaign was conducted to establish the provenance of sedimentary units on both sides of the east-west trending Trollfjorden-Komagelva Fault Zone (TKFZ), which separates two different Neoproterozoic to Cambrian successions. The age and geochemical signature of mafic igneous rocks that intruded these strata was also investigated. Finally, 15 broadband seismometers operated for a period of 2 years, forming a north-to-south transect approximately following the Tana river from Karigasniemi in Finland to the Norwegian Barents Sea coast, crossing some major structures and terrane boundaries in the region, including the TKFZ.

The main goal of the project is to characterise the tectonic history of the region, to test whether the TKFZ forms a major crustal-scale suture, separating different terranes and to determine how these terranes were juxtaposed. The seismological data will be used to construct images of the deep lithospheric structure and tectonic contacts. Preliminary results indicate that the TKFZ forms a sub-vertical crustal-scale boundary indicating major strike-slip motion, but also signs for an accretionary component are observed. The major and trace elements geochemistry coupled with ΔNb values on the dolerites from the Varanger Peninsula suggest that they originated from different magmatic sources. The dykes exposed in the southeastern part of the peninsula display an enriched mantle signature (E-MORB), while the dolerite dykes from the northwestern part of Varanger are characterised by a depleted mantle signature (N-MORB). U-Pb zircon geochronology was successfully performed only on the dolerites from the southeastern part of the peninsula. The obtained $^{207}Pb/^{206}Pb$ crystallization ages are c. 325 Ma and c. 332 Ma. Although the northwestern dykes did not yield zircon, field observations (e.g., dykes folded together with Neoproterozoic sediments), and geochemical data suggest an Ediacaran age.

Topical Session 2 – Talks

Digital Arctic

The Value of Mapping the Arctic Ocean Floor: Enhancing Data Availability for Scientific Progress

M. Jakobsson

Stockholm University, Geological Sciences, Stockholm, Sweden

A wide range of marine activities—such as geohazard assessments, habitat characterization, and planning expeditions with associated sampling campaigns—depend on detailed information about seabed depth, morphology, and composition, which is obtained through geophysical and geological mapping. These data are crucial for scientific studies in fields like, for example, marine geology, geophysics, and oceanography. History has shown that making such data accessible to the broader scientific community significantly accelerates progress. However, despite technological advancements in mapping over recent decades, the perennial sea ice in the central Arctic Ocean continues to hinder rapid surveying efforts. Therefore, coordination among the few expeditions undertaken and the availability of acquired mapping data are of utmost importance.

In this talk, I will present the most recent gridded compilation of the International Bathymetric Chart of the Arctic Ocean (IBCAO): Version 5.0, completed in early summer 2024. The IBCAO project was initiated in St. Petersburg, Russia, in 1997, when less than 1% of the central Arctic Ocean had been mapped using echosounders. Today, IBCAO represents a well-established community effort, built on data sharing across scientific and governmental institutions, industry, and other entities involved in bathymetric mapping. The latest Version 5.0 provides a 100 × 100 m grid on a Polar Stereographic projection. Over 25% of the IBCAO region is now mapped by direct measurements, based on a criterion that considers water depth when calculating seafloor coverage from depth soundings. Since 2017, the IBCAO initiative has been supported by the Nippon Foundation-GEBCO Seabed 2030 project, ensuring a long-term commitment to continuously improving the bathymetric compilation as new depth data become available.

This talk will also highlight some mapping results from the GEOEO North of Greenland 2024 Expedition aboard the Swedish Icebreaker Oden, which explored the previously completely uncharted Victoria Fjord in North Greenland and parts of the Lincoln Sea, a region known for the most severe sea-ice conditions in the Arctic Ocean. These newly acquired mapping data provide valuable insights into both the relatively recent glacial history and the long-term geological evolution of the region. The data are now being integrated into the IBCAO database.

A digital geoscience data repository for Arctic reconstructions

C. Gaina[1], A. Minakov[1], P. Gromov[2], NOR-R-AM

[1]University of Oslo, PHAB, Oslo, Norway, [2]University of Oslo, Oslo, Norway

Despite its remoteness and harsh conditions, the natural environment of the northern polar region received increased attention in the last two decades. In recent years considerable effort has been invested by several groups and institutions to make various data and results available online and to use it for science, education and outreach. While a wealth of data can be located and viewed in these databases and data repositories, the scientific community and geoscience educators may benefit from a collection of geological and geophysical data that can be easily visualized in a polar map, analyzed and used for a quick assessment of present-day settings and further for paleogeographic reconstructions in the circum-Arctic region.

A group of scientists from four Arctic countries and their collaborators aimed to consolidate and further develop the Arctic-related common scientific basis and educational programmes under the auspices of the Norwegian Research Council programme INTPART (International Partnerships for Excellent Education, Research and Innovation).The project NOR-R-AM (https://norramarctic.wordpress.com/), established in 2017, focused on assessing the openly available information accumulated at participating institutes. Here we will present the resulting digital Circum-Arctic geodynamics platform that incorporates geological and geophysical data and models, tomographic and kinematic models and paleogeography and paleoclimate indicators in openly accessible formats that are compatible with GPlates, GeomapApp and Google Earth. Examples of how this platform can be used for reconstructing the Arctic's tectonic and paleooceanographic evolution will be part of the presentation.

Svalbox: Digitizing Svalbard through Drone Photogrammetry

T. Mosociova[1,2], N. Rodes[2], P. Betlem[3], A. Smyrak-Sikora[4], A. Sartell[2,5], A. Dahlin[1,2], R. Horota[2], K. Senger[2]

[1]University of Oslo, Department of Geosciences, Oslo, Norway, [2]University Centre in Svalbard, Department of Arctic Geology, Longyearbyen, Norway, [3]Norwegian Geotechnical Institute, Oslo, Norway, [4]Norwegian University of Science and Technology, Department of Geosciences, Trondheim, Norway, [5]University of Helsinki, Department of Geosciences and Geography, Helsinki, Finland

Acquiring data in the High Arctic poses unique challenges due to its harsh weather conditions, remote locations, and logistical constraints. The barren landscapes of the Norwegian Svalbard archipelago (74°N–81°N) offer an extraordinary geological playground with world-class exposures of various geological archives. The Svalbox team, based at the University Centre in Svalbard (UNIS), has been systematically mapping outcrops using drone-based photogrammetry since 2016. The resulting georeferenced digital outcrop models (DOMs) enable year-round geological analysis and improve understanding of outcrops that are otherwise difficult to access. Svalbox (www.svalbox.no) is an open-access repository designed to facilitate research and education through DOMs and photospheres from Svalbard. The growing database at present contains over 230 DOMs, cumulatively covering 114 km of stratigraphy from the Proterozoic to the Cenozoic. By following FAIR principles (Findable, Accessible, Interoperable, Reusable), Svalbox ensures that all metadata, including geological and technical parameters, are available for reuse and reprocessing in addition to the DOMs, Agisoft Metashape projects, and input imagery. Over 20 master's and PhD students have completed theses as part of Svalbox and contributed to Svalbard's digitalization through internships and dedicated field campaigns. Here, we present the extent and achievements of acquisition campaigns completed by the Svalbox team over the past field seasons from 2020 to 2024.

The database is geographically constrained to Svalbard and integrates DOMs and photospheres with other geoscientific datasets, such as geological maps, borehole data, and geophysical surveys. The DOMs and photospheres are favourable for a wide range of geoscientific activities, from pre-fieldwork planning to real-time field observations and post-fieldwork quantitative analysis. At UNIS, Svalbox is integrated into Arctic Geology courses, extending the short physical field season due to the lack of sunlight and long-lasting snow cover through virtual field trips and digital analyses. Students and researchers can study outcrops virtually, and gain an understanding of structures, stratigraphy, and architecture at multiple scales — from centimetre-level details to large-scale regional correlations. This approach not only enhances both field-based education and research but also facilitates improved data sharing and more efficient and sustainable fieldwork.

Topical Session 2– Poster

Digital Arctic

T2-1

Why are Arctic data lacking in EPOS? – Time to act!

H. Lorenz[1], T. Funck[2]

[1]*Uppsala University, Department of Earth Sciences, Uppsala, Sweden,* [2]*Geological Survey of Denmark and Greenland (GEUS), Department of Geophysics and Sedimentary Basins, Copenhagen, Denmark*

The European Plate Observing System (EPOS-ERIC) is the only pan-European research infrastructure for solid Earth sciences. This distributed e-infrastructure provides homogenised data, data products and services that span both national and thematic boundaries. EPOS is an ambassador for FAIR data, Open Access and Research Data Management, and it is the solid Earth sciences partner in the European Open Science Cloud (EOSC). Advancements in solid Earth sciences are highly reliant on accumulated knowledge in both space and time. EPOS fulfils one of the most basic needs of every geoscientist: discovery and access to data of the area of interest, making the infrastructure highly valuable for top level research. A major aim of EPOS is to ensure that homogeneous and consistent transnational data sets exist, are preserved, and are easily accessible for researchers. By providing a framework for efficient, homogeneous, well-documented and quality-assured access to data of very different types, EPOS simplifies the process for researchers to combine information from very different fields and across national boundaries.

Data and data services available through EPOS are developed and provided by thematic expert communities, the Thematic Core Services (TCS), presently consisting of the TCSs Seismology, Near-Fault Observatories, GNSS Data and Products, Volcano Observations, Satellite Data, Geomagnetic Observations, Anthropogenic Hazards, Geological Information and Modelling, Multi-Scale Laboratories and Tsunami. Communities for built environment data, gravity data and active source seismic data are presently under formation. This bottom-up approach encourages but also requires direct involvement of the research community in building the content of EPOS. Thus, both thematic and geographical gaps occur where support by the research community is lacking. The high Arctic is still a barren region in existing EPOS data services, and dedicated data services for the Arctic area do not exist. Scientists working in the high Arctic are missing out on the unique chance of both sharing their data and getting credit for it, and of discovering and integrating existing information for new research. This presentation aims to initiate the discussion on how to best utilise EPOS for high Arctic research, initially by contributing relevant thematic content.

T2-2

A new magnetic compilation of Greenland from airborne and satellite data

B. Heincke[1], W. Szwillus[2], J. Freienstein[2], A. Wansing[2], **J. Ebbing**[2]

[1]*GEUS, Copenhagen, Denmark,* [2]*Kiel University, Geosciences, Kiel, Germany*

In remote, inaccessible Artic regions such as Greenland, magnetic compilations are considered as an essential source for obtaining information about the lithospheric structure and are relevant for various geological applications such as understanding the tectonic history, plate reconstruction and regional geological mapping. Particularly on the ice sheet, magnetic is the geophysical method with the densest data coverage and is key important for mapping geological domains and major lineaments under the ice and linking them with outcropping geology in the coastal areas
Since the last magnetic compilation covering all of Greenland in 2011, a significant number of new aeromagnetic surveys have become available as well as new magnetic satellite models. In general, earlier compilations were created by using conventional methodologies where magnetic grids from aeromagnetic datasets were simply merged and long-wavelength components from satellite data were included through simple Fourier-transform based filtering.
Here, we present a new compilation, where an approach was used that combines equivalent source modelling and spherical harmonic expansion to properly integrate datasets with variable data quality and survey

parameters such that the final compilations are presented with an optimal and flexible resolution. This means that resolution is automatically adapted to the variable data coverage and e.g.,magnetic anomalies in the densely surveyed coastal regions of South and West Greenland are presented in great detail.
The total magnetic intensity anomaly map presented here comprises southern and north-eastern Greenland and is a preliminary version of a larger compilation that will be gradually extended to cover entire Greenland including the ice sheet and adjacent shelf regions.

T2-3

ESA Climate Change Initiative (CCI) – Permafrost time series WebGIS maps as Essential Climate Variable products primarily derived from satellite measurement

A. Haas[1], B. Heim[2], A. Bartsch[3], A. Walter[1], M. Wieczorek[2], G. Grosse[2,4], F. M. Seifert[5]

[1]*Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Computing and Data Centre, Bremerhaven, Germany,* [2]*Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Polar Terrestrial Environmental Systems, Potsdam, Germany,* [3]*b.geos, Wien, Austria,* [4]*Earth and Environmental Science Institute, University of Potsdam, Potsdam, Germany,* [5]*ESA, ESRIN, Italy*

GIS server and desktop GIS technology support scientific work at all levels, from data collections and processing to data management and data visualisation. Here we present how the development and publication of a scalable WebGIS supports the ESA DUE Globpermafrost (2016-2018) and the follow-on ESA CCI+ Permafrost I (2018-2021) and II (2022-2025).
Within GlobPermafrost a wide range of experimental remote sensing products were processed: Landsat multispectral index trends, Arctic land cover, lake ice grounding, surface deformation, and rock glacier velocities. According to the ECVs required by the Global Climate Observing System (GCOS) the main products were global permafrost temperature, Active Layer Thickness and permafrost probability maps produced by a TTOP model forced by satellite derived surface temperature and snow. CCI+ Permafrost continued with enhanced modelling based on the community CryoGrid permafrost model producing mean annual ground temperature MAGT per depth down to 10 m, Active Layer Thickness (ALT), and Permafrost Probability and Extent (PEX) per pixel.
To make resulting data products accessible via visualisation, several WebGIS projects e.g. 'Arctic' WebGIS visualising circum-artic products, as well as small-scale regional WebGIS projects like 'Alps', 'Andes' or 'Central Asia' that visualise e. g. higher spatial resolution products like rock glacier movements have been made publicly available using WebGIS technology within maps@awi (http://maps.awi.de), a highly scalable data visualisation unit within AWI's data workflow framework O2A (from Observation to Archive). GIS services have been created and designed using ArcGIS Pro and finally published as Web Map Services (WMS), an internationally standardized format (Open Geospatial Consortium (OGC)), using ArcGIS Server. The project-specific data WMS as well as a resolution-specific background map WMS are embedded into a GIS viewer application based on Leaflet, an open-source JavaScript library.
The CCI+ Permafrost Time Series WebGIS provides circumpolar MAGT, PEX, and ALT for 1997-2021 as a time slider visualization in annual resolution. Beside remote sensing and model-derived data products, the locations of the GCOS ground-monitoring networks of the permafrost community, the Global Terrestrial Network for Permafrost (GTN-P) managed by the International Permafrost Association (IPA) were add as feature layer. ESA CCI+ data products are DOI-registered and archived in the ESA CEDA data archive.

T2-4

Validation in ESA CCI+ Permafrost - Compilation of a permafrost temperature data collection using international and national permafrost monitoring networks

B. Heim[1], M. Wieczorek[1], A. Irrgang[2], S. Lisovski[1], H. Matthes[3], G. Grosse[2], A. Haas[4], K. Elger[5], S. Westermann[6], C. Pellet[7], R. Delaloye[7], F. Miesner[2], A. Bartsch[8]

[1]*Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meereswissenschaften, Polare Terrestrische Umweltsysteme, Potsdam, Germany,* [2]*Alfred-Wegener-Instit Helmholtz-Zentrum für Polar- und Meereswissenschaften, Permafrost, Potsdam, Germany,* [3]*Alfred-Wegener-Instit Helmholtz-Zentrum für Polar- und Meereswissenschaften, Physik der Atmosphäre, Potsdam, Germany,* [4]*Alfred-Wegener-Instit Helmholtz-Zentrum für Polar- und Meereswissenschaften, Rechenzentrum, Bremerhafen, Germany,* [5]*GFZ German Research Centre for Geosciences, Potsdam, Germany, GFZ Data Services, Potsdam, Germany,* [6]*University of Oslo, Department of Geosciences, Oslo, Norway,* [7]*University of Fribourg, PERMOS, Fribourg, Switzerland,* [8]*b.geos, Korneuburg, Austria*

Special emphasis in the Climate Change Initiative (CCI) programme of the European Space Agency (ESA) is placed on validation of the CCI Essential Climate Variable (ECV) products using in situ data from international and national monitoring networks in cooperation with the involved communities. Permafrost_cci (phase I 2018-2021, phase II 2022-2025) is producing circumpolar time series from 1997 to 2021 of annually circum-Arctic permafrost maps on mean annual ground temperature (MAGT) at different depths down to 10 m, Active Layer Thickness (ALT) and Permafrost Probability within the permafrost extent (PEX). We describe here the data compilation and standardisation for the collection of the validation data set for Permafrost_cci MAGT products and the assessment.

We compiled a new circum-Arctic collection on ground temperature temporal records from the main communities' (permafrost, meteorology) pre-existing in situ ground temperature records. Like this, we could assemble ground temperature within a wide range of depths from shallow measurements mainly from the Global Terrestrial Network for Permafrost (GTN-P) managed by the International Permafrost Association (IPA) and also from associated communities such as the NASA ABOVe Program, and from the Russian meteorological measurement program Roshydromet (RHM. Despite they are community efforts, they are not standardised and not ready-to use time-series depth data suitable for validation. We optimised the ground temperature data collections by error-checking, and depth and metadata standardization.

This newly compiled, harmonised data collection of ground temperature depth-time series from 1997 to 2021 is published in the PANGAEA data repository and as an ESA CCI+ Climate Research Data Package (CRDP) providing the first consistent circum-Arctic data collection with standardized measurement depths. It covers all permafrost zones from continuous to discontinuous, sporadic and isolated of the Northern Hemisphere with measurement depths from the surface, a dense coverage of shallow ground depths and also encompassing deeper going permafrost down to 20 m.

T2-5

A Sustainable Spatial Data Infrastructure for the Automated Integration of Distributed Research Data

P. Konopatzky, A. Walter, C. Krämmer, N. Harms, R. Heß, R. Koppe

Alfred Wegener Institute, Computing and Data Centre, Bremerhaven, Germany

The growing demand for discoverable and accessible research data and metadata, driven by FAIR principles and user requirements for data portals, repositories, and search engines, has led to an increasing popularity of interactive, particularly map-based, data exploration. However, aligning technical realities with custom user visions in the design of sustainable services for interactive map viewers remains challenging.

To overcome these challenges, the O2A Spatial framework has been developed, enabling rapid and low-effort deployment and configuration of classic Spatial Data Infrastructure (SDI) components such as storage, databases, geo web servers, and catalogues. Additionally, it facilitates the creation and curation of data products compiled from diverse sources, including the PANGAEA repository, the Observations to Analysis and Archives (O2A) pipeline, Sensor Observation Services, and data provided by scientists directly. Hence, simple metadata harmonisation is offered.

Publicly available Standard Operating Procedures and data exchange specifications guide scientists and institutions in providing their data products as standard-compliant OGC web services, further contributing to their FAIR status.

This modular, scalable, and highly automated SDI has been developed and operated at the Alfred Wegener Institute for over a decade, continuously improving and providing map services for GIS clients and portals, including the Marine Data and Earth Data Portals. Long-term maintainability is ensured through the use of common open-source technologies, established geodata standards, containerization, and extensive automation. The modularity of O2A Spatial and SDI components ensures flexibility and future expandability. Embedded within O2A, development and operation are financially and staff-wise secured in the long term.

T2-6

Surface to subsurface expression of a long-lived structural element: the Billefjorden Fault Zone in Svalbard

A. Smyrak-Sikora[1], K. Senger[2], P. T. Osmundsen[1], J. Janocha[3], T. M. Mosociova[4], F. Ammerlaan[1], M. Bülhoff,[5], R. Horota[2], A. Braathen[4]

[1]*Norwegian University of Science and Technology, Department of Geosciences, Trondheim, Norway,* [2]*The University Centre in Svalbard, Department of Arctic Geology, Longyearbyen, Norway,* [3]*The Arctic University of Norway, Department of Geosciences, Tromsø, Norway,* [4]*University of Oslo, Department of Geosciences, Oslo, Norway,* [5]*University of Innsbruck, Department of Geology, Innsbruck, Austria*

The Billefjorden Fault Zone is a major structural lineament that influence a bedrock of Svalbard over a distance of 200 kilometres. This long-lived structural element shaped the paleo-landscape, uplift and subsidence and routing of sediments of central Spitsbergen since the Devonian. The brittle fabrics are aligned with the metamorphic foliation developed c. 420 Ma within Paleoproterozoic to Mesoproterozoic basement units. The multiple deformation events include: Devonian shortening during the Svalbardian event, Pennsylvanian extension and rifting along with a mild reactivation during Paleogene contraction. The extensive structures allowed for hydrothermal fluids circulation during emplacement of High Arctic Large Igneous Province in the Early Cretaceous.
The detailed architecture of the Billefjorden Fault Zone can be studied in the surface data, such as aerial images and digital outcrop models, accompanied with documentation of depositional settings along and across the individual fault segments. This dataset can be complemented with the subsurface data, including 2D seismic lines, borehole data and potential field data facilitating the establishment of a southward continuation of this lineament. The fault zone exposes a system consisting of two parallel NNW-SSE striking master faults, accompanied by several smaller-scale parallel to oblique faults, the later interpreted as faults breaching relay ramp. The flip-flopped structural evolution during the Late Paleozoic facilitated the reversal in source-to-sink systems geodynamics seen as a change in uplift of source areas for deposits filling accommodation created by downfaulted blocks.
In this study we present the georeferenced three-dimensional architecture of the Billefjorden Fault Zone along an 80 km long segment from Odejfjellet in the north to Flowerdalen in the south. We especially focus on the advanced understanding of fault geometries integrating the mapping on digital outcrop models with interpretation of subsurface data and extensive traditional field work. The results are recorded as an updated geological map of the c. 80 km long transect along the Billefjorden Fault Zone exposures, highlighting recently described faults e.g. Mimerbukta fault. Simultaneously, the subsurface data allow for mapping the fault zone for additional 40 km. We investigate the development and reactivation of individual faults assessing their role in nearly 400 My long evolution of the entire long-lived lineament.

T2-7

Seismic Surveys in the Arctic: Visualization on maps and link to data archive at the Alfred Wegener Institute

E. Weigelt[1], A. Walter[2], N. Selke[3], A. Haas[2]

[1]*Alfred Wegener Institute for Polar and Marine Research, Geophysics, Bremerhaven, Germany,* [2]*Alfred-Wegener Institute for Polar and Marine Research, Data and Computing Centre, Bremerhaven, Germany,* [3]*MARUM, Center for Marine Environmental Sciences, PANGAEA, Bremerhaven, Germany*

Seismic reflection experiments are carried out to image the structure of the subsurface and reconstruct geological or geophysical events such as erosion, modifications in depositional conditions or tectonic. The findings provide constraints on the development of ocean basins, gateways, ridge- and rifts-systems, and how they influenced paleoceanography and natural climate variability on long timescales.
The contribution presents the way in which the Alfred Wegener Institute makes its seismic data visible and accessible, and the difficulties that arise. Aim is to visualize the marine seismic profiles measured to date on maps via track lines and to make the corresponding data accessible to the geoscientific community via the digital library system „PANGAEA" as part of the „Open Access Agreement".

For a first overview the online portal https://marine-data.de presents the location of the acquired seismic reflection lines. By clicking on the profile, it displays meta data as expedition data, contact persons, descriptions of the surveys, and link to the cruise report. JPG-Images are provided for some significant seismic profiles. These maps can be quickly updated after new expeditions to keep the community informed about where data has been collected and where there are still gaps.

In a second step the Marine Data Portal is linked to the data archive "PANGAEA". The data itself can be accessed there within the scope of the "Open Access Agreement". This is what we are still working on. Some of the expedition data are already archived in Pangaea, but as this step is very time-consuming, it will take us some additional time to enter all available seismic data. The Pangaea archive provides the basis for the data to be permanently visible to the scientific community and to be digitally available for future projects. Another major advantage is that the data is assigned a DOI, which is becoming increasingly important for the submission of publications, research proposals and other applications.

Topical Session 3 – Talks

Deep-time Climate Archives & the Impacts on Life and the Environment

The long-term impact of Cretaceous volcanism on the arctic environment.

S. Grasby

Geological Survey of Canada, Calgary, Canada

Ingniryuat, Northwest Territories, Canada, was also named The Smoking Hills by Richardson of the Franklin Expedition due to the ever-present clouds of sulphuric acid smoke produced by the auto-combusting shales exposed along the sea cliffs and river valleys. Similar burning mudstones occur in Yukon, northern Alberta, British Columbia and western Greenland (as recorded in the Viking Sagas). These burning shales where deposited during the Cretaceous Oceanic Anoxic Event's (OAEs) 2 and 3, ~94-84 million years ago, across the arctic region. Metals in the Smoking Hills Formation are enriched over 1000x average shale values. The metal concentrations strongly correlate with the mineral heulandite in the shales, an alteration product of volcanic glass, suggesting an origin related to enhanced volcanic ashfall, then metal draw down under anoxic ocean conditions related to biobloom caused by volcanic fertilisation. Abundant bentonite beds in the Smoking Hills Formation support deposition during active volcanism. This is further consistent with the eruption history of the High Arctic Large Igneous Province to the north, and Cretaceous arc related volcanics to the west. Rare earth element patterns support Arc volcanisms as the main source of metals.
Modern slumping due to permafrost melt initiates combustion and weathering, releasing these metals into

the otherwise modern pristine Arctic environment, generating hyper acidic brines (recording negative pH values) with metal concentrations several orders of magnitude higher than safe drinking levels. Seepage of these acidic and toxic brines into local water ways is negativeli impacting water quality of local river systems, which in some areas becomes unsafe to drink. Results demonstrate that Cretaceous eruptions that dramtically impacted arctic environments in deep time, are still driving widespread deleterious environmental impact today.

Episodic Global Tectonics as the Fundamental Driver of Mass Extinctions: Examples from the Arctic

A. Embry

Retired, Toronto, Canada

The proposed causes of mass extinctions include specific intrinsic factors including major climate change, sea level change, ocean acidification, marine anoxia/euxinia, toxic metals, and ozone damage. Such factors have been tied to the eruption of large igneous provinces. The main extrinsic cause is a large asteroid impact. Stratigraphic studies of the Arctic Phanerozoic succession have documented the occurrence of an unconformity underlying every significant extinction from Cambrian to Miocene. A tectonic origin for the unconformities is reflected in angular relationships and major changes in depositional and tectonic regimes. The associated extinction event occurs within the overlying transgressive systems tract (TST) which records a time of rapid subsidence (collapse phase) that was terminated at the maximum flooding surface (MFS).
The time interval between the start of tectonic uplift which created the unconformity and the termination of rapid subsidence at the MFS has been termed a tectonic episode. Current data indicate that tectonic episodes are less than 2 million years long and are separated by much longer times of relative tectonic quiescence. Many of the tectonic episodes recognized in the Arctic occur in other basins on different continents and consequently they have been referred to as global tectonic episodes (GTEs). The favoured interpretation of the GTEs is that they are the product of episodic changes in the speed and direction of plate movements and consequent changes in stress fields. The intervening, longer intervals of tectonic quiescence represent quasi-equilibrium in the plate tectonic mosaic.
The greatly enhanced tectonic activity of GTEs, especially the significantly increased volcanism during the collapse phase, can drive many life-adverse, environmental changes. Given this, and the 100% correlation between extinctions and GTEs, I suggest that the fundamental driver of significant extinctions is the occurrence of intermittent, short-lived, tectonic episodes that affected the planet in the Phanerozoic. A corollary of this thesis is that notable extinctions are not cyclic but are related to nonlinear dynamics and chaotic behavior associated with plate tectonics. Finally, I would suggest that the end Cretaceous extinction was primarily driven by the environmental effects of a GTE and was greatly enhanced by the effects of a chance occurrence of a large asteroid strike during the environmentally-stressed collapse phase of the GTE.

Volcanic and environmental proxies from the northern Pangean margin across the end-Permian mass extinction: Evidence of pulsed Siberian Traps activity

M. Jones[1,2], A. Rooney[3], V. Zuchuat[4], J. Frieling[5], L. E. Augland[2], A. Sleveland[2], H. Svensen[2], J. I. Faleide[2], H. Turner[6], Ø. Hammer[6], K. Senger[7], P. Betlem[7], A. Sartell[8], S. Planke[2,9]

[1]Umeå University, Ecology and Environmental Science, Umeå, Sweden, [2]University of Oslo, Oslo, Norway, [3]Yale University, New Haven, United States of America, [4]Commonwealth Scientific and Industrial Research Organisation, Kensington, Australia, [5]Oxford University, Oxford, United Kingdom, [6]Natural History Museum, Oslo, Norway, [7]University Centre in Svalbard (UNIS), Longyearbyen, Norway, [8]University of Helsinki, Helsinki, Finland, [9]Volcanic Basin Energy Research (VBER) AS, Oslo, Norway

The End Permian Mass Extinction (EPME; 251.9 Ma) was the largest such event in the Phanerozoic, with more than 80% of marine species and around 75% of terrestrial species wiped out across a short (<100 kyr) time frame. The extinction event is marked by a negative carbon isotope excursion (CIE) that indicates a huge release of isotopically light carbon to the atmosphere. The EPME is coincident with the peak activity of the Siberian Traps large igneous province (LIP), suggesting that magmatic degassing and thermogenic volatiles from contact metamorphism were primary contenders for driving the carbon cycle and environmental changes across the Permian-Triassic boundary. However, the timing and rate of Siberian Traps volcanic activity and magmatism relative to the mass extinction can be better constrained. We investigated four shallow-marine localities from Svalbard and the Barents Sea, which at 250 Ma were part of a semi-enclosed epicontinental sea on the northern margin of the Pangean supercontinent. These sites are in the 'Goldilocks Zone' for volcanic proxies: proximal enough to record volcanic activity but distal enough to not be swamped by the signal. We use mercury (Hg) enrichments along with carbon ($\delta^{13}C$) and osmium ($^{188}Os/^{187}Os$) isotopes to constrain peaks in volcanic and magmatic activity with respect to the environmental disturbances. Our results indicate that the main negative CIE is coincident with elevated volcanic proxies, with fluctuating signals thereafter that are interpreted to reflect pulsed Siberian Traps activity. The large variations in detrital Os isotopes across the EPME further indicate stochastic volcanic activity, with the extreme $^{188}Os/^{187}Os$ shifts potentially indicating that the seaway was partially enclosed so that rapid seawater chemistry changes could be preserved. These results can be directly tied to biomarker and radiometric age constraints for the EMPE to improve the relative and absolute chronologies for both the extinction event and the peak in Siberian Traps activity.

The lipid biomarker record across the Permian/Triassic boundary in Svalbard

S. Z. Buchwald[1], D. Birgel[1], Y. Pei[2], A. Frank[1], M. A. Gómez Correa[1], T. Mosociova[3], K. Senger[4], J. Peckmann[1], W. J. Foster[1]

[1]*University of Hamburg, Department of Earth System Sciences, Hamburg, Germany,* [2]*China University of Geosciences, State Key Laboratory of Biogeology and Environmental Geology, Wuhan, China, People's Republic of,* [3]*University of Oslo, Department of Geosciences, Oslo, Norway,* [4]*The University Centre in Svalbard, Department of Arctic Geology, Longyearbyen, Norway*

The Svalbard archipelago with its nearly continuous Palaeozoic and Mesozoic succession provides a unique opportunity to explore the response of shallow marine, higher-latitude ecosystems to the end-Permian mass extinction on the northern shelf of Pangaea. When extracting molecular fossils (lipid biomarkers) at Lusitaniadalen in central Spitsbergen, we identify a special hydrocarbon inventory in mudstones and siltstones deposited in the extinction aftermath compared to pre-extinction mudstones. Notably, chlorophyll-derived lipid biomarkers, primarily pristane and phytane, accumulated in the extinction aftermath, indicating an extended phytoplankton bloom. Furthermore, we observe a strong increase in the abundance of the enigmatic biomarker C_{33}-*n*-alkylcyclohexane (C_{33}-*n*-ACH) from < 50 µg/g_{TOC} prior to the extinction event to 513.5 µg/g_{TOC} in the extinction aftermath. Similarly, phytanyl toluene is detected exclusively above the extinction horizon with up to 425.4 µg/g_{TOC}. While the source organisms of C_{33}-*n*-ACH and phytanyl toluene remain unidentified, these compounds were likely synthesized by photosynthetic organisms thriving in the post-extinction environment. We can also utilise the biomarker inventory to test the hypothesis that ultrashallow marine anoxia or euxinia caused the extinction event. However, based on the pristane/phytane redox proxy and the absence of biomarkers like isorenieratane that derive from anaerobic microorganisms adapted to sulfidic conditions in the chemocline – as expected in the case of euxinia – we only find short-time occurrences of anoxic conditions in the deepest facies at Lusitaniadalen.

Anoxia – Trigger or Companion of end-Permian shallow marine extinctions?

A. B. Frank[1], S. W. Poulton[2], S. Grasby[3], Y. Xiong[2], V. Zuchuat[4,5], F. Scholz[1], S. Buchwald[1], M. A. Gomez Correa[1], W. Foster[1]

[1]*Universität Hamburg, Institute for Geology, Hamburg, Germany,* [2]*University of Leeds, School of Earth and Environment, Leeds, United Kingdom,* [3]*Geological Survey of Canada – Calgary, Calgary, Canada,* [4]*RWTH Aachen, Geological Institute, Aachen, Germany,* [5]*CSIRO Mineral Resources, Perth, Australia*

The end-Permian mass extinction marks the most catastrophic loss of marine biodiversity during the Phanerozoic. Widespread anoxia, or even euxinia, is commonly suggested as a global driver of the marine extinctions in shallow and deep basins. However, there is increasing evidence for spatial and temporal variability in redox conditions during the Permian-Triassic transition, highlighting the need to not only constrain the extent of anoxic and euxinic conditions, but to also link it back to the timing and evolution of the extinction event. Here, we present iron speciation and redox sensitive element data from shallow marine

sections from the Svalbard archipelago to understand the role oxygen availability played in driving the shallow marine extinction in a higher latitudinal setting. Generally, low Mo enrichments suggest that euxinia did not develop across the basin, which is supported by Fe_{py}/Fe_{T} values generally below 0.6 at the proximal Reinodden section. The redox sensitive elements Cr, V and U show enrichments within the Vardebukta Formation at Reinodden, suggesting deoxygenation, potentially creating anoxic conditions. However, these enrichments developed after the onset of the extinction. Redox sensitive trace metal trends for sections deposited in deeper water further indicate that oxic conditions prevailed when the extinction commenced, suggesting that anoxia did not extend into the shallow marine settings of the Barents Basin. This potentially excludes anoxia as a trigger for the extinctions in Svalbard, highlighting that other climatic changes may have caused the biodiversity loss in this higher latitudinal setting. However, the delayed occurrence of reduced oxygen availability would likely still have contributed to the intensity of the extinction, hindering the onset of recovery.

The first record of ostracods from Svalbard in the aftermath of the end-Permian mass extinction

M. A. Gómez Correa[1], C. Suchau[1], A. Ernst[1], S. Buchwald[1], T. Mosociova[2], V. Zuchuat[3,4], A. Frank[1], K. Senger[5], W. Foster[1]

[1]*Universität Hamburg, Hamburg, Germany,* [2]*University of Oslo, Oslo, Norway,* [3]*CSIRO Mineral Resources, Perth, Australia,* [4]*RWTH Aachen University, Aachen, Germany,* [5]*University Centre in Svalbard, Svalbard, Norway*

The Permian-Triassic climate crisis was characterized by drastic environmental changes, including thermal stress, deoxygenation, and potential ocean acidification, leading to a mass extinction. Ostracods were among the taxa affected by these drastic environmental changes; however, they are one of the most diverse and abundant groups in the fossil record of the Permian-Triassic transition. While previous research has primarily focused on the evidence and effects of this extinction in regions along the Palaeo-Tethys margins—such as the South China Block, Tibet, the Bükk Mountains, the Dolomites, the Taurus Mountains, and the Elbourz Mountains—our study shifts attention to Svalbard, located on the northern shelf of Pangaea. We analyzed fine sandstone layers from the Early Triassic of the Festningen section in western Spitsbergen and found Triassic bryozoan (*Arcticopora* sp.) and the earliest Triassic ostracods in Svalbard (e.g., *Bairdiacypris caeca*, *Paracypris* cf. *gaetanii* and *Cavellina* cf. *rotunda)*. A comparison with previously reported assemblages reveals that the ostracods identified in the Triassic exhibit closer affinities to species from the Permian, equatorial Tethys, particularly those from South China. This evidence suggests the potential migration of ostracods from lower to higher latitudes, indicating that environments between mid-to-high latitudes may have functioned as thermal refugia during the Permian-Triassic climate crisis.

Response of marine organisms to the Permian-Triassic Climate Crisis based on new findings from Spitsbergen, Svalbard

W. J. Foster[1], G. Asatryan[2], S. Rauzi[3], J. Botting[4], S. Buchwald[1], D. Lazarus[2], T. Isson[3], J. Renaudie[2], W. Kiessling[5]

[1]*Universität Hamburg, Department of Earth System Sciences, Hamburg, Germany,* [2]*Museum für Naturkunde, Berlin, Germany,* [3]*University of Wakaito, Hamilton, New Zealand,* [4]*National Museum Wales, Cardiff, United Kingdom,* [5]*Friedrich-Alexander Universität, Erlangen, Germany*

Siliceous marine organisms play a critical role in shaping the Earth's climate system by influencing rates of organic carbon burial and marine authigenic clay formation (i.e., reverse weathering). The ecological demise of silicifying organisms associated with the Permian-Triassic mass extinction is postulated to have prolonged a greenhouse climate during the Early Triassic. Whilst radiolarians experienced their strongest diversity loss in their evolutionary history and perhaps also the greatest population decline of silica-secreting organisms, only a small number of post-extinction localities that record siliceous organisms are known. Here, we report newly discovered latest Changhsingian to early Griesbachian radiolarians and siliceous sponge spicules from Svalbard. This fauna documents the survival of a low-diversity radiolarian assemblage alongside stem-group hexactinellid sponges making this the first described account of post-extinction silica-secreting organisms from the Permian/Triassic boundary in a shallow marine shelf environment and a mid-northern paleolatitudinal setting. Our findings indicate that latitudinal diversity gradients for silica-secreting organisms following the mass extinction were significantly altered, and that silica productivity was restricted to high latitude and deep water thermal refugia. This result has potential to further shape our understanding of changes in marine dissolved silica levels and in turn rates of reverse weathering, with implications for our understanding of carbon cycle dynamics during this interval.

OAE2 carbon cycle dynamics along a deepwater-to-shelf transect across the Arctic Alaska margin

R. Lease[1], M. Jones[2], K. Whidden[3], N. Griffis[3], J. Gooley[1]

[1]*U.S. Geological Survey, Anchorage, United States of America,* [2]*U.S. Geological Survey, Reston, United States of America,* [3]*U.S. Geological Survey, Denver, United States of America*

Oceanic Anoxic Event 2 (OAE2) spanning the Cenomanian-Turonian boundary is characterized by enhanced marine burial of organic carbon (OC) and a global positive carbon isotope excursion (CIE). The high-latitudes have been invoked as a key region for Cretaceous carbon cycling and greenhouse climatic feedbacks, based on amplified spectral power in the obliquity cycle band in lower latitude records and postulated ocean-climate teleconnections. For the newly formed, partially enclosed Arctic Ocean, however, high-resolution empirical data from OAE2 are sparse. Here, we establish an OAE2 stratigraphic framework for a 350-km-long deepwater to shelf transect across the Arctic Alaska margin north of ~75°N paleolatitude.

First, the deepwater Hue Shale records a 7-m-thick OAE2 interval with a 2.5‰ CIE and doubling of total organic carbon (TOC) concentrations at multiple sites. A highly resolved 10 cm (~10 kyr) $\delta^{13}C_{org}$ data series at the Hue Creek outcrop captures a relatively conformable record of OAE2 that preserves the characteristic CIE segments. Preliminary time-domain spectral analyses of TOC data, assuming a linear sedimentation rate based on CIE correlation to well-dated records from the US Western Interior Seaway, exhibit significant spectral peaks (28–50 kyr/cycle) around the short obliquity cycle band, consistent with high-latitude climatic forcing of Arctic marine OC burial.

Second, the shelfal Seabee Formation at the Umiat #1 well is interpreted to record OAE2 in an interval with a four-fold increase in TOC and decrease in carbonate that coincides with late Cenomanian and early Turonian zonal markers of *Inoceramus pictus* and *Mytiloides labiatus*, respectively. Forthcoming $\delta^{13}C_{org}$ will determine whether the CIE occurs over a broad 70 m interval where TOC and Hydrogen Index (HI) values gradually increase and then decrease, or a shorter 27 m interval with maximum 3-6% TOC and 200-500 HI values and abundant fishbone fragments and inoceramids.

Overall, we estimate that OC mass accumulation rates increased by factors of 2 and 4 during OAE2 for Arctic Alaska deepwater and shelf environments, respectively, which when extrapolated to the circum-Arctic may account for one-third of the global excess (above background) OC burial estimated for OAE2. Our results support the theory that high-latitude regions played an outsized role for the Cretaceous carbon cycle with obliquity-paced processes that enhanced primary productivity and preservation of OC in the Arctic Ocean.

A high-resolution stratigraphic record of the Paleocene margin of Arctic Alaska: Implications for regional sequence stratigraphic framework

W. Craddock[1], R. Lease[2], J. Wycech[3], D. Roberts[3], M. Dreier[3], J. Gooley[2]

[1]*U.S. Geological Survey, Reston, VA, United States of America,* [2]*U.S. Geological Survey, Anchorage, AK, United States of America,* [3]*U.S. Geological Survey, Denver, CO, United States of America*

Analysis of sediment cores collected two decades ago from the Lomonosov Ridge, in the central Arctic Ocean, revolutionized understanding of the Paleocene-Eocene hothouse climate and ocean at polar latitudes. However, the Lomonosov Ridge records are stratigraphically incomplete (e.g., total depth is in the uppermost Paleocene interval) and significant potential exists for geological insights from comparable records along contemporaneous Arctic margins. Here, we present a study of the Sagwon Bluffs section located in the central Colville foreland basin, Alaska. Most of the section consists of delta plain strata.
Palynomorphs from the basal and upper part of the outcrop previously have been interpreted to be

Danian (~66–62 Ma) and Selandian-Thanetian (~62–56 Ma), respectively. Furthermore, regional geologists commonly have correlated the unconformity at the top of the outcrop to a ~60 Ma sequence boundary inferred from subsurface data to the northeast, implying no preservation of strata as young as Thanetian (~59–56 Ma). We show maximum depositional ages of tephra beds (zircon U-Pb dates determined via laser ablation-inductively coupled plasma-mass spectrometry) from the lower part of the section that support assignment of a Danian age to the lower strata. High-resolution organic carbon isotope ($\delta^{13}C_{org}$) stratigraphy (bulk organic material determined via continuous flow-isotope ratio mass spectrometry) supports this interpretation and appears to record the late Danian carbon isotope excursion. Notably, a gradual increase in $\delta^{13}C_{org}$ values at the top of the section suggests relatively complete preservation of the Selandian-Thanetian interval and implies that the aforementioned sequence boundary at the top of the section is millions of years younger than previously thought (closer to ~56 Ma). The implied age of the upper sequence boundary is similar to a sequence bounding unconformity that we recently resolved using similar methods, in basal strata at a second locality (Franklin Bluffs), about 40 km to the north, suggesting that the surface may be of regional significance and related to dynamic changes across the Paleocene-Eocene boundary. Our work highlights a need to revisit pre-existing sequence stratigraphic framework interpretations of the Paleogene section of Arctic Alaska with high resolution geochronologic methods, with potential implications for the history of regional and circum-Arctic tectonics, climate, and sea level.

Oligocene-Miocene Glendonites as Paleoclimatic Archives in Arctic Alaska, USA

J. Counts[1], M. Vickers[2], R. Stokes[1], M. Jones[1], S. Bernasconi[3], M. Jaggi[3]

[1]*U.S. Geological Survey, Geology, Energy & Mineral Science Center, Reston, United States of America,*

[2]*Umeå universitet, Department of Ecology and Environmental Science, Umeå, Sweden,*

[3]*ETH Zürich, Department of Earth and Planetary Sciences, Zürich, Switzerland*

On the eastern North Slope of Alaska (USA), Cenozoic uplift of the Marsh Creek anticline resulted in the present-day exposure of marine sediments dated to the Oligocene-Miocene boundary. Because strata of this age are rare on the North American Arctic margin, these deposits provide a unique window into the paleoenvironment and paleoclimate of the arctic of this time, which coincides with a global cooling episode (the Mi1 glaciation) and is characterized by open questions regarding the connectivity between the Arctic and other world oceans. Exceptional preservation of large, well-developed glendonite crystals in certain horizons in the section provide clear evidence of cold-water conditions. Glendonite is a pseudomorph of the mineral ikaite ($CaCO_3 \cdot 6H2O$) that can form radial aggradations of euhedral crystals (usually between 1 – 10 cm across) primarily in low-temperature marine environments. Glendonites reported here are found along with sedimentary structures such as dropstones and tidal bundles, indicating a shelfal to inner-shoreface environment with periodic ice cover. Internal glendonite mineralogy reveals a multi-stage ikaite-to-calcite transformation process, with at least three distinct calcite phases present, each of which is compositionally distinct and contains a unique distribution of microporosity that can potentially entrap fluids and gases, including methane. Identification of early-phase calcite allows for analytical work to exclude later diagenetic phases and focus on those that retain original ikaite isotopic composition, improving our reconstructions of the geochemical environment at the time of glendonite formation just below the sediment-water interface. $\delta^{13}C$ values of glendonite carbonates often show low or highly depleted values, indicating organic and/or methanogenic sources for carbon. Temperature estimates in glendonites derived from $\delta^{18}O$ values are hampered by uncertainties in the isotopic composition of coastal arctic water in the Oligocene-Miocene; however, preliminary quantification of paleotemperatures through clumped-isotope methods (Δ47) yield reasonably cold temperatures of between ~0° and 5° C, similar to modern sea-surface temperatures and potentially demonstrating increased cooling during the Mi1 glaciation. Ongoing work aims to expand and refine the clumped isotope paleothermometry data set to include both glendonites and macrofossils, and to integrate results into late Oligocene-early Miocene regional climate models.

Autochthonous organic carbon supports Arctic nearshore food webs even in degrading permafrost coasts

G. A. Juma[1], H. Grotheer[2], C. Meunier[1], G. Mollenhauer[2], M. Boersma[1]

[1]*Alfred Wegener Institut Helmholtz Zentrum für Polar- und Meeresforschung, Shelf Sea System Ecology, Helgoland, Germany,* [2]*Alfred Wegener Institut Helmholtz Zentrum für Polar- und Meeresforschung, Bremerhaven, Germany*

Arctic permafrost erosion is projected to increase by a factor of 2-3 by 2100. This increase will intensify carbon, nutrients and sediment supply into the nearshore zones. However, it remains understudied how this phenomenon will shift the contribution of marine versus terrestrially derived organic carbon (OC) in the nearshore food web. Here, we quantified the isotopic composition (^{13}C, ^{14}C and ^{15}N) of different pelagic and benthic carbon pools to understand the sources and pathways of OC in the trophic chain. We sampled the nearshore zone, up to 1000 m along a retrogressive thawing slump-affected transect, and along a non-slump-affected transect on Herschel Island, Canadian Arctic. In the pelagic zone, DIC $\delta^{13}C$ and $\Delta^{14}C$ increased with distance from the shore, from -0.75 to 0.01‰ and from -41.70 to -30.49‰ respectively, suggesting that older terrestrial carbon dominated nearshore sampling stations while younger marine carbon dominated the offshore stations. Similarly, POC $\Delta^{14}C$ increased from -501.30 to -404.38‰. In the sediment, the slump-affected transect had lower $\delta^{13}C$ values than its counterpart transect, indicating higher composition of terrestrial material. Surprisingly, the benthos (polychaetes, amphipods and isopods) did not live of this carbon. Overall, the benthos had higher $\delta^{13}C$ values, mean (-23.81±2.08), than pelagic consumers, (capelin, jelly fish and zooplankton), mean (-26.30±2.37‰), suggesting that the benthos highly utilized autochthonous carbon. Using mass balance formula, we estimated that marine sources contribute up to 80% of the organic carbon in the nearshore food web. Our work emphasizes the significance of autochthonous carbon in the nearshore trophic chain, even in the highly degrading Arctic permafrost coasts.

Topical session 3 – Poster

Deep-time Climate Archives & the Impacts on Life and the Environment

T3-2

Arctic glaciation began between 20-34 Ma: Evidence from sediment deposition history of the Eurasian Basin, Arctic Ocean

P. Tan, C. Wang

Second Institute of Oceanography, MNR, China, Hangzhou, China, People's Republic of

The Cenozoic marks a major climate transition from a Greenhouse to an Icehouse, well-documented in Antarctica but less known in the Arctic. By analyzing 31 seismic profiles, we examined sediment deposition in the Eurasian Basin to understand its relationship with climate changes since the Eocene. Before 45 Ma, sedimentation rates were very high, reaching 15-30 cm/kyr. However, after 45 Ma, these rates significantly decreased: in the Amundsen Basin, they dropped to 6 cm/kyr (34-45 Ma), 3.5 cm/kyr (20-34 Ma), and 2 cm/kyr (0-20 Ma), while in the Nansen Basin, they fell to 12 cm/kyr (34-45 Ma) and 5 cm/kyr (0-34 Ma). This widespread decline suggests that climate cooling was the primary factor, although local influences like tectonic uplift and river discharges may have contributed to regional variations. This decline aligns with global climate cooling, indicating Arctic glaciation began between 20-34 Ma, earlier than previously thought, and mirrors Antarctic glaciation.

Ash deposits link Oceanic Anoxic Event 2 to High Arctic volcanism

W. Dummann[1], V. Wennrich[2], C. J. Schröder-Adams[3], N. Leicher[2], J. O. Herrle[1]

[1]*Goethe University Frankfurt, Institute of Geosciences, Frankfurt a.M., Germany,* [2]*University of Cologne, Institute of Geology and Mineralogy, Cologne, Germany,* [3]*Carleton University, Department of Earth Science, Ottawa, Canada*

Oceanic Anoxic Event 2 (OAE 2) is a major environmental perturbation that occurred ~94 million years ago. It is associated with profound changes in global climate and carbon cycling, which are commonly attributed to large-scale carbon release from large igneous province (LIP) volcanism. However, the specific LIP(s) involved and the mechanisms of carbon release remain poorly understood, as indicated by discrepancies between carbon release rates suggested by numerical models and LIP degassing estimates. Our study refines the eruptive history of the High Arctic large igneous province (HALIP) by dating ashfall deposits in marine sediments from the Canadian High Arctic using an integrated stratigraphic approach. Our results show that silicic HALIP volcanism began tens of thousands of years before OAE 2, suggesting a causal link. Volcanic activity coincides with a marked shift in carbon isotope values, linked to the degassing of HALIP magmas and/or thermogenic gas release. We propose that the concurrent activity of two LIPs—the HALIP and the Kerguelen Plateau—could account for the high rates of carbon release inferred for OAE 2, providing a hypothesis for its pervasive environmental impact..

Where are the undiscovered hydrothermal vents in the Arctic Ocean

X. Huang

Chinese Academy of Sciences, Institute of Deep-Sea Science and Engineering, Sanya, China, People's Republic of

Hydrothermal vents are among the most fascinating environments that exist within the modern oceans, being home to highly productive communities of specially-adapted fauna, supported by chemical energy emanating from the Earth's subsurface. They can be found around the world at the junctions of drifting tectonic plates and ultraslow spreading mid-ocean ridges such as Gakkel Ridge. Thin oceanic crust and resulting shallow heat sources can drive hydrothermal fluid circulation and detachment faults can act as fluid pathways, resulting in serpentinization of the oceanic crust. In the decade since, the submersible and other tools have explored three hydrothermal vent fields along the Gakkel Ridge adjacent to the North Pole: Auroa, Polaris, and—most recently, in 2023—Lucky B. The three sites sit within a few hundred kilometers of each other on the 1,800-kilometer-long ridge. The hydrothermal plumes rising nearly 800 meters into the water column, carrying hydrogen and sulfur compounds that fuel unique microbial life. These plumes revealed elevated microbial carbon fixation rates, far exceeding background levels, driven by chemosynthetic bacteria. But there are many hydrothermal fields still to be discovered, perticularly at the east part of the Gakkal ridge, where recent volcanims may exist. This study will review the discovered hydrothermal vents in the Arctic Ocean and discuss the potential locations of the new hydrothermal vent sites and volcanos along the Gakkel Ridge by means of their associated signatures in seafloor geomorphology, temperature, chemical tracers and suspended particulate material as well as using manned submersibles.

Arctic Education & Outreach

Petroleum and whale oil. How to not talk about marine vertebrates

L. Liebe Delsett

University of Oslo, Natural History Museum, Oslo, Norway

A few times in the history of life on Earth have land-living vertebrates transitioned to an aquatic life. The best known among them are today's whales and the marine reptiles of the Mesozoic, such as ichthyosaurs and plesiosaurs. They have always been key inhabitants of marine ecosystems in the north: Marine reptile fossils are known from all parts of the Arctic, and whales are ecosystem engineers and top predators.

These animals are often used in science communication, teaching and the media, but what stories do we use them for? How has this changed? What could they tell?

Whales and marine reptiles are often featured because of their size or new fossil findings or human encounters. They have fossil records that give unique insights into evolutionary adaptations, recovery after mass extinctions and record-breaking body shapes and sizes. However, they are also intimately linked to questions about climate change, biodiversity loss and human consumption. From a Norwegian viewpoint, Jurassic marine reptile fossils originate from the same sedimentological layers as our main export: oil and gas, and the Norwegian involvement in large scale industrial whaling ending only some decades ago, was massive, and led many populations to the brink of extinction.

These linkages are not often explored by scientists communicating marine Arctic history, either in deep time or from recent human history, but might provide opportunities and have been preliminarily explored in some recent projects. Our view on whales has changed dramatically from sea monsters, via a source of income to symbols of biodiversity in museums all over the world, and this could potentially be extended into deep time by using Mesozoic marine reptiles.

In the emerging field of conservation paleobiology, the fossil record is used for understanding and better taking care of present biodiversity. The further away in deep time, the less resolution, and the harder it is to link cause and effect in such a way that it provides meaningful knowledge for conservation measures. This might not however, be a missed opportunity, if our knowledge about marine vertebrates can be used in science communication to start discussions on human relations to life in the oceans and the long history of life on Earth.

Polar Education in Schools in Germany

F. Warringsholz, R. Lehmann

Europa-Universität Flensburg, Interdisziplinäres Institut für Umwelt-, Sozial- und Humanwissenschaften, Flensburg, Germany

Young people are our future. They should be given the best possible education in order to be able to assess and master the challenges ahead. The 21st century will continue to be characterized by numerous transformations and changes that will have a very strong impact on our environment. Climate change in particular will have an impact on the natural environment, but also on society. This makes it all the more important to have sound background knowledge of these changes and the resulting consequences. These are already evident, particularly in the polar regions. Polar Educators Germany of the German Society for Polar Research (DGP) is therefore committed in many ways to involving teachers in the development of new polar teaching materials for use in schools. In a new project entitled Cool Classes in Antarctica (CIA) in collaboration with the Federal Environment Agency, the European University of Flensburg and the Association of Polar Early Career Scientists (APECS) to transfer current research questions, methods and results into student-friendly work materials and make them available online for teachers free of charge on the DGP website so that they can be accessed nationwide and globally.
The areas of geography/geosciences, biology, physics and chemistry are addressed. In addition to the teaching materials, there will be online training courses for teachers. The project will also be widely publicized through

public relations work in the press and social media. The public relations work is intended to draw politicians' attention to the project and the working group with the aim of raising awareness in order to bring about necessary changes in the subject requirements and curricula.
Using examples from the new CIA project, possibilities for cooperation between polar science and the working group will be shown in order to convey scientific findings to the younger generation.

Arctic Tectonics and Volcanism: a multi-scale, multidisciplinary educational approach

K. Senger[1], G. Shephard[2], F. Ammerlaan[3], O. Anfinson[4], P. Audet[5], B. Coakley[6], V. Ershova[7], J. I. Faleide[2], S.-A. Grundvåg[8], R. Horota[9], K. Iyer[10], J. Janocha[8], M. Jones[11], A. Minakov[2], M. Odlum[12], A. Sartell[13], A. Schaeffer[14], D. Stockli[15], M. Vander Kloet[16], C. Gaina[2]

[1]*The University Centre in Svalbard, Department of Arctic Geology, Longyearbyen, Norway,* [2]*University of Oslo, Oslo, Norway,* [3]*Utrecht University, Utrecht, Netherlands,* [4]*Sonoma State University, Sonoma, United States of America,* [5]*University of Ottawa, Ottawa, Canada,* [6]*University of Alaska, Fairbanks, Fairbanks, United States of America,* [7]*St Petersburg State University, St Petersburg, Russian Federation,* [8]*UiT - the Arctic University of Norway, Tromsø, Norway,* [9]*The University Centre in Svalbard, Longyearbyen, Norway,* [10]*Geomodsol, Hamburg, Germany,* [11]*University of Umeå, Umeå, Sweden,* [12]*University of California San Diego, San Diego, United States of America,* [13]*University of Helsinki, Helsinki, Finland,* [14]*National Resources Canada, Sidney, Canada,* [15]*University of Texas, Austin, United States of America,* [16]*University of Bergen, Bergen, Norway*

Geologically, the Arctic is one of the least explored regions of Earth. Obtaining data in the high Arctic is logistically, economically and environmentally expensive, but the township of Longyearbyen (population 2617, as of 2024) at 78°N represents a relatively easily accessible gateway to Arctic geology and is home to The University Centre in Svalbard (UNIS). These unique factors provide a foundation from which to teach and explore Arctic geology via the classroom, the laboratory, and the field. UNIS was founded in 1993 as the Norwegian "field-university", offering field-based courses in Arctic Geology, Geophysics, Biology, and Technology to students from Norway and abroad.

In this contribution we present an international collaboration project 'NOR-R-AM' ("Changes at the Top of the World through Volcanism and Plate Tectonics") which ran from 2017 to 2024. One of the key deliverables of NOR-R-AM was a new graduate course (Masters and PhD level) on Arctic Tectonics and Volcanism that we have established and taught annually at UNIS since 2018 and detail herein. The course's main objective is to decipher the geological evolution of the Arctic from the Devonian (~420 million years ago [Ma]) to present-day through integrating multi-scale data sets and a broad range of geoscientific disciplines. We outline the course itself, before presenting student perspectives based on both an anonymous questionnaire (n = 27) and in-depth perceptions of four selected students. The course, with an annual intake of up to 20 MSc and PhD students, is held over a 6-week period, typically in spring or autumn. The course comprises modules on field and polar safety, Svalbard/Barents Sea geology, wider Arctic geology, plate tectonics, mantle dynamics, geo- and thermochronology, and geochemistry of igneous systems. A field component, which in some years included an overnight expedition, provides an opportunity to appreciate Arctic geology and gather field observations and data. Digital outcrop models and photospheres provide complementary state-of-the-art data visualisation tools in the classroom and facilitate efficient fieldwork through pre-fieldwork preparation and post-field work quantitative analyses. The course assessment is centred on an individual research project that is presented orally and in a short and impactful Geology journal-style article.

Divers for Ocean Temperature (BlueDOT) - Coastal temperature database for monitoring ocean surface water past and present

C. Galerne[1], R. Zitoun[2], A. Kopf[3], A. Schwab[4]
[1]*MARUM Center for Marine Environmental Sciences, Bremen, Germany,*
[2]*GEOMAR Helmholtz Centre for Ocean Research Kiel, Kiel, Germany,*
[3]*MARUM Center for Marine Environmental Science, Bremen, Germany,*
[4]*Schwab Research Technology (SchwaRTech), Achim, Germany*

The BlueDOT is a new citizen science project led by MARUM and GEOMAR, designed to bridge the data-gap in monitoring ocean temperatures. By collecting data from standard dive computers and centralizing it, we provide scientists with valuable insights on ocean warming dynamics in shallow and coastal waters. Our database not only tracks current temperature trends but also allows for the analysis of historical dive data, since dive computers have been widely used in the scuba diving community for safety reasons over the past 30 years. Our database is aiming at a worldwide coverage. While some warm regions are easily covered by recreation divers, arctic areas are more technical and thus largely only accessible to more experience divers who dive for work. Here we want to advertise the BlueDOT citizen science project to this particular community.

Topical session 4 – Poster

Arctic Education & Outreach

T4-1

Arctic Geology research-based field education in Billefjorden, Svalbard, Norway

A. Smyrak-Sikora[1], K. Senger[2], A. Braathen[3], T. Birchall[2], P. Betlem[4], R. Horota[2], S. Olaussen[2], P. T. Osmundsen[1], N. Rodes[2]
[1]*Norwegian University of Science and Technology, Department of Geosciences, Trondheim, Norway,* [2]*The University Centre in Svalbard, Department of Arctic Geology, Longyearbyen, Norway,* [3]*University of Oslo, Department of Geosciences, Oslo, Norway,* [4]*Norwegian Geotechnical Institute, Oslo, Norway*

For decades, the Billefjorden area was a destination for diverse geological education activities and industry excursions. These included multiday fieldwork for bachelor, master and PhD level academic courses led by the University Centre in Svalbard (UNIS), along with summer field schools and day-long field trips. The outstanding world-class exposures and relatively easy access from Longyearbyen allowed for boat and scooter-based transportation of the participants. Accommodation during the field activities included tent camps, trapper huts, local field stations and a hotel in the Russian town of Pyramiden. The field learning was typically organized as a show and tell guided excursions and hands-on fieldwork, with students divided into groups performing data collection, analysis and interpretation which was placed in the overall wider geological context. Learning objectives that were addressed covered a broad geological theme centered on the architecture and evolution of a Carboniferous rift basin, paleo-karst features and long-lived structural lineaments. Overall, the Upper Paleozoic stratigraphy recorded in Billefjorden was used to demonstrate tropical and sub-tropical deposits of coal, gypsum, carbonates and red siliciclastics deposited when Svalbard was located near the equator. Through immersive, hands-on fieldwork combined with utilization of digital resources form Billefjorden, students have engaged directly into sedimentological and structural data collection and following up interpretation. In addition to practicing the traditional field-based skills and analysis of digital resources, the Arctic's harsh conditions taught adaptability and resilience, crucial for aspiring geologists.
In this contribution we share the experiences coming from the last decade of research-based field education performed in Billefjorden as a part of the courses organized at UNIS. We present the learning outcomes and related activities linked with bachelor to PhD level education, outreach and virtual geological trips. We focus on pre-fieldwork introduction, data collection in challenging Arctic conditions and following up post-fieldwork wrap- up, simultaneously highlighting a role of digital resources, notably digital outcrop models and photospheres openly shared via Svalbox.no and VRSvalbard.com, respectively.

T4-2

Online-based Virtual Field Learning: An Interactive Tool for Geoscience Education and Outreach

R. K. Horota[1,2], M. Jonassen[2,3], A. Smyrak-Sikora[4], M. Böhme[1,5], K. Senger[1]

[1]*The University Centre in Svalbard, Arctic Geology, Longyearbyen, Norway,* [2]*University of Bergen, Bergen, Norway,* [3]*The University Centre in Svalbard, Arctic Geophysics, Longyearbyen, Norway,* [4]*Norwegian University of Science and Technology, Department of Geosciences, Trondheim, Norway,* [5]*University of Kiel, Faculty of Mathematics and Natural Sciences, Kiel, Germany*

Geoscience education relies heavily on field experiences, where students engage directly with natural environments to observe and interpret Earth's processes. However, fieldwork is often constrained by logistical challenges, adverse weather, accessibility issues, and high costs, particularly in remote regions like the Arctic. The rising demand for remote learning has driven the development of innovative tools offering virtual alternatives to traditional field-based learning. Cesium, a 3D geospatial platform, provides immersive, interactive virtual field experiences that are accessible to students and educators worldwide.

We have created thematic Virtual Field Guides (VFGs) using Cesium, integrating diverse geospatial data such as digital elevation models (DEMs), satellite imagery, 3D models, and digital outcrop data. These elements can be combined with multimedia resources like photos, videos, text annotations, and 360° panoramic images, creating comprehensive virtual environments. Hosted in the cloud, it makes these datasets easily accessible through web browsers, allowing seamless interaction without specialized software, making it an ideal solution for expanding virtual field learning and also geoscientific outreach.

At the University Centre in Svalbard (UNIS), the VFGs have been integrated into courses as part of the VRSvalbard project. This platform offers open-access virtual tours of key geoscientific sites in the Svalbard archipelago (https://vrsvalbard.com/virtual-field-guide/), enabling students to explore the region's geological structures, glacial landscapes, and tectonic features. Cesium's versatility allows students to interact with terrain and geological structures in new ways, enhancing spatial awareness and engagement. As such, the tool is useful for instance for developing thematic digital excursions to several tectono-thermal events in Svalbard (e.g., Billefjorden Trough, West Spitsbergen Fold and Thrust Belt, Bockfjorden Volcanic Complex).

This presentation will demonstrate how we enhance geoscience education and outreach through using an online data integration platform. We will explore its technical framework, showcase case studies from Svalbard, and discuss how the tool can be applied globally to support geoscience education. The platform addresses key challenges such as accessibility, inclusivity, and cost, while offering a rich, immersive learning experience that complements and extends traditional fieldwork.

T4-3

Building bridges between Polar Science and Society – an example from the German Society of Polar Research

C. Spiegel[1], J. Herrle[2]

[1]*University of Bremen, Department of Geosciences, Bremen, Germany,* [2]*Goethe-University Frankfurt, Institute for Geosciences, Frankfurt am Main, Germany*

The German Society of Polar Research was originally founded more than 90 years ago as a means for knowledge exchange between Polar scientists, similar to many other scholar societies worldwide. Since then it has evolved into an organization mostly dedicated to communication between the different disciplines of Polar Research – be it in Science or in Arts – and between polar enthusiasts from both, academia and outside academia. Another focus is to support young people interested in polar topics, including early-career scientists, but explicitly also undergraduate students and pupils. Our main structures and activities are briefly described in the following:

- Membership is open to everybody, independent from background or nationality; the annual membership fee is affordable (40 Euro for regular members and 20 Euro for students).
- The society includes different working groups (Biology and Ecology of Polar Regions, Geology and Geophysics of Polar Regions, Polar Geodesy and Glaciology, History of Polar Research, Permafrost, Polar Educators, Polar Politics). The working groups usually meet once a year in an informal way, allowing for networking and exchange.

- Every 2 ½ years, the Society organizes a conference meeting for members and non-members. The talks are organized in a way that they should be understandable for people from all disciplines and backgrounds.
- The society intensely cooperates with the German chapter of the Association of Polar Early Career Scientists (APECS). Together with APECS, we organize the bi-monthly online talk series "Polarstunde" ("Polar Hour"). For this, different polar topics of broad interest are presented by a tandem of a senior and an early-career scientist. The talks regularly attract 50 - >100 attendees.
- The Society publishes a journal named "Polarforschung", which is entirely dedicated to knowledge transfer. Contributions can be submitted in German or in English. The journal is open-source and handled by the Copernicus publishing company (www.polarforschung.net).
- We financially support early-career and pre-career polar enthusiasts. This includes funding for conference participations, summer schools, polar field trips etc. Applications involve very little paperwork and are not bound to any deadlines.

For the future, more international cooperation is planned, particularly with similar organizations from Austria and Switzerland. For more information, see www.polarforschung.de.

APECS Germany – Empowering Polar and Alpine Early CareerResearchers

A. Zuhr[1,2]

[1]*Alfred Wegener Institute for Polar and Marine Research, Department of Geosciences, Bremerhaven, Germany,*
[2]*UniversityTübingen, Department of Geophysics, Tübingen, Germany*

The Association of Polar Early Career Scientists (APECS) Germany serves as a vibrant network for early career researchers (ECRs) in the fields of polar, alpine, and cryospheric sciences. As a national committee of the interdisciplinary and global APECS organization, APECS Germany fosters interdisciplinary networking, career development, science communication and outreach as well as inspiring young people about the polar regions. It connects polar enthusiasts in the early career stage with peers, creating a supportive environment for networking and communication.

APECS Germany organizes diverse initiatives, including workshops, webinars, and competitions, focusing on transferable skills, career planning and outreach activities. The group also strengthens Germany's presence in international polar and alpine science by engaging with national institutions and global networks.

Through its efforts, APECS Germany plays a pivotal role in shaping the next generation of polar and alpine researchers, equipping them with the tools and connections to address urgent environmental challenges and contribute to the advancement of cryospheric sciences.

The poster will highlight achievements, projects and plans by APECS Germany and is a place for connecting with fellow ECRs.

Bridging Knowledge Gaps in Arctic Research and Education: Methods from Polar Educators International

S. Weeks, M. P. Casarini, J. Diederich, J. Dooley, M. E. Santo, N. Singh, R. Vijayaraghavan, D. Vural

Scott Polar Research Institute, Polar Educators International, Cambridge, United Kingdom

This presentation highlights the ongoing activities of Polar Educators International (PEI), a global network established during the 2007-08 International Polar Year (IPY). PEI focuses on enhancing education and outreach at the polar-climate nexus and aims to promote greater international collaboration in Arctic research and education in the lead-up to the next IPY (2032-33). Central to PEI's mission is the need for a shift in how Arctic science is communicated, particularly as research priorities evolve and new challenges emerge. The presentation will explore three key PEI initiatives: the 6th International Conference for Polar Educators, the World Cafe style Global Conversation, and the ongoing revision of the IPY Polar Resource Book.

PEI's community of practice is dedicated to bridging gaps between Arctic science and public understanding by using innovative educational methods and resources. These efforts aim to connect scientists and educators working in the Arctic with broader audiences, fostering interdisciplinary collaboration across Earth Sciences, Life Sciences, and Social Sciences. While many scientists are developing outreach materials and tools to communicate their research, a lack of integrated platforms for cross-disciplinary exchange limits the

effectiveness of these efforts. PEI's approach encourages sharing knowledge and skills across these fields to improve the visibility and impact of Arctic research.
PEI's World Cafe style Global Conversation promotes an inclusive approach to Arctic education by fostering dialogue among scientists, educators, and Indigenous communities. This collaborative platform emphasizes the role of Indigenous knowledge in addressing urgent Arctic issues like climate change and biodiversity loss. This presentation will provide an overview of PEI's interdisciplinary methods, focusing on their potential to enhance international cooperation, raise public awareness, and inspire global stewardship of Arctic environments.

Topical Session 5

The Opening of the Arctic Ocean

Comparing and contrasting multiple phases of Arctic Ocean development; insights on tectonics and magmatism from recent numerical modelling approaches including the surface and mantle.

G. Shephard[1,2]

[1]*University of Oslo, Centre for Planetary Habitability, Department of Geosciences, Oslo, Norway,* [2]*Australian National University, Research School of Earth Sciences, Canberra, Australia*

The two major subdivisions of the Arctic Ocean, namely the Amerasia Basin and the Eurasia Basin are often considered separately when investigating their tectonic and magmatic evolution. This is largely driven by their spatial footprint but also their discrete temporal evolutions; older Amerasia Basin opening thought to be dominantly in the Cretaceous or earlier, and younger Eurasia Basin opening largely from the Paleogene. However, there are many common tectono-magmatic processes that have shaped the basins, or sub-regions thereof, and geographically overlapping structures or overprinting events that have affected both basins. The identification and consideration of which may further aid our understanding of their development. Understanding their opening histories, individually and together, not only demands a consideration of extensional tectonics (including rifting, exhumation, seafloor spreading, micro-continent or continental sliver formation), but also compressional events (including subduction and orogenesis) and inheritance from earlier Arctic deformation. Additionally, the link to the deeper convecting mantle including via magmatic and volcanic additions, and interactions with mantle plumes such as the High Arctic Large Igneous Province plume and/or a "Svalbard" plume can be considered. Finally, farther field effects from the interactions of the surrounding major continents and oceans are another avenue of commonality and contrast. Qualitative and quantitative links between the two basins become especially apparent when placing available geological and geophysical constraints into a geodynamic framework in 4-dimensions. Numerical modelling techniques are particularly useful in this endeavour, and can include digital, plate reconstruction models using the software GPlates, and mantle convection models, for example using the finite element code ASPECT. In this invited talk, I will review the opening history of the Eurasia and Amerasia Basins from a tectonic and magmatic perspective, and as built by many decades of discovery and collaborations from the international, Arctic community. I will then present recent advances from numerical models of mantle convection and deformable plate tectonic models. As a discrete example, I will elaborate on a recent modelling paper (Heyn et al., 2023) that could potentially explain the long-lived nature of HALIP, and explore what this means for the opening of Arctic Ocean.

New aeromagnetic and seismological data reveal insights into the transition of Gakkel Ridge to Lena Trough

M. C. Schmidt-Aursch[1], G. Eagles[1], L. Driesch[2], M. Pilot[1], V. Schlindwein[1]
[1]*Alfred-Wegener-Institut, Helmholtz-Zentrum für Polar- und Meeresforschung, Bremerhaven, Germany,*
[2]*Christian-Albrechts-Universität, Kiel, Germany*

The 1800 km long Arctic Gakkel-Ridge (GR) is an ultra-slow spreading ridge. It consists of several segments with different magmatic characteristics. The full spreading rate ranges between 6 mm/yr in the Siberian sea and 13 mm/yr at its western termination. The Western Volcanic Zone (WVZ) is characterised by orthogonal spreading and robust magmatism. It is continued to the South by the Lena Trough (LT), a highly oblique-spreading 300 km long deep. In contrast to the magma-rich WVZ, the Lena Trough shows amagmatic spreading with Peridotites exposed on the sea floor. The transition between GR and LT is marked by a sharp bend and deepening of the central rift valley. The pronounced magnetic spreading anomalies of GR lose their clarity in LT, where more diffuse anomalies dominate. Likewise, seismicity as recorded by the global seismic network shows a marked decrease from an active area at the western end of Gakkel Ridge to an inactive are in northern Lena Trough.

The large hydrothermal Aurora Vent Field is located close to the western end of Gakkel Ridge. It was subject to several research expeditions. Among other things, eight broadband ocean-bottom seismometers (OBS) were deployed around Aurora. They recorded between August 2022 and July 2023 numerous small earthquakes in the region. In July 2023, a helicopter-borne magnetic survey was conducted in this region. Nearly 1400 nm of magnetic lines could be recorded covering the central valley, the rift flanks, and parts of the adjacent basins. Due to the low flight level of 100 m, a high resolution of the magnetic anomalies could be achieved.

The seafloor spreading record in the magnetic anomalies of the GR record divergence of the Eurasia and North America plates over at least the last 11 Myr. Anomalies on the Eurasian side of the ridge, where the bathymetry is shallower and apparently more complicated by the presence of multiple abyssal hills, appear sharper and taller than their North American counterparts. A preliminary analysis of the microseismicity recorded by the OBS network shows that the earthquake activity is mainly concentrated in the area of the positive magnetic anomaly at Aurora mound, following its extent towards the southeast whereas the area of the negative magnetic anomaly in Lena Trough shows clearly reduced, deeper seismicity.

Forlandsundet Graben – a missing piece of puzzle for understanding the water exchange between the Arctic Ocean and Atlantic Ocean in the late Paleogene (Eocene to Oligocene)

K. K. Sliwinska[1], E. Sheldon[1], J. Bojesen-Koefoed[2], S.-A. Grundvåg[3], M. Jones[4], S.-M. Knutsen[5], J. S. Laberg[3], K. Senger[6], M. Weber[3]
[1]*Geological Survey of Denmark and Greenland (GEUS), Geoenergy and storage, Copenhagen, Denmark,*
[2]*Geological Survey of Denmark and Greenland (GEUS), Copenhagen K, Denmark,*
[3]*UIT The Arctic University of Norway, Department of Geosciences, Tromsø, Norway,* [4]*University of Umeå, Department of Ecology and Environmental Science (EMG), Umeå, Sweden,* [5]*Norwegian Offshore Directorate, Harstad, Norway,*
[6]*The University Centre in Svalbard, Longyearbyen, Svalbard and Jan Mayen*

The Fram Strait, located between Svalbard and Northeast Greenland, is today the only deep oceanic passage linking the Arctic and Atlantic Oceans. The water exchange across the Fram Strait plays a key role in the Atlantic Meridional Overturning Circulation, influencing global climate. Increased water exchange between the Arctic and Atlantic Oceans might have been one of the main factors driving global climate into an icehouse state at the Eocene-Oligocene Transition, around 34 million years ago. However, proxy evidence is very scarce due to limited sedimentary archives from the region.
The <20 km-wide Forlandsundet Graben, located on the western Svalbard margin, is one of several pull-apart basins formed when the continental plates hosting Greenland and Svalbard began to diverge in the early Paleogene. The Forlandsundet Graben may represent a precursor to the Fram Strait and may have allowed water exchange earlier than previously thought. However, the thickness and age of the graben fill are poorly constrained. A better stratigraphic framework of its sedimentary succession is therefore crucial for understanding the events leading to the seaway's opening and deep-water connection to the Arctic Ocean.

Vintage seismic data across the graben indicate that the thickness of the sedimentary succession may exceed 4 km. An exploration well (7811/5-1) drilled in 1974 at Sarstangen reached metamorphic basement rocks at 1046 m and penetrated over 1 km of mostly marine mudstones and sandstones, which were initially dated as possibly Eocene and Oligocene.
To improve the stratigraphy and estimate paleo-environments and maturity of the sedimentary succession in the graben, we collected 15 sediment samples from three cored intervals of the 7811/5-1 well (1026.4-1023 m, 912.5-907 m, and 653.4-648.7 m). Combined dinocyst and foraminifera assemblages suggest a middle Eocene age for the lowermost core and an upper Eocene to early Oligocene age for the uppermost core. The foraminifera suggest an outer neritic to upper bathyal water depth of 100-500 m in the Eocene. Pollen and spores are more common than marine dinocysts, and the uppermost core yields coal fragments. TOC values range from 0.57% to 0.89%. The T_{max} values are fairly constant in the range 437 °C to 431 °C. HI values range between 79 and 143. Combined these values suggest overall inert kerogen of mixed origin, classified as type III/IV.

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Provenance insights into the Cretaceous source-to-sink system in the Greater Barents Sea Basin

A. Gilmullina[1], A. Mordasova[2], S.-A. Grundvåg[3], L.-E. Pedersen[1], M. E. Jelby[1], I. Midtkandal[4], T. O. Sømme[5], A. G. Doré[6], C. H. Eide[1]

[1]*University of Bergen, Bergen, Norway,* [2]*Lomonosov Moscow State University, Moscow, Russian Federation,* [3]*UiT the Arctic University of Norway, Tromsø, Norway,* [4]*University of Oslo, Oslo, Norway,* [5]*Equinor ASA, Oslo, Norway,* [6]*Retired, London, United Kingdom*

The several kilometers thick succession of Cretaceous strata on the Norwegian Continental Shelf bears witness to a period characterised by contemporaneous hinterland uplift, basin subsidence and high sedimentation rates. The northern part of the NCS – informally referred to as the Greater Barents Sea Basin (GBSB) – represented an epicontinental sea dominated by mud-dominated clinoforms exhibiting a wide range of progradational directions. Multiple source areas have thus been suggested based on paleocurrent measurements onshore Svalbard, seismic mapping, petrological analyses, as well as limited provenance data. Although the Lower Cretaceous succession has received considerable attention, Upper Cretaceous strata, which is severely eroded across much of the area, is under-explored. Therefore, volumetric calculations and an in-depth understanding of provenance variations for the whole Cretaceous succession of the GBSB are currently lacking.
In this study, we use >3500 2D seismic lines over the area of 1.500.000 km^2 to map Cretaceous sequences from the Eastern and Western Barents Sea and calculate sediment input rates (megatons/year) for eight different seismic units spanning from the Valanginian to the Campanian. We provide new detrital zircon dates from the Lower Cretaceous succession onshore Svalbard. Collectively, this provides insights into sediment volumes, provenance and sediment supply variations during the Cretaceous in the GBSB.
Detrital zircons from Svalbard record a Greenlandic source for the Valanginian to Barremian, a mixed Greenlandic and reworked Triassic sediment source for the Aptian, and finally, a purely reworked Triassic source signal for the Albian. The dramatic increase of sediment supply and detrital zircons with a Greenlandic signature in the Barremian suggest that the hinterland in the northwest of the GBSB was affected by an active igneous province in the northwest, the High Arctic Large Igneous Province (HALIP). The mixed detrital zircon signal and high sediment supply in the Aptian suggest an influence of a newly emerged Triassic source in the north, which may be attributed to catchment reorganization related to the cessation of the HALIP activity. This source became dominant in the Albian and likely remained so until the end of the Cretaceous. Quantitative source-to-sick study like this aims to improve understanding of the effects of the HALIP and the opening of the Canada Basin on the large-scale Cretaceous sedimentary system.

When did the Fram Strait open? U-Pb calcite ages date the rifting process

L. Haaland[1], T. Slagstad[2], P. T. Osmundsen[1], T. Redfield[2]
[1]*Norwegian University of Science and Technology, Department of Geosciences, Trondheim, Norway,*
[2]*Geological Survey of Norway, Trondheim, Norway*

The opening of a deep oceanic gateway between the Arctic and North Atlantic oceans led to a significant change in the global climate. Although much is known about the preceding rifting process between Svalbard and Greenland, the timing of events remains unclear. Onshore the western Svalbard margin, the eastern basin-bounding fault of the Forlandsundet Basin, the Sarsbukta fault, is interpreted to relate to a possibly important regional lineament. As the basin formation likely records the initial phases of crustal thinning, deformation in the basin is interpreted to reflect the early stages of oblique rifting between Svalbard and Greenland. We used U-Pb to date calcites precipitated in fault-related veins along the Sarsbukta fault to assess the evolution of the Forlandsundet Basin. We found a wide range of ages, indicating several phases of fault reactivation. Our oldest sample is Permo-Triassic, indicating that the Sarsbukta fault, and likely the related regional lineament, is a long-lived structure. Eight of our samples range in age from 41-33 Ma, which overlaps with depositional ages of rocks from the Forlandsundet Basin from fossil data. This cluster of ages indicates that the Forlandsundet Basin formed during 41-33 Ma and further suggests that oblique extension between Svalbard and Greenland initiated before the well-established reorganization of spreading ridges in the North Atlantic during Chron 13 (35.5-33.7 Ma). As kinematics recorded in Forlandsundet closely match the direction of extension in the Molloy Deep, we suggest that deformation in Forlandsundet is the precursor to Molloy spreading, and that the regional reorganization of spreading ridges caused a jump in deformation from Forlandsundet to structures to the west. Our youngest calcite sample is 13 Ma, which indicates that faulting was ongoing along the Sarsbukta fault long after basin deposition in Forlandsundet. If we assume that onshore faulting ceases as seafloor spreading initiates, our youngest age of 13 Ma may record the final onshore extension before spreading began along the Molloy Ridge during Chron 5 (19.6-9.8 Ma).

Complex seafloor spreading and crustal structure of the Fram Strait: interpretation from aeromagnetic data

M.-A. Dumais[1], L. Gernigon[1], O. Olesen[1], A. Lim[2], S. E. Johansen[3], M. Brönner[1]
[1]*Geological Survey of Norway, Trondheim, Norway,* [2]*Argeo, Oslo, Norway,*
[3]*Norwegian University of Science and Technology, Trondheim, Norway*

Interest in the polar regions has increased during the last few decades with newer technologies allowing research activities in this hostile environment and permitting investigation of the tectonic and geodynamic history of the North Atlantic and Arctic oceans. In particular, the crustal and lithospheric structure of the Fram Strait and the transition from the Knipovich Ridge to the Barents Sea shelf and Svalbard are still poorly understood. Several multi-geophysical investigations from various campaigns since the 90s along the Western Barents Sea margin and the Northeast Greenland margin resulted in limited and contradicting interpretations of the crust and upper mantle. In this work, we study the spreading of the Knipovich Ridge and the regional tectonic of the Fram Strait and the Svalbard Margin.
A recent aeromagnetic data survey compiled with reprocessed existing aeromagnetic data allowed us to study the complexity of the seafloor spreading history of the Fram Strait region. The high-resolution data identified the magnetic isochrons around the Knipovich Ridge and suggest the presence of several oceanic fracture zones and lineaments in the Fram Strait. The Knipovich ridge spreading initiated at C6 (20 Ma) and a ridge jump occurred at C5E. The crustal domains were consequently delineated and confirmed with the Werner deconvolution and Curie point depth estimation This new survey suggests the relocation of continent-ocean boundary on the east Barents margin up to 150 km farther west compared to previous studies. A 3-D magnetic inversion modelling identified zone with weak magnetization along the rift valley correlated with the absence of volcanic or bathymetric rise evidence. Combined with seismicity data available along the Knipovich Ridge, amagmatic and magmatic accretions show a segmentation of the seafloor spreading that correlates with the variation in magnetization along the rift valley. Furthermore, the new location of the continent-ocean boundary has prompted to revise the existing 2-D seismic interpretations in terms of crustal interpretation and tectonic. This is tested further using joint 2-D gravity and magnetic field modelling and electromagnetic/magneto-telluric (CSEM/MT) data. A wide transition lithospheric domain likely comprising an exhumed lower crust or mantle is delineated from our interpretation.

Exploring the North American segment of the Lomonosov Ridge, Arctic Ocean

Y. Kristoffersen[1], J. K. Hall[2], E. Harris Nilsen[3]
[1] *(retired) University of Bergen, Geoscience, Bergen, Norway,*
[2] *(retired) Geological Survey of Israel, Jerusalem, Israel,* [3] *AKER BP ASA, Oslo, Norway*

The 12 month *Fram-2014/15* ice drift crossed the Lomonosov Ridge between the North Pole and the Ellesmere Island 4½ times with continuous acquisition of good quality seismic reflection data. The main findings are:

- the North American ridge segment was the site of late Mesozoic volcanism over a distance of 600 km with four discrete magmatic pulses suggested to represent HALIP magmatism. This magmatism on the Lomonosov Ridge bridges the continental HALIP volcanism in the Franz Josef Land domain with magmatism in the greater Amerasia Basin;

- the presence of gas pipes on top of the ridge indicates sub-basalt (pre-Late Cret.?) petroleum source rocks matured by the volcanic heat;

- local sediment accumulations (<200 m thick, >35 km wide) within two discrete Eocene stratigraphic levels, are bordering the north end of the southern plateau of the Lomonosov Ridge. This suggests plateau uplift and erosion, here interpreted as a result of northward directed crustal-scale thrusting during Eurekan compressional events stratigraphically dated to the latest Paleocene/early Eocene and later during the middle Eocene.

- during the Eocene, several sediment drifts appeared inboard of the flanks on top of the North American segment as well as near the ACEX drill site. The period of enhanced bottom circulation may have been a result of the connection to the western Siberian seaway.

We consider published model experiments of continental convergence and suggest the asymmetry of the Eurekan Orogeny and the first order fault geometry north of an indenting Greenland plate relate to partial compliance in the western Eurekan domain by large scale N-S folding and arch formation.

The Eurekan Deformation across North Greenland, the Morris Jesup and Yermak plateaus – a multidisciplinary perspective

K. Meier[1], W. Geissler[2], P. Klitzke[3], G. Eagles[2], A. Ruppel[3], N. Koglin[3], L. Reinhardt[3], S. Estrada[4], K. Piepjohn[5]
[1] *University of Bremen, Bremen, Germany,* [2] *Alfred Wegener Institute Helmholtz-Centre for Polar and Marine Research, Bremerhaven, Germany,* [3] *Federal Institute for Geosciences and Natural Resources (BGR), Hannover, Germany,* [4] *retired from Federal Institute for Geosciences and Natural Resources (BGR), present address Thieshof 10, Hannover, Germany,* [5] *retired from Federal Institute for Geosciences and Natural Resources (BGR), present address Jacobistraße 34, Hannover, Germany*

Paleocene/Eocene continental break-up and seafloor spreading involved the northward movement of Greenland and Eurekan deformation across the Arctic realm. The deformation extends for several hundred kilometres across the Canadian Archipelago, North Greenland, as well as Western Svalbard, and is at least partly associated with the reactivation of a large-scale Palaeozoic transform system. While the overarching tectonic framework seems conclusive, there is still much to be understood regarding the onshore-offshore correlation of faults assisting terrane translation, as well as the extent of deformation and volcanism. Published structural data clearly delineate Eurekan deformation across N Greenland and along the West Spitsbergen Fold-and-Thrust Belt. New apatite thermochronology data from N Greenland suggest that differential exhumation and burial of crustal blocks were controlled by major Eurekan fault zones along the NE-SW oriented Wandel Hav Mobile Belt. Further to the west, the latter terminates abruptly at the W-E trending Harder Fjord Fault Zone. New multichannel seismic data from the Morris Jesup Plateau demonstrate that Eurekan transpressional and transtensional deformation continued offshore albeit less pronounced. This suggests either that the locus of deformation may occur even further seaward, or that the Harder Fjord Fault Zone and the Kap Cannon Thrust Zone ultimately played a more significant role in translating Eurekan deformation towards the Canadian Archipelago.

A new regional plate reconstruction provides a context that allows some of these structures to be correlated between N Greenland and the Yermak Plateau on the basis of potential field data. Further analyses and inversion of magnetic data permit the creation of three-dimensional models and facilitate comparison with seismic data, particularly in the area of the Morris Jesup and Yermak plateaus. Seismic reflection data reveal compressional/transpressional features across the Yermak Plateau, Sophia Basin, and the SW Nansen Basin. New petrographic, geochemical, Sr–Nd isotopic, and Ar–Ar geochronological data from rock fragments dredged at the northeastern Yermak Plateau yielded mid-Cretaceous ages and shared geochemical characteristics with similar-aged rocks from Ellesmere Island and N Greenland. This suggests that the northeastern Yermak Plateau is a continental fragment, which together with the conjugate Morris Jesup Spur was formerly a part of the North American plate.

Crustal structure of the North Svalbard Margin

J. C. Meza-Cala[1], J. I. Faleide[2], A. Minakov[2], M. M. Abdelmalak[2], G. E. Shephard[2], W. H. Geissler[3], P. Klitzke[4], C. Gaina[2]

[1]*University of Oslo, Geosciences, Oslo, Norway,* [2]*University of Oslo, Oslo, Norway,* [3]*Alfred Wegener Institute, Bremen, Germany,* [4]*Federal Institute for Geosciences and Natural Resources, Hannover, Germany*

The North Svalbard continental margin is a frontier area that holds important clues to understand the initial opening configuration of the youngest portion of the Arctic Ocean, the Eurasia Basin. In this contribution, we focus on the basin architecture and crustal structure of this margin as inferred from geophysical data. New marine seismic data has become available in the SW Eurasia Basin in the last years, including data acquired by the Norwegian Offshore Directorate in the context of the UN Law of the Sea, seismic lines by Federal Institute for Geosciences and Natural Resources (BGR), Alfred Wegener Institute (AWI), and results of the GoNorth-2022 expedition (collaborative efforts of several Norwegian research institutions and Geological Survey of Denmark and Greenland, GEUS). We perform 2D gravity and magnetic modelling along a series of synthetic crustal transects, constrained by geological observations onshore Svalbard and seismic data offshore. We identify major margin segments characterized by specific geophysical properties expressed in terms of their varying basement structure, nature, and composition. Moreover, we aim to explore the presence of pre-existing structures and their role during breakup and subsequent opening of the Eurasia Basin. Our results provide important constraints for models of Paleogene continental rifting in the Eurasia Basin and for the tectono-magmatic evolution of the Yermak Plateau and Sophia Basin.

A new relative plate motion context for post Santonian development of North Atlantic and Arctic plate boundary zones

G. Eagles[1], J. Adam[2], L. Pérez Díaz[3], W. Geissler[1], P. Klitzke[4], A. Ruppel[4], A. Causer[2]

[1]*Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany,* [2]*Royal Holloway, University of London, Earth Sciences, London, United Kingdom,* [3]*Halliburton, Oxford, United Kingdom,* [4]*Federal Institute for Geosciences and Natural Resources (BGR), Hannover, Germany*

Strain histories in convergent and conservative plate boundary regions may be interpreted from their rocks and crustal architecture but are known to be incomplete for a variety of reasons, some intractable. Divergent boundaries are less affected by these difficulties, and in oceanic crust may even leave a record approaching 100% of relative motion. Taking advantage of this condition, we generate a new model of plate boundary development in the North Atlantic region since 84 Ma, based entirely on divergent relative plate motions recorded in the North Atlantic and Eurasian basins. The inversion technique enables access to an order of magnitude more data from fracture zone crossings than used for any previous model, contributing to quantified uncertainties of a few tens of kilometres at most throughout the model domain. These uncertainties are not only smaller than those based on field-based strain estimates, but crucially are also devoid of the cryptic errors that strongly affect them. The new model's high reliability can be confirmed by its accurate independent prediction of the locations of observed seafloor spreading markers in the Labrador Sea. The model offers a high-resolution context within which to more confidently interpret available geological records of the development of the region's less well-known remote divergent and/or convergent and conservative paleo-plate boundaries. New and refined hypotheses defined in this way include how a length of North American/Greenlandic mid-ocean ridge in Baffin Bay initiated 25 Myr later, and expired 7 Myr earlier,

than its counterpart in the Labrador Sea; how Nares Strait hosted a left lateral transtensional plate boundary in early Paleocene times; how the Eurekan collision evolved via three Paleogene stages, first affecting Ellesmere Island with left lateral transpression, later with orthogonal convergence, and finally right lateral transpression; and how Eocene migration of the Greenland/North America/Eurasia triple junction necessitated southwards jumps of the Greenland/North America and Greenland/Eurasia plate boundaries, causing an evolution from oblique collision to divergence through the Yermak Plateau-Morris Jesup Rise/Spur region, and from transpression to nearly pure strike-slip on the Lomfjorden and Billefjorden fault zones and Spitsbergen's western continental margin.

Exploring the opening of the Amerasia Basin using lithospheric numerical modelling

J. E. Rich[1], G. E. Shephard[2,3], P. J. Heron[1,4]

[1]*University of Toronto, Earth Sciences, Toronto, ON, Canada,* [2]*University of Oslo, Centre for Planetary Habitability (PHAB), Oslo, Norway,* [3]*Australian National University, Research School of Earth Sciences, Canberra, ACT, Australia,*
[4]*University of Toronto Scarborough, Physical and Environmental Sciences, Toronto, ON, Canada*

Over several decades, a number of different tectonic models describing the opening kinematics of the Arctic Ocean have been proposed, with most focusing on the Amerasia Basin as a starting point. Methods such as geological mapping, geophysical surveying, geochemical analysis, and plate reconstruction models have been employed to better understand the rifting dynamics of the Arctic Ocean, which has produced varying interpretations of how and when the Amerasia Basin first opened. However, the use of high-performance computing and lithospheric numerical modelling has yet to be adopted to investigate Arctic rifting. In addition, the role of structural inheritance, a process in which previous tectonic deformation can influence younger tectonic events, has not been fully explored in Arctic tectonic models.
Given the limited amount of data on Arctic tectonics due to harsh conditions and perennial sea ice cover, identifying the mechanism (e.g., inherited structures) that promoted the opening of the Amerasia basin may further our understanding of how the present-day Arctic formed. In this work, we hypothesize that past tectonic activity from supercontinent cycles may play a role in Arctic rifting dynamics and the opening of the Amerasia Basin. For the first time, we test this hypothesis using lithospheric numerical models in the presence of inherited structures and compare our simulations to the heterogeneous nature of the present-day Arctic lithosphere.
In our numerical models, we use the open-source geodynamic code ASPECT to investigate the mechanism, timing, and style of the opening of the Amerasia Basin in the Late Cretaceous. Given the uncertainty with the tectonic history of the region, we apply a number of different structural inheritance scenarios to our numerical models – changing lithospheric rheological and rift velocity conditions, as well as simulating different deformation styles from a range of ancient tectonic boundaries in the region. Given the constraints in real world data, for this presentation we welcome community discussion on any critical criteria required to successfully model the opening of the Amerasia Basin. As a result, we want to work toward establishing a set of non-negotiable tectonic features that need to be shown in numerical models of Arctic dynamics.

The Porcupine Fault System of Yukon and Alaska: An underappreciated piece of the Arctic Puzzle

J. V. Strauss[1], K. Faehnrich[2], W. C. McClelland[3], M. L. Odlum[4], E. E. Donaghy[1], E. T. Rasbury[5], M. Colpron[6]

[1]*Dartmouth College, Department of Earth Sciences, Hanover, United States of America,*
[2]*University of Adelaide, School of Biological Sciences, Adelaide, Australia,*
[3]*University of Iowa, Department of Earth and Environmental Sciences, Iowa City, United States of America,*
[4]*Scripps Institution of Oceanography, Geosciences Research Division, San Diego, United States of America,*
[5]*Stony Brook University, Department of Geosciences, Stony Brook, United States of America,*
[6]*Yukon Geological Survey, Whitehorse, Canada*

The tectonic significance of the Porcupine fault system (Porcupine megashear, Porcupine lineament, Porcupine shear zone, Kaltag-Porcupine fault, etc.) of northern Yukon and Alaska has been debated in the literature for decades. Some models highlight limited evidence for deformation within the "fault system", while others rely on it to accommodate hundreds to thousands of kilometers of displacement prior to and/or during the opening of the Arctic Ocean. Here, we review recent field and analytical investigations of the Porcupine fault system conducted over four separate field seasons from 2017–2024 traversing the Porcupine River via raft, boat, and helicopter. We compile integrated geological mapping, sedimentological and stratigraphic observations, and paleontological, geochronological, geochemical, and structural data to reconstruct an overview of the complex history of sedimentation and deformation within the fault zone. In addition to recognizing clear evidence for polyphase Paleozoic, Mesozoic, and Cenozoic deformation, we also demonstrate this region hosts an important tectonic boundary between the composite Arctic Alaska terrane, the northwestern margin of Laurentia, and several poorly understood crustal fragments that were caught up within this reactivated tectonic suture. Together, these data suggest the Porcupine fault system played a fundamental role in the tectonic evolution of the Arctic, particularly during the opening of the Amerasian Basin.

Topical Session 5 – Poster

The Opening of the Arctic Ocean

T5-1

The crustal structure of Canada Basin

T. Funck[1], W. S. Priyanto[2], B. J. Coakley[2], J. R. Hopper[1,3]

[1]*GEUS, Copenhagen, Denmark,*

[2]*University of Alaska, Geophysical Institute, Fairbanks, Alaska, United States of America,*

[3]*University of Copenhagen, Institute of Geosciences and Natural Resources, Copenhagen, Denmark*

The formation of the Canada Basin in the Arctic Ocean remains enigmatic despite decades of geological and geophysical research. The most commonly assumed opening model is a counter-clockwise rotation of northern Alaska relative to the northern Canadian margin. Oceanic crust is implied in the central part of the basin, where (i) sonobuoys indicate P-wave velocities resembling oceanic crust, (ii) a gravity low is interpreted at the location of an extinct spreading centre, and (iii) paired magnetic anomalies are identified to either side of the gravity low. No agreed age is allocated to these anomalies and the opening of the basin is believed to have occurred in Early or Mid-Cretaceous time.

Based on velocities obtained from sonobuoys, different crustal domains could be mapped: oceanic crust in the central part of the basin, fringed by transitional and continental crust. To substantiate these initial crustal divisions, a seismic experiment was carried out onboard *R/V Sikuliaq* in 2021, employing a 200-m long streamer for the seismic reflection acquisition that was supplemented by ocean bottom seismometers (OBS) to record crustal refractions and wide-angle reflections. The OBS were deployed in two arrays: one within the interpreted transitional crust and one in the oceanic crust at the edge of the oldest interpreted magnetic anomaly in the basin.

Velocity models were developed by forward modeling of travel times. The geometry of basement and the sedimentary layers was correlated with the coincident seismic reflection data. The models for the array on the transitional crust show a 2 to 3 km thick upper crustal section, where the top 500-1000 m have velocities of 4.7–5.4 km/s and display a series of high-amplitude sub-parallel reflections, tentatively interpreted as basaltic flow units. The remainder of the upper crust has velocities around 6.4 km/s, while the lower crust is 4 km thick with velocities of 7.2 km/s and a clear Moho reflection. This layer is interpreted as a magmatic addition. Within the interpreted oceanic zone, a similar high-velocity lower crust (HVLC) is observed in proximity to what is thought to be the oldest seafloor spreading anomaly in the basin. Here the HVLC is underlying a 2-km-thick upper crust. More distal to the magnetic anomaly, the HVLC disappears, and 5-km thick crust is observed with a velocity structure resembling oceanic crust. The HVLC indicates magmatic activity during the time of break-up of the basin or shortly thereafter.

T5-2

Detrital zircon-based provenance of sedimentary rocks in the circum-Arctic and an update on their constraints on rifting models for the Amerasian Basin

E. Miller

Stanford University, Earth and Planetary Sciences, Stanford, United States of America

Chukotka and adjacent shelf regions of Arctic Russia are underlain by pre-Mississippian rock units tied to the Timanides and overlain by Triassic strata tied to the Siberia traps region. Chukotkas's footprint was small prior to Triassic rifting (which truncated and removed part of the Uralian orogen) and then broadened and "continentalized" during Cretaceous magmatism and E-W extension. These data preclude the original proposed rotational opening model for the Amerasia Basin, where Lomonosov Ridge is interpreted as a basin-wide transform fault (full windshield wiper model). The data instead support opening of the oldest part of the Amerasian Basin by rifting mostly orthogonal to the Lomonosov Ridge with right-lateral motion of Chukotka eastward and southward away from the New Siberian Islands and Verkhoyansk to its present-day position. Mississippian to Jurassic shelfal units of Alaska and Arctic Canada (Sverdrup Basin) share depositional systems and sources and favor counterclockwise rift rotation opening of the Canada Basin. However, some pre-Mississippian units of the Brooks Range and Seward Peninsula have correlatives in the Polar Urals Timanian orogenic belt. The CATS hypothesis suggests that pre-Mississippian units of Arctic Canada may represent post-Caledonian left-lateral strike-slip bound slivers, in which case the basement of the Brooks Range-North Slope could be in part composed of strike-slip bound units as well.
Chukotka and Arctic Alaska are linked together across the Bering Strait based on shared geologic histories and locus of Cretaceous magmatism but have been affected by variable N-S extension that has moved Alaska southward relative to Chukotka. The 115-90 Ma filling of Colville Basin with Russia-derived clastics was associated with continental rift-related magmatism in Chukotka (extending to the Koyukuk Basin and Yukon-Tanana) prior to collapse of thermal topography, overlap of source granitoids in Chukotka by 85-90 Ma lavas and formation of E-W trending basins during NS extension between Russia and Alaska.
Dredges from Chukchi Borderland restrict its original position: Here a contact between North America Franklinian margin sediments and Cambro-Ordovician arc rocks of the internal zones of the Caledonides may restore to Pearya and the CATS slivers of Arctic Canada.
In summary, a multi-component, stepwise opening model for the Amerasia Basin is suggested by geologic and detrital zircon data.

T5-3

Subsurface detrital zircon U/Pb affinities of pre-Mississippian basement beneath the Arctic Alaska margin: Implications for circum-Arctic evolution

R. Lease[1], C. Connors[2,3], J. Dumoulin[1], W. McClelland[4], J. Strauss[5], D. Houseknecht[3]

[1]U.S. Geological Survey, Anchorage, United States of America, [2]Washington and Lee University, Lexington, United States of America, [3]U.S. Geological Survey, Reston, United States of America, [4]University of Iowa, Iowa City, United States of America, [5]Dartmouth College, Hanover, United States of America

Circum-Arctic tectonic reconstructions increasingly rely on detrital zircon U-Pb (DZ) data to provide paleographic insights. In the past decade, a wealth of DZ data has been published for Neoproterozoic–Devonian strata of the North Slope subterrane from outcrops in the northeast Brooks Range (NEBR) of Arctic Alaska (AA). However, comparatively little is known from the AA subsurface in coastal plain and offshore areas, where the North Slope subterrane is buried beneath Colville Basin strata. We present subsurface DZ and petrographic data for pre-Mississippian basement samples from 20 wells located along the AA Beaufort rifted margin flanking the Canada Basin. Two fundamentally different provenance signatures emerge along this 500-km-long transect.

Towards the east (between the Canning and Colville river deltas), quartz- and feldspar-rich samples are characterized by >1.0 Ga DZ grains with peaks at ca. 1.8 and 2.7 Ga. These may be an extension of the widespread Laurentian age signature in Neoproterozoic-Cambrian basinal and platformal rocks in the NEBR, which have been correlated to coeval strata along the northern Laurentian margin in the Canadian Arctic Islands (CAI).

In contrast, towards the west (between the Colville delta and Point Barrow), chert-rich samples with Silurian–Early Devonian maximum depositional ages (MDAs) are dominated by ca. 400–500 Ma DZ grains with minor ca. 500–700 Ma and 900 Ma–2.0 Ga grains. The coeval Clarence River Group in the NEBR has similar age distributions that have been correlated to the CAI Pearya terrane and Franklinian basin and suggested to indicate synorogenic arc sources that extended northward beyond the Caledonides. Phyllitic schist samples from the western AA subsurface have comparable age populations but are distinguished by Late Devonian MDAs and an increase in ca. 500–700 Ma and 900 Ma–2.0 Ga grains relative to ca. 400–500 Ma grains. A similar upsection DZ change in CAI Franklinian strata has been suggested to relate to the Ellesmerian orogen.

Across the North Slope subsurface, the westward shift from Laurentian to Caledonian/Ellesmerian DZ signatures coincides with a structural change mapped in regional seismic data from generally south-directed Devonian thrust belts to north-directed Devonian belts that were reactivated in the Carboniferous. These relationships link the broad subsurface region of the North Slope subterrane to the CAI prior to later translation, transtension, and opening of the Canada Basin.

T5-4

Latest Triassic – Early Cretaceous Sequence Boundaries and the Evolution of the Amerasia Basin

A. Embry[1], J. Dixon[2]

[1]*Retired, Toronto, Canada,* [2]*Retired, Calgary, Canada*

The most widely accepted model for the opening of the Amerasia Basin is by counterclockwise rotation of the Arctic Alaska-Chukotka microplate (AACM) away from the Canadian Arctic Islands. This model includes a north-south spreading ridge emanating from the Mackenzie Delta region, and a transform fault near the base of Lomonosov Ridge. General agreement on the timing of the various stages of opening includes rifting and hyperextension of the lithosphere in Jurassic/earliest Cretaceous followed by sea floor spreading in Early Cretaceous.

Tectonic events in the evolution of an ocean basin (e.g. start sea floor spreading) are most often marked by major, tectonically-generated sequence boundaries in the bordering sedimentary basins. Given this, the latest Triassic to Late Cretaceous stratigraphy of four Arctic basins surrounding the Amerasia Basin - Arctic Alaska, Mackenzie Delta, Sverdrup Basin, and Svalbard – has been reviewed to identify Arctic-wide, major sequence boundaries that potentially mark key events in the evolution of the Amerasia Basin. This review has identified, within the above-named Arctic basins, four tectonically-generated sequence boundaries which, most often, are characterized by a major unconformity signifying widespread uplift. The ages of these sequence boundaries are base Rhaetian (latest Triassic), base Bajocian (Middle Jurassic), base Barremian (Early Cretaceous) and base Cenomanian (mid-Cretaceous).

In the Mackenzie Delta region, which occupies the pivot for the opening basin, these four unconformities are readily identified and can be related to the various stages of basin evolution by their relationship to extensional faulting. The base Rhaetian boundary marks the initiation of extensional faulting and basin rifting, the base Bajocian boundary marks a significant expansion of the faulting and rifting, the base Barremian boundary marks a significantly increased rate in extensional faulting reflecting the initiation of sea floor spreading, and the base Cenomanian boundary marks the cessation of extensional faulting and sea floor spreading.

Tectonic and depositional regime changes across these sequence boundaries in the other Arctic basins provide additional supporting evidence for this interpretation. It appears the sea floor spreading stage was characterized by ultra slow spreading rates. Notably, the first pulse of the HALIP directly followed the start of spreading with the second pulse occurring soon after spreading termination.

T5-5

Reconstruction of paleomagnetic field intensity during the Cretaceous Normal Superchron using volcanic rocks

Y. Yoshimura[1], M. Fujii[1], H. Sato[2]

[1]*National Institute of Polar Research, Tachikawa, Tokyo, Japan,*

[2]*Senshu University, School of Business Administration, Kawasaki, Kanawgawa, Japan*

The absence of geomagnetic polarity reversals for ~37 million years during mid-Cretaceous period, known as the Cretaceous Normal Superchron (CNS), is a notable phenomenon (Yoshimura, 2022). The nature of paleomagnetic field intensity (paleointensity) during the CNS is useful in determining the age of the seafloor and understanding plate tectonics at that time. However, there are two conflicting hypotheses regrading paleointensity variations: (1) strong and stable (Tarduno et al., 2001, 2002), and (2) highly variable (Tauxe & Staudigel, 2004; Granot et al., 2007).

To reveal the paleointensity during the CNS, it is essential to recover 25 or more reliable paleointensity. Our ongoing studies on the Kerguelen Large Igneous Province (LIP) in the Southern Ocean, as well as research on the High-Arctic LIP (HALIP), known for its extensive Cretaceous activity, will be valuable in obtaining such data. HALIP is distributed around the Arctic region, including the Canadian Arcitc Islands, Svalbard, Franz Josef Land, New Siberian Islands, and Alpha-Mendeleev Ridge of the Amerasia Basin. The duration of LIP activity is 128 to 77 Ma (> 50 Myr) with the main three pulses (Dockman et al., 2018). This long duration of HALIP volcanism is thought to be caused by a plume-lithosphere interaction (Heyn et al., 2024).

Here, we will discuss the prospects for Arctic research in understanding paleointensity variations in the CNS, based on our previous work with lavas from Ethiopia (Yoshimura et al., 2020, 2023) and Indian mid-ocean ridge (Yoshimura & Fujii, 2024) and our current efforts at the Kerguelen LIP. We hope to work on this theme through international collaboration. Several studies have conducted petrological studies on volcanic rocks from HALIP. However, paleomagnetic studies remain limited. To promote such research, it will be necessary to utilized archived volcanic rocks from HALIP, as well as resources like the new Japanese icebreaker Arctic Research Vessel, Mirai II.

T5-6

High-Density Systematic Rock Sampling: A Key to Understanding Intraplate Volcanism

H. Sato[1], M. Fujii[2], T. Sato[3], Y. Yoshimura[2], Y. Nogi[2]

[1]*Senshu University, School of Business Administration, Kawasaki, Japan,* [2]*National Institute of Polar Research, Tachikawa, Japan,* [3]*National Institute of Advanced Industrial Science and Technology, Tsukuba, Japan*

In Japan, construction of the new icebreaker *Mirai II* is underway for research in the Arctic region. Solid Earth scientists with experience in Antarctic and Southern Ocean research consider the vessel's potential for conducting „high-density systematic rock sampling" in the Arctic. Although speculations and estimations based on the tectonics of the surroundings and available data are essential for science, they often lead to extrapolation or misinterpretation.
Recently, we determined the chemical composition and radiometric age of volcanic rocks from the Conrad Rise, an intraplate rise in the southwestern Indian Ocean (Sato et al., 2024). Previous studies in the 1980s suggested that the seamounts of the Conrad Rise formed during the Late Cretaceous, likely due to the interaction between a mantle plume and a ridge-ridge-ridge triple junction. However, new radiometric data indicate volcanic activity during the Eocene and Miocene, prompting a reconsideration of the formation process.
Intraplate volcanoes are often attributed to deep mantle plumes, yet some intraplate volcanoes, such as „petit spots" and the Puka-Puka Ridge (e.g., Hirano et al., 2006; Sandwell & Fialko, 2004), are linked to other mechanisms, such as subducting plate flexure or lithospheric fractures. High-density systematic rock sampling is crucial to elucidate the origin of intraplate volcanism. By determining the chemical composition and radiometric age correlating them with the seafloor spreading history, we can gain deeper insight into Arctic volcanism and tectonics on a precise time scale.

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T5-7

Eocene-Miocene continental break-up and seafloor spreading in the high Arctic inferred from magnetic data

C. Gaina, A. Minakov, J. C. Meza-Calla
University of Oslo, PHAB, Oslo, Norway

Our knowledge about processes that lead to continental break-up and seafloor spreading had several break-through during the last few decades. Among them, recognizing a distinct transitional phase of deformation between the continental rifting and oceanic seafloor spreading . The duration of this phase can be linked to the style of deformation during the rifting stage as well as to physical properties of the continental lithosphere including pre-existing geological structures with preffered orientation.
In this contribution, we focus on the crust formed north of the Barents Sea and Svalbard (and its conjugates at the Lomonosov Ridge) since Eocene/Miocene continental break-up. Our aim is i) to re-visit the existing magnetic anomaly trackline data in the light of new concepts that postulate the existence of exhumed continental mantle bordering the continental and oceanic domains; ii) to discuss the geophysical properties of the crystalline basement.
According to a classical view, the magnetic anomaly data that show alternating positive and negative linear anomalies are usually indicative of basaltic crust formed by seafloor spreading. However, recent studies postulated that corridors of exhumed mantle imaged by seismic reflection data in the Nansen Basin were formed in the Eurasia Basin since its inception. Recent seismic refraction was acquired in 2022 to test this hypothesis. New magnetic data has been collected in the Fram Strait, west of Barents Sea, as part of the international EPOS programme. Its interpretation also postulates the existence of a wide zone of exhumed mantle.
The vintage and more recent magnetic data are re-interpreted by taking into account the influence of sediment thickness and the relief of top basement constrained by new seismic reflection and refraction data. Our final aim is to shed light on processes that influenced Eocene-Miocene continental break-up and seafloor spreading in the high Arctic.

T5-8

Sedimentary source-to-sink of the northern Barents Shelf continental margin and its implication for the opening of the Nansen Basin

A. P. E. Lasabuda[1,2], T. Salles[2], S. Zahirovic[2], G. Shephard[1,3], J. I. Faleide[1], D. Müller[2]
[1]*University of Oslo, Geosciences, Oslo, Norway,* [2]*The University of Sydney, Geosciences, Sydney, Australia,*
[3]*Australian National University, Research School of Earth Sciences, Canberra, Australia*

Reconstructing Cenozoic sedimentary source-to-sink in the greater Barents Sea is highly uncertain due to heavily eroded Cenozoic strata during the Quaternary glaciations. This uncertainty led to diverging models of the Barents Shelf paleo-landscape in the Cenozoic, ultimately affecting the accuracy of climate, oceanographic and sediment source-to-sink simulations. The ratio between off-shelf Cenozoic pre-glacial and glacial sediments is relatively higher in the Barents Sea northern continental margin than the western margin. This observation and other studies point to a hypothesis of an elevated terrain of the paleo-northern Barents Sea in the Paleogene-Neogene. However, it is not clear when and how this paleo-topographic high was formed, and how it evolved throughout the Cenozoic. The spatio-temporal pattern of the catchment area supplying sediments to the evolving ultra-slow seafloor spreading of the Nansen Basin remains enigmatic. Moreover, the impact of rift-flank uplift on the sediment routing from the source to the sink area is also unclear, considering a relatively sharp boundary between the continental and oceanic plates in the study area. Here we used

Badlands forward modelling coupled with GPlates tectonic reconstructions to simulate the basin-filled stratigraphy in the Nansen Basin and the landscape evolution of the northern Barents Sea. We compared the numerical outcomes with the seismic data from and across the continental margin. Our simulations shed light on constraining the opening configuration of the Nansen Basin, reflecting interactions between tectonic (deeper mantle processes, isostasy), climatic and surface processes (sediment erosion, transport and deposition).

T5-9

Mantle exhumation since the early formation of the Eurasia Basin, Arctic Ocean

R. Lutz[1], D. Franke[1], K. Berglar[1], I. Heyde[1], P. Klitzke[1], W. Geissler[2]

[1]*BGR, Hannover, Germany,* [2]*AWI, Bremerhaven, Germany*

We study the basement configuration in the slow-spreading Eurasia Basin, Arctic Ocean. Two multichannel seismic (MCS) profiles, which we acquired during ice-free conditions with a 3600m long streamer, image the transition from the North Barents Sea Margin into the southern Eurasia Basin. The seismic lines resolve the up to 5000m thick sedimentary section, as well as the crustal architecture of the southern Eurasia Basin along 120 km and 170 km, respectively. The seismic data show large faulted and rotated basement blocks. Gravity modeling indicates a thin basement with a thickness of 1–3 km and a density of $2.8*10^3$ kg/m^3 between the base of the sediments and the top of the mantle, which indicates exhumed and serpentinized mantle. The Gakkel spreading ridge, located in northern prolongation of the seismic lines is characterized by an amagmatic or sparsely magmatic segment. From the structural similarity between the basement close to the ultra-slow spreading ridge and our study area, we conclude that the basement in the Eurasia Basin is predominantly formed by exhumed and serpentinized mantle, with magmatic additions. An initial strike-slip movement of the Lomonosov Ridge along the North Barents Sea Margin and subsequent near-orthogonal opening of the Nansen Basin is supposed to have brought mantle material to the surface, which was serpentinized during this process. Continuous spreading thinned the serpentinized mantle and subsequent normal faulting produced distinct basement blocks. We propose that mantle exhumation has likely been active since the opening of the Eurasia Basin.

T5-10

Revisiting the origin of the Morris Jesup Plateau: What can we learn from potential field modelling?

A. Ruppel[1], P. Klitzke[1], G. Eagles[2], W. Geissler[2], L. Reinhardt[1], K. Piepjohn[3]

[1]*Federal Institute for Geosciences and Natural Resources (BGR), Hannover, Germany,* [2]*Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany,* [3]*retired from (1), present address: Jacobistraße 34, Hannover, Germany*

The Morris Jesup Plateau, located north of Greenland, comprises distinct physiographic features including the Morris Jesup Spur and the Morris Jesup Rise. It is characterised by a prominent positive magnetic anomaly and its origin has been subject of considerable debate, with several hypotheses put forward to explain its formation. These include: (1) intrusion of extended continental crust in the vicinity of a triple junction influenced by the initial opening of the Eurasia Basin (2) formation of oceanic crust (3) origin in a uniform volcanic plateau associated with the Kap Washington volcanics at 71-61 Ma, hence, predating the opening of the Eurasian Basin and Eurekan deformation. As for the Yermak Plateau north of Svalbard, recent geophysical studies suggest that at least the southern and northwestern portions might be underlain by extensive continental crust. However, seismic data across both plateaus are scarce and a detailed understanding of the age and formation mechanisms remains speculative.

In a new regional plate reconstruction, the plateaus are conjugates that separate at 33.5 Ma after a period as a spur on the Eurasian continental margin north of Svalbard since 46 Ma. The spur forms when the Sofia Basin opens as part of the Greenland/Eurasia plate boundary to the east of the Yermak plateau at 50-46 Ma, whilst contemporaneously experiencing ~72 km of convergence with the North American plate to the west of Morris Jesup Spur. Prior to 54 Ma, the plateaus are part of a continuous Eurasian plate margin that diverged – together with Kap Washington – from Ellesmere Island since around 63 Ma.

Using airborne magnetic data for 2D forward modelling and 3D inversion in combination with seismic data acquired during Polarstern cruise PS115.1 allow for construction of a new 3D crustal model with particular focus on the Morris Jesup Plateau and Northern Greenland. With the modelling approach, we aim to test the aforementioned hypotheses addressing the origin of the Morris Jesup Plateau. Forward and inverse modelling is used to determine the sub-surface property distribution that would result in the observed anomaly and is compared to the depth of the volcanic basement interpreted from seismic reflection data. Magnetic modelling combined with seismic interpretation demonstrates a high probability of polyphase volcanism younging towards Greenland. These sequences are thinning substantially below the Greenland shelf.

T5-11

The Eurekan in northern Greenland: Insights from low-temperature thermochronology

K. Meier[1], P. O'Sullivan[2], M. Jochmann[3], P. Monien[1], K. Piepjohn[4], S. Estrada[5], F. Lisker[1], C. Spiegel[1]

[1]*University of Bremen, Bremen, Germany,* [2]*GeoSep Services, Moscow, Idaho, United States of America,* [3]*University of Bergen, Bergen, Norway,* [4]*retired from Federal Institute for Geosciences and Natural Resources (BGR), present address Jacobistraße 34, Hannover, Germany,* [5]*retired from Federal Institute for Geosciences and Natural Resources (BGR), present address Thieshof 10, Hannover, Germany*

The Eurekan Belt is an intraplate transform orogen that extends several hundred kilometres across the Arctic Realm and is closely associated with large-scale transform faults. Paleogene spreading in the Labrador Sea-Baffin Bay, the Eurasian Basin, and the Norwegian-Greenland Sea moved Greenland northward and caused deformation across the continental margins of Canada, northern Greenland, Svalbard, and Barents Sea. The resulting geological structures are complex and difficult to correlate between the affected areas, complicating the reconstruction of the Eurekan evolution.

We applied apatite fission-track and (U-Th-Sm)/He thermochronology on samples from northern Greenland in the central part of the Eurekan Orogen. Here, two segments of the Eurekan Belt have developed with different structural patterns, but their temporal and kinematic evolution and mutual relationships are poorly constrained. Our goal is to investigate the thermal evolution of the different segments of the Eurekan Belt of northern Greenland to better understand timing, exhumation, kinematic evolution, and cause of the Eurekan orogeny.

New apatite fission-track and (U-Th-Sm)/He data from both Eurekan Belt segments range between 13 and 304 Ma. Thermal histories modelled from these data indicate common cooling stages occurring during the Late Cretaceous to Paleocene, the Eocene and the Oligocene and refer to exhumation episodes before, during and after the Eurekan.

The exhumation history of northern Greenland correlates with similar histories recorded on Ellesmere Island and western Svalbard and implies, together with stratigraphic and structural geological evidence, that the Eurekan fault zones exerted a primary control on the evolution of the Barents and Greenland margins. Crustal blocks in the vicinity of these main crustal structures show differential exhumation and burial during and subsequent to the Eurekan orogeny and were likely sheared and faulted. We also recognised increased heat transport along the major fault systems and a locally strongly enhanced geothermal gradient during the Late Cretaceous.

Our new data suggest that crustal inheritance, active transform fault systems as well as distribution of heat play a major role for the development of intraplate orogenic belts. They also highlight the potential of low-temperature thermochronology for correlating different crustal segments in a regional context and providing reliable time constraints on involved tectonic processes.

T5-12

Evidence for Eurekan deformation within and around the Morris Jesup Plateau, Arctic Ocean

P. Klitzke[1], W. Geissler[2], L. Reinhardt[1], A. Ruppel[1], M. Engels[1], R. Lutz[1], D. Franke[1]

[1]*Federal Institute for Geosciences and Natural Resources, Hannover, Germany,* [2]*Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung (AWI), Bremerhaven, Germany*

The Morris Jesup Plateau is located offshore North Greenland and includes the Morris Jesup Rise in the west and the Morris Jesup Spur in the east. The Yermak Plateau north of Svalbard represents the conjugate margin of the Morris Jesup Plateau. Both margins are separated by the southernmost part of the Eurasia Basin with the Gakkel Ridge. The wider Eurasia Basin started to open in Paleocene-Eocene times. At those times, Greenland moved northwards due to active spreading both in the NE Atlantic and the Labrador Sea. This northward motion of Greenland resulted in the Eurekan compressional deformation between Greenland and Svalbard and limited or strongly influenced the opening of the Eurasia Basin towards the southwest. Only with the cessation of the Eurekan deformation in late Eocene times, the spreading system of the Eurasia Basin advanced southwards and finally separated the Yermak and Morris Jesup plateaus.

While Eurekan deformation is well documented onshore across the West Spitsbergen Fold-and-Thrust Belt and complex thrust and strike-slip zones in North and NE Greenland, only little is known about how these compressional/transpressional structures continue offshore across the North Greenland continental margin towards the Morris Jesup Plateau. Furthermore, the extent to which the Morris Jesup Plateau was affected by extension prior to its separation from the Yermak Plateau in the early Oligocene is poorly resolved. Answering these questions is essential to determine where the Morris Jesup and Yermak plateaus were situated along the North American margin in the late Mesozoic and earliest Cenozoic. Was the opening of the Eurasia Basin compensated by deformation within the plateaus, or did strike-slip movements reactivate the ancient Paleozoic Canadian Arctic transform system? Are there any indications for initial subduction to the North of Greenland as previously proposed on base of potential field data?

Here we report on the first multichannel seismic survey along with magnetic data of the southern Morris Jesup Plateau. The seismic data image transpressional and transtensional deformation likely associated with the two Eurekan deformation episodes, the transition to passive margin evolution as well as glacial sedimentation. We compare the results with two seismic lines of the northern Morris Jesup Plateau, which allow to discuss structural variations along the Morris Jesup Spur.

T5-13

Evidence for Eurekan deformation within and around the Yermak Plateau, Arctic Ocean

W. Geissler[1], P. Klitzke[2], G. Eagles[1], L. Reinhardt[2], M. Weber[3], K. Berglar[2], A. Ruppel[2]

[1]*Alfred Wegener Institute (AWI), Helmholtz Centre for Polar and Marine Research, Bremerhaven, Germany,* [2]*Federal Institute for Geosciences and Natural Resources (BGR), Hannover, Germany,* [3]*UiT - The Arctic University of Norway, Tromsø, Norway*

The Yermak Plateau is a submarine plateau that lies to the north of Svalbard. Strong magnetic anomalies over its northeastern part led early interpretations of an origin by volcanic processes in an oceanic setting, during the formation of the SW Eurasia Basin and the Fram Strait between Svalbard and Greenland. However, subsequent geophysical research delivered evidence that at least the southern and northwestern parts of the plateau might be underlain by extended continental crust. This implies that plate reconstructions for times before the opening of the Eurasia Basin should account for these continental fragments. Up until now, the true northward extent of this microcontinent and neighbouring parts of Svalbard, and their late Cretaceous and Paleogene relative locations, have been incompletely known.

Moreover, during the late Cretaceous and Paleogene, large areas along the Northern Canadian and North Greenland continental margins, as well as the West Svalbard and Southwest Barents Sea continental margins were affected by compressional and strike-slip deformation that culminated in at least two discrete phases together referred to as the Eurekan orogeny, which dates from 53 to 34 Ma. Considering that the continental fragments of Yermak Plateau were located to the north of Greenland or even north of the Canadian Arctic Islands, it is conceivable that the Eurekan deformation might have also left traces within or around the present-day Yermak Plateau.

Here we report on evidence from seismic reflection data from the Sophia Basin, which separates the Yermak Plateau from Svalbard. Evidence for compressional and transpressional features beneath a Neogene-Quaternary sedimentary cover can be correlated to the two Eurekan deformation phases. Reconstructing the Yermak Plateau towards the North Greenland margin by closing the Neogene-Quaternary Lena Trough spreading system based on aeromagnetic data, we also found further evidence for continuity of geological structures between North Greenland and the northwestern Yermak Plateau.

T5-14

Is the Yermak Plateau a continental fragment from North America?

N. Koglin[1], S. Estrada[1], F. Riefstahl[2], H. Nopper[2], W. Geissler[3], **C. Spiegel**[2]

[1]*BGR Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover, Germany,*

[2]*University of Bremen, Department of Geosciences, Bremen, Germany,*

[3]*Alfred Wegener Institute Helmholtz-Centre for Polar and Marine Research, Bremerhaven, Germany*

The Yermak Plateau (YP) north of Svalbard is a prominent bathymetric feature in the Eurasia Basin of the Arctic Ocean, forming the northwesternmost margin of the Eurasian plate. Seismic data indicate that the YP comprises continental basement, however, little is known about its geology. Rock fragments, which were previously recovered by dredges and corers from basement highs of the northeastern and southwestern YP, are dominantly of magmatic origin. New petrographic, geochemical, Sr–Nd isotopic, and Ar–Ar geochronological data combined with available literature data, and comparison with volcanic and sedimentary rocks from onshore and offshore areas adjacent to the YP indicate that the northeastern YP and the southwestern YP are different regarding their geological evolution. The southwestern YP comprises an alkaline basaltic suite for which an Ar–Ar biotite age of 51 Ma was previously reported. The suite was formed in a continental extensional regime offshore northern Svalbard. Associated sedimentary rocks (sandstone, several limestones) show petrographic similarity with rocks of the Devonian Old Red Sandstone on Svalbard. From the northeastern YP, in contrast, we recovered mildly alkaline basaltic rocks with mid-Cretaceous Ar–Ar ages (102 ± 3 and 98 ± 3 Ma). The rocks show certain geochemical characteristics (partial enrichments of P, Ba and Eu), which overlap with similar-aged Cretaceous basaltic rocks from northern Ellesmere Island of Canada and North Greenland. We suggest that the northeastern YP is a continental fragment derived from the North American plate, which was separated from the conjugate Morris Jesup Rise and juxtaposed to the geologically distinct southwestern YP by the propagation of the Gakkel Ridge spreading centre since the early Oligocene.

Topical Session 6 - Talks

Arctic Geopolitics, Governance & Society

UNCLOS: Beyond 200 M in the Arctic Ocean

D. Mosher

Natural Resources Canada, Geological Survey of Canada, Dartmouth, Canada

The UN Convention on the Law of the Sea allows for States to exercise sovereignty over the seabed beyond their 200 nautical mile (M) limit (EEZ), if their continental shelf extends that far. The continental shelf is defined in Article 76 of the Convention, which also provides the prescriptions for its delineation. These prescriptions consist of geodetic and scientific criteria and are not political. It is, therefore, common that continental shelf areas of States beyond 200 M overlap.

Five coastal States border the Arctic Ocean and because of its circular geography and extensively elevated features, their continental shelves extend towards each other creating amongst the largest overlap areas in the World. In addition, the remoteness, difficult operational conditions, financial burden and limited capability in the Arctic of any one State has led to a high degree of collaboration amongst the Arctic coastal States and with other States that have Arctic exploration interests and capabilities. This collaboration has led to immense benefits of significant new scientific understanding of the Arctic basins.

Aside from Article 76, several other articles of the UN Convention on the Law of the Sea are critical to know for Arctic Ocean explorers. Paramount amongst these are:
1) coastal States exercise sovereign rights for the purpose of exploring and exploiting its natural resources; no one may may undertake these activities without the express consent of the coastal State. Additionally, these rights exist even before the limits of the shelf are defined.
2) all States, irrespective of their geographical location, have the right to conduct marine scientific research (MSR).
3) coastal States have the right to regulate, authorize and conduct MSR on their continental shelf and MSR shall be conducted with the consent of the coastal State.
4) coastal States shall establish rules and procedures ensuring that such consent will not be delayed or denied unreasonably.

This presentation shall explain some of the complexities of article 76 in context of the Arctic, discuss the current status of continental shelf jurisdiction, and elucidate some of the rights and responsibilities of States with respect to the continental shelf.

Energy sovereignty of remote arctic communities - assessing the potential for geothermal energy in northern Canada

S. Grasby

Geological Survey of Canada, Calgary, Canada

Remote northern communities are dependant on imported fuel oil/diesel (by sealift, airlift, and ice roads) for heat and electricity - there is strong interest to decarbonize these energy needs and increase energy sovereignty. Wind and solar are not ideal for northern communities given the winter dark period, blade icing etc. They also require significant energy storage solutions to be reliable, however battery efficiency plummets in cold climates. Local geothermal resources can provide renewable heat and potentially electricity that is both reliable and scalable to fluctuating demand, greatly reducing reliance on imported energy. It could also provide low level heating to improve battery efficiency or greenhouses, supporting northern food security and nutrition.
New research is examining geothermal potential for remote northern communities and government facilities in northern Canada. Assessments provide insight into the geothermal potential across a broad range of geologic environments, with new criteria being developed to help focus future investment in more detailed and costly geothermal exploration. Results suggest that higher heat flow regions of Yukon and SW Northwest territories may have electrical potential. Other broad areas of the arctic may have potential for heat production, helping to offset the >60% of total energy demand in the north.

Navigating the complex world of ESG in the Canadian Arctic: Insights from a collaborative research project on the Ni-Cu-PGE potential of the Mackenzie LIP, Nunavut

M.-C. Williamson

Geological Survey of Canada, Natural Resources Canada, Ottawa, Canada

Recent reports on the environmental, social, and governance (ESG) factors associated with the mining cycle suggest that ESG is the main source of risk in metal and mineral supply over the coming decades. For mineral exploration companies, ESG translates into *a set of practices and metrics used to evaluate their record beyond financial performance*. For federal government scientists carrying out boots-on-the-ground research on critical minerals in the Canadian Arctic, ESG starts with community engagement. This process ensures that the decisions about research priorities and methods are made in collaboration with northern communities. However, the duration of many research projects (typically 3-5 years) stands in sharp contrast to the long-term impacts that new knowledge on mineral targets may have on northern communities (> 10 years).

How can ESG principles become an integral part of the consultation, planning and implementation process of an arctic geoscientific research project in a way that takes long-term impacts into account?

We present the scientific roadmap for a new project funded by the Geological Survey of Canada's Critical Minerals and Geoscience Data (CMGD) program focused on the Mackenzie large igneous province (LIP). The 1.27 Ga Mackenzie LIP includes flood basalts and feeder dykes of the Coppermine River Group, the Muskox intrusion, and the Mackenzie dyke swarm. Previous studies of the Mackenzie LIP have focused on each of these three elements of the magmatic architecture; however, our goal is to fill knowledge gaps to produce a regional synthesis that specifically highlights Ni-Cu-PGE prospectivity. The project brings together a team of experts from government, industry and academic institutions. Revisiting the Mackenzie LIP will no doubt contribute to ongoing exploration efforts in Nunavut that will determine this specific region's potential as a world-class Ni-Cu-PGE target. Here, we use examples from the Mackenzie LIP project to (1) outline an ESG *path forward* in the hope of raising awareness of the obstacles and rewards inherent in this process; (2) foster a discussion within the ICAM community; and (3) compare our observations with those obtained during similar research projects carried out in circum-Arctic regions.

Greenland mineral policy – change from investor-friendly to nationalistic and protectionistic

F. G. Christiansen

flemmingGC, Vanløse, Denmark

Minerals and energy have for many years been an important part of the political game in Greenland with a strong wish of gaining economic independence from Denmark. Following joint decisions between Denmark and Greenland from 1979, Greenland took over the administration in 1998 and the full legislation in 2010 after establishment of Self-Governance. Although the potential is high for many different commodities and with some periods giving a significant income for society, later years have demonstrated a modest level of activities and low interest from investors. Globally there are many fluctuations in resource investments but the decline in Greenland seems to be the direct result of political decisions and administrative procedures in Greenland. As a follow up on recent reviews in Resources Policy, Mineral Economics and Extractive Industries and Society on the petroleum, mineral and drilling history, this talk shows how the level of activities can be monitored over time. It is discussed why several interesting projects with already granted exploitation licenses are still years from start of mining, if they will ever start, and how the Uranium Act of 2021 and recent changes in the Mineral Resources Act make Greenland less investor friendly. Among the main issues are long-time political disagreements between the two large governing parties on resource policy, especially petroleum and uranium. Ongoing arbitration and legal cases with license holders paint a picture of a risky jurisdiction with many unanswered questions on legal requirements, expropriation, dispute resolution, and appeal options.

Studies on Sámi Shamanism - Indigenous Knowledge about the Arctic Ecosystem in the Context of Global Climate Change

M. Przybyl

University of Lapland, Rovaniemi, Finland

The contribution has a cultural-ecological research focus and it is a contribution to historical cultural anthropology and especially to the cultural heritage of the fenno-scandinavian and russian Sámi. The cultural diversity of the indigenous Sámi people and their numerous individual aspects such as philosophy, spiritual ideas, social relationships etc. are unique in the history of mankind and of inestimable value for the evolution of human history. A closer look at the Sámi way of life reveals that cultural diversity is closely related to biodiversity. By preserving these traditional cultures within their natural Arctic environment, two objectives can be achieved:

1. the preservation of cultural diversity and 2. preservation of biodiversity. With my transdisciplinary study I will make a contribution to key discussions to the question of processes of knowledge acquisition in human environment relations and how this knowledge can be used in the spirit of „indigenous science". A deeper and holistic understanding of Arctic indigenous peoples knowledge of their environment will play a key role in climate research and must therefore be taken much more into account in order to be able to respond appropriately to the rapidly changing climate, to unpredictable regional weather conditions, to natural disasters and to become more resilient.

In order to be successful in reducing global warming and its effects, greater participation of the Sámi people in social opinion-forming and decision-making processes is crucial. The implementation of SDGs Goal 10 (reducing inequality) and Goal 13 (climate action) of the UN 2030 Agenda are of great importance here, as this will facilitate the participation of the Sámi people in political decision-making processes, while at the same time their cultural achievements can be more adequately understood, classified and appreciated. In building a sustainable future for the arctic indigenous Sámi people, „Arctic Diplomacy" and „Science Diplomacy" will be crucial helping to build links between the past and the present to shape the future. It is a contribution to the healing of the earth and its countless natural cycles.

Topical Session 6 - Poster
Arctic Geopolitics, Governance & Society

T6-1

Upcoming Canadian research expeditions in the central Arctic Ocean

K. Boggild[1], M.-L. Dickson[1], M. J. Duchesne[2], D. C. Mosher[1], J. Bustamante Restrepo[2], S. Hynes[1]

[1]*Natural Resources Canada, Geological Survey of Canada, Dartmouth, Nova Scotia, Canada,* [2]*Natural Resources Canada, Geological Survey of Canada, Quebec, Canada*

The Canadian UNCLOS program will undertake new marine research expeditions in the central Arctic Ocean beginning in 2025. This series of expeditions builds upon results of extended continental shelf surveys between 2006-2011 and 2014-2016 which involved international collaboration with U.S.A., Sweden, Denmark and Germany. Due to the thick multi-year sea ice which accretes in the western Arctic, international collaboration using two icebreakers has been key to success of extended continental shelf surveys in the central Arctic Ocean and has led to a multifold increase in seismic data quality and coverage in areas that were previously inaccessible. Upcoming surveys will continue this approach aboard CCGS *Louis S. St-Laurent* and IB *Oden*, with fieldwork that will focus on seismic reflection/refraction profiling and hydroacoustic mapping (multibeam bathymetry and subbottom profiling). Areas of interest include the Central Arctic Plateau (including Alpha-Mendeleev Ridge Complex, Lomonosov Ridge) and Amundsen Basin, where numerous scientific questions exist concerning the tectonic, paleoenvironmental and sedimentary history of the central Arctic. Data will be collected in support of Canada's 2022 addendum submitted under Article 76 of UNCLOS, which defines criteria for delineating the outer edge of a coastal state's extended continental shelf. In summer 2024, a preparatory cruise was completed aboard CCGS *Louis S. St-Laurent* along the northwestern Atlantic margin of Canada centered on Newfoundland Ridge. These results add new information to similar scientific questions along this margin regarding its geologic evolution.

Topical Session 7 – Talks
Scientific Drilling on Arctic Margins: Past Achievements & future Opportunities

Natural gas hydrates: the hidden climate risk factor in the polar regions – why we should care

J. M. Schicks

GFZ German Research Centre for Geosciences, Potsdam, Germany

Polar regions are warming faster than the rest of the planet leading to drastic and cascading environmental impacts including ice shield and glacier melting, sea ice decline, and rapid permafrost thawing. Permafrost hosts methane and other hydrocarbon gases stored in gas hydrates. The stability of these gas hydrates requires low temperature and high-pressure conditions; therefore, gas hydrates occur not only within or below permafrost but also in the shallower parts of the Arctic Ocean as well as beneath large ice shields. Current estimates of the methane stored in these environments are highly uncertain, ranging from 27 to 800 gigatons of methane, whereas older studies even suggest up to several thousand gigatons.
Despite the potentially large methane stores, cryosphere associated gas hydrates are currently understudied. The magnitude, location and temporal evolution of hydrate dissociation rates, as well as of resulting methane

emissions to the atmosphere over the next decades and centuries are unknown. The gaps in knowledge also include, for example, understanding which factors influence dissociation behavior, such as the influence of the host sediments or the composition of the gas hydrates, which can lead to different dissociation behavior. Vice versa, gas hydrates can also influence the geo-mechanical properties of the host sediments; studies have shown a direct correlation between hydrate saturation and the shear strength of the sediment. It should also be noted that gas hydrates have a stronger influence on the strength of the sediment than ice. The dissociation of gas hydrates in permafrost areas could therefore lead to greater destabilization of the soil and endanger the infrastructure than the incipient thawing of the permafrost already does.
In order for the results of such individual studies to lead to a reliable prediction of the possible effects of cryosphere-associated gas hydrates on the climate, a coordinated, cross-scale, interdisciplinary and international research project including data mining and modeling, a land-to-sea-drilling campaign and an interdisciplinary and coordinated global collaboration on laboratory experiments should be initiated. In addition to a brief overview of the current state of knowledge and individual detailed results, ideas for future research on cryosphere-associated gas hydrates will also be presented.

Identifying meta-stable gas hydrate hot-spots in the Arctic: natural gas hydrate cyclicity vs. climate change-related triggers

E. Burwicz-Galerne[1], S. Gupta[2,3]
[1]*MARUM - Center for Marine Environmental Sciences, University of Bremen, Bremen, Germany,* [2]*GEOMAR Helmholtz Centre for Ocean Research Kiel, Kiel, Germany,* [3]*University of Malta, Msida, Malta*

Gas hydrate (GH) formation and stability in high-latitude systems are controlled by local pressure-temperature-salinity (p-T-s) conditions, which are governed by complex, highly coupled multiphysics reactive transport processes. Detailed analyses of natural GH dynamics using high fidelity numerical simulations suggest that the long-term stability of these systems is more intricate than previously thought. Firstly, even in the absence of external environmental triggers, such as bottom water temperature fluctuations and sea-level changes, natural gas hydrate systems can develop periodic, meta-stable steady-states characterized by cyclic growth and dissolution of gas hydrate layers, along with the formation of local overpressure regimes, which enhance free gas migration through the gas hydrate stability zone (GHSZ). Our new modelling results indicate that, due to preferential environmental conditions, Arctic gas hydrates are particularly prone to reveal such cyclic behavior, which may manifest as spontaneous development of seafloor pockmarks, gas seepage sites, and vigorous fluid transport within marine sediments. Secondly, the Arctic region remains highly sensitive to the rates of global warming, making it one of the most vulnerable locations, with potentially cascading responses (i.e., tipping points) to increased heat accumulation. This unique combination of factors directly affects our ability to accurately estimate regional and global present-day GH inventories through steady-state analysis. In this study, we present a distribution map of both periodic and quasi-steady-state gas hydrate deposits in the Arctic, which could serve as a new uncertainty measure that sets the hard limits on the predictability of present-day gas hydrate inventories and their future dynamics. In that context, we discuss the relationship between the time-periods of the cyclic states and the external triggers affecting gas hydrate systems in the Arctic (e.g., anthropogenic warming, sea level changes, glacial- interglacial cycles) to improve our understanding of the high-latitude system behavior.

A prolific Tertiary source rock of terrestrial origin in the eastern Nordic Seas

J. Knies[1], R. Mattingsdal[2], T. Brekke[3], K. Sliwinska[4], K. Grøsfjeld[1], S. Planke[5]
[1]*Geological Survey of Norway (NGU), Trondheim, Norway,* [2]*Norwegian Offshore Directorate, Harstad, Norway,* [3]*Brekke CHEMO, Førde, Norway,* [4]*Geological Survey of Denmark and Greenland (GEUS), Copenhagen, Denmark,* [5]*Department of Geosciences, University of Oslo, Oslo, Norway*

Oil seeps and borehole sediments were studied in the Norwegian sector of the Nordic Seas. Biomarker characteristics of seep-oil samples reveal a similar prolific source rock of deltaic/terrestrial origin, earlier proven at ODP Site 909. Age-diagnostic source-specific biomarkers of the oil suggest the origin from a Tertiary source rock. The absence of freshwater/lacustrine signatures rules out the Middle Eocene *Azolla* event as the source for the oil. Instead, the enrichment of terrestrial organic matter identified in three DSDP/ODP/IODP boreholes suggest the Early to Middle Miocene organic-rich deposits in the eastern Nordic Seas as the most likely source. Analogous to the Niger Delta environment, the analyzed oil seeps are generated from a source rock containing mixed marine and terrestrial kerogen, confirmed from bulk and biomarker analyses of sediment cores from the three DSDP/ODP/IODP boreholes. Paleogeographic- and oceanographic reconstructions suggest that a regional source rock of Miocene age could be present in large parts of the eastern Nordic Seas. This agrees with SAR-satellite observations of many clustered natural oil slicks at the sea surface on the western Barents Sea slope, which might indicate a young, previously unrecognized, working petroleum system underneath a thick Quaternary sediment package.

Recurrent physical-properties patterns for three post Mid-Brunhes interglacials off Western Svalbard

C. Gebhardt[1], S. De Schepper[2], S. Adukkam Veedu[3], G. Goss[4], N. Greco[5], A. K. I. U. Kapuge[6], L. Adriane[7], O. Libman-Roshal[8], L. Monito[9], Y. Sakai[10], Y. Suganuma[11], R. G. Lucchi[12], K. St John[13], T. Ronge[14], M. A. Barcena[15], L. Duxbury[16], A. Gonzalez-Lanchas[17], J. Grützner[1], L. Haygood[18], K. Husum[19], M. Iizuka[20], Y. Liu[21], B. Reilly[22], Y. Rosenthal[23], Y. Zhong[24], and the JOIDES Resolution Exp403 technical support team

[1]*Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Geosciences, Bremerhaven, Germany,* [2]*NORCE Norwegian Research Centre & Bjerknes Centre for Climate Research, Bergen, Norway,* [3]*Central University of Kerala, Department of Geology, Kasaragod, India,* [4]*Yale University, New Haven, United States of America,* [5]*National Center for Ecological Analysis and Synthesis, Santa Barbara, United States of America,* [6]*University of Delaware, Department of Earth Sciences, Newark, United States of America,* [7]*Binghamton University, Binghamton, United States of America,* [8]*Montclair State University, Department of Earth and Environmental Studies, Montclair, United States of America,* [9]*University of Florida, Department of Geological Sciences, Gainesville, United States of America,* [10]*Kyoto University, Department of Urban Management, Kyoto, Japan,* [11]*Institute of Polar Research, Tokyo, Japan,* [12]*National Institute of Oceanography and Applied Geophysics - OGS, Trieste, Italy,* [13]*James Madison University, Harrisonburg, United States of America,* [14]*Texas A&M University, Integrated Ocean Drilling Program, College Station, United States of America,* [15]*University of Salamanca, Geology, Salamanca, Spain,* [16]*Institute for Marine and Antarctic Studies, Battery Point, Australia,* [17]*University of Oxford, Oxford, United Kingdom,* [18]*Oklahoma State University, Stillwater, United States of America,* [19]*Norwegian Polar Institute, Tromsø, Norway,* [20]*The National Institute of Advanced Industrial Science and Technology (AIST), Higashi, Japan,* [21]*The First Institute of Oceanography, State Oceanic Administration, Qingdao, China, People's Republic of,* [22]*Lamont-Doherty Earth Observatory, Palisades, United States of America,* [23]*Rutgers University, Department of Marine and Coastal Sciences, New Brunswick, United States of America,* [24]*Southern University of Science and Technology, Shenzhen, China, People's Republic of*

During the past decades, an increasing number of Arctic sediment cores have been collected, yet absolute dating often results in ambiguous age models. However, lithological, petrophysical, and geochemical characteristics of single cores are often similar over large distances, allowing for correlation between different locations. Lithological, petrophysical, and geochemical patterns associated with certain paleoenvironmental intervals are, therefore, a reliable tool to correlate cores and generate relative age models. However, knowledge of such patterns is mostly restricted to the period since the penultimate glaciation.

During IODP Expedition 403 "Eastern Fram Strait Paleo-Archive" (FRAME), we drilled two sites with a total of 8 holes into the Bellsund Drift off western Svalbard. Both sites yielded high-resolution records of Pleistocene glacial-interglacial cycles influenced by the interplay of the northward-flowing West Spitsbergen Current and the dynamics of the Svalbard-Barents Sea Ice Sheet. Since the cores of each site were drilled within a few tens of meters and both sites are located in similar settings some kilometers apart, they offer the unique opportunity to distinguish between sedimentation patterns that are highly local and those that are typical for a specific period in a more regional context. For example, while the deposition of ice-rafted debris might be characteristic for a particular time interval, the distribution of single dropstones and clasts most likely differ between sites, resulting in slightly different sedimentation patterns and proxy values.

Physical properties data of all eight drill cores were investigated for recurrent patterns and combined with lithological and dinoflagellate cyst information for a first assessment of their paleoenvironmental classification. Sediments are mostly siliciclastic and partly contain ice-rafted debris, sediment pellets derived from icebergs, or are laminated possibly due to meltwater sedimentation. Dinoflagellate cyst assemblages in selected samples suggest warm North Atlantic waters for intervals with slight bioturbation and enhanced percentages of biogenic particles, most likely representing the peak interglacial. Bringing all data together, a remarkably similar pattern is observed in the physical properties for three recent glacial-interglacial cycles, characterizing the glacial termination followed by a stepwise transition into the interglacial and subsequently into the successional glacial.

Scientific Ocean Drilling on the Chukchi Borderland; What are we waiting for?

B. Coakley[1], C. Gebhardt[2]

[1]*University of Alaska, Geophysical Institute, Fairbanks, United States of America,*

[2]*Alfred Wegener Institute, Geophysics, Bremerhaven, Germany*

The Arctic Ocean is the bright white gap in our knowledge of ocean stratigraphy. While piston cores across the Arctic have revealed parts of the Quaternary history of the region, the complete lack of scientific drilling in the Amerasia Basin leaves us in the dark about its earlier history and origins. The regional stratigraphy across the Chukchi Borderland includes inferred Paleozoic and Mesozoic sediments at drillable depths overlain by a Cenozoic section. Stratigraphy observed on the Northwind Ridge and Chukchi Cap, likely pelagites are prime drilling targets. The condensed section preserved on the bathymetric highs has the potential to reveal the paleoceangraphy of the Amerasia Basin and the adjacent Arctic Pacific gateway.

The relatively thin sediments preserved here also make sampling and dating of the older sediments and basement possible. The age and composition of the basement can be constrained from samples to the south on the Chukchi Shelf (e.g., Wrangel Island), to the east in northern Alaska, to the north from dredges, and on Northwind Ridge from rocks (piston) cored. Identifying and dating basement will provide essential constraints for the tectonic reconstruction of the continental Borderland to its pre-opening position.

Multichannel seismic reflection data collected across the northern Chukchi Shelf and southern Borderland in 2011, make it possible to select drilling sites and define a variety of objectives ranging from the youngest strata to basement rocks of diverse acoustic properties, stratification, and structure. Through drilling, we will examine the complex history of the Amerasia Basin on the southern Chukchi Borderland during the Quaternary, Cenozoic and Mesozoic and perhaps earlier. Successful drilling will permit a more complete assessment of the record of western Arctic climate for comparison with that from the Southern Hemisphere and the Eastern Arctic (ACEX) as well as complementing records from Leg 323 (Bering Sea) and from Lake El'gygytgyn (Siberia). Critical temporal events include the Eocene-Oligocene shift, Mid-Miocene climate optimum, Greenhouse to Icehouse transition; Mid-Pleistocene transition; the Mid Bruhnes Event, and Quaternary super-interglacials. The western Arctic is critical for understanding the sea- level controlled history of connection with the Pacific and the tectonics of the region.

High-resolution coring of Svalbard's sedimentary record of the onset of glaciations at the Eocene–Oligocene Transition (ICDP application SVALCLIME-Hot2Cold)

D. K. Kulhanek[1], S.-A. Grundvåg[2], M. E. Jelby[3], M. T. Jones[4,5], A. Lasabuda[6,7], H. Lorenz[8], S. Planke[5,9], K. Senger[10], G. Shephard[6,11], M. Sinnesael[12], K. K. Sliwinska[13], A. Smyrak-Sikora[14], M. L. Vickers[4], V. Zuchuat[15], SVALCLIME extended science team

[1]*Kiel University, Institute of Geosciences, Kiel, Germany,* [2]*UiT the Arctic University of Norway, Department of Geosciences, Tromsø, Norway,* [3]*University of Bergen, Department of Earth Science, Bergen, Norway,* [4]*Umeå University, Department of Ecology and Environmental Science (EMG), Umeå, Sweden,* [5]*University of Oslo, Department of Geosciences, Oslo, Norway,* [6]*Centre for Planetary Habitability (PHAB), University of Oslo, Department of Geosciences, Oslo, Norway,* [7]*The University of Sydney, School of Geosciences, Sydney, Australia,* [8]*Uppsala University, Department of Earth Sciences, Uppsala, Sweden,* [9]*Volcanic Basin Energy Research (VBER), Oslo, Norway,* [10]*The University Centre in Svalbard (UNIS), Department of Arctic Geology, Longyearbyen, Norway,* [11]*The Australian National University, Research School of Earth Sciences, Canberra, Australia,* [12]*Trinity College Dublin, The University of Dublin, Department of Geology, Dublin, Ireland,* [13]*Geological Survey of Denmark and Greenland (GEUS), Geo-energy and -storage, Copenhagen, Denmark,* [14]*Norwegian University of Science and Technology, Department of Geoscience and Petroleum, Trondheim, Norway,* [15]*Commonwealth Scientific and Industrial Research Organisation (CSIRO), Kensington, Australia*

Humanity is witnessing an unprecedented period of rapid climate change due to vast anthropogenic emissions of CO_2 into the atmosphere. Without immediate action, pCO_2 will reach sustained levels comparable to the Oligocene (>450 ppm) by 2100 CE, making the transition from the early Paleogene Greenhouse to Oligocene Coolhouse climate a critical research target. Gradual cooling in the late Eocene culminated in the formation of a continental-scale ice sheet on Antarctica and establishment of the precursor to modern thermohaline circulation across the Eocene–Oligocene Transition (EOT). Declining pCO_2 and changes in tectonic gateways and ocean circulation are leading hypotheses as drivers for these changes. The formation of a deepwater proto-Antarctic Circumpolar Current after the opening of the Drake and Tasman Passages is tied to this interval, but the timing of the Fram Strait opening, which allowed cold, dense water to flow out of the Arctic and into the North Atlantic, remains equivocal. A major contributing factor to this uncertainty is the lack of high Arctic records from this critical time. To-date, the only Arctic scientific ocean drilling was IODP Expedition 302, which collected sediment dating back to the late Paleocene but the EOT is missing in an ~26 Myr unconformity that spans from the middle Eocene to early Miocene. Other planned drilling was cancelled due to geopolitics and ship availability.

The International Continental Drilling Program (ICDP) *SVALCLIME-Hot2Cold* Land-to-Sea (L2S) proposal seeks to collect drill core records from Svalbard across the EOT to test the hypothesis that the opening of Fram Strait played a major role in the establishment of global thermohaline circulation and cooling of Earth's climate. We propose to drill two deep (1–2 km) boreholes in Forlandsundet between King Karls Forland and western Spitsbergen, one onshore near Sarstangen and another in nearby shallow water (<250 m). The Forlandsundet Graben formed in the early Paleogene as the transpressive margin between Greenland and Svalbard switched to transtensional. Coring this Paleogene record will help to unravel the sequence of events that led to the opening of Fram Strait. The *SVALCLIME-Hot2Cold* preproposal submitted in January 2024 included a Late Paleozoic Ice Age target; however, based on reviewer feedback, we will submit a workshop proposal focused on the EOT objectives. Once approved, we will publish an open call for the workshop to further develop this proposal.

Deep-time Arctic climate archives: High-resolution coring of Svalbard's Permian to Paleogene sedimentary record (ICDP application SVALCLIME-P2P)

A. Smyrak-Sikora[12], M. Jones[1,2], J. Barta[3], S. Danise[4], W. J. Foster[5], S.-A. Grundvåg[6], D. K. Kulhanek[7], H. Lorenz[8], S. Planke[2,9], K. Senger[10], K. K. Sliwinska[11], L. Tarhan[13], M. L. Vickers[1], W. Xu[14], V. Zuchuat[15], SVALCLIME extended science team

[1]*Umeå University, Ecology and Environmental Science, Umeå, Sweden,* [2]*University of Oslo, Oslo, Norway,* [3]*University of South Bohemia, Centre of Polar Ecology/Department of Ecosystem Biology, Ceske Budejovice, Czech Republic,* [4]*Università degli Studi di Firenze, Dipartimento di Scienze della Terra, Firenze, Italy,* [5]*University of Hamburg, Institute for Geology, Hamburg, Germany,* [6]*UiT the Arctic University of Norway, Department of Geosciences, Tromsø, Norway,* [7]*Christian-Albrechts-University of Kiel, Institute of Geosciences, Kiel, Germany,* [8]*Uppsala University, Department of Earth Sciences, Uppsala, Sweden,* [9]*Volcanic Basin Energy Research (VBER) AS, Oslo, Norway,* [10]*University Centre in Svalbard (UNIS), Longyearbyen, Norway,* [11]*Geological Survey of Denmark and Greenland (GEUS), Geoenergy and -storage, København, Denmark,* [12]*Norwegian University of Science and Technology, Department of Geoscience and Petroleum, Trondheim, Norway,* [13]*Yale University, Department of Earth and Planetary Sciences, New Haven, Connecticut, United States of America,* [14]*University College Dublin, School of Earth Sciences, Dublin, Ireland,* [15]*Commonwealth Scientific and Industrial Research Organisation, Kensington, Australia*

Life on Earth has continued for billions of years, yet there is evidence of mass extinction events in terrestrial and marine ecosystems throughout the geological record. These extinctions often coincided with rapid global warming events known as hyperthermals, indicative of vast emissions of greenhouse gases into the atmosphere. One of the natural processes capable of causing such rapid large-scale environmental perturbations are large igneous provinces (LIPs), which are characterised by exceptionally high volumes of magma that were rapidly erupted or emplaced close to the Earth's surface. Both volcanic degassing and contact metamorphism of sediments can potentially emit large volumes of carbon into the atmosphere. However, the mechanisms that trigger such rapid environmental changes remain debated, and ecosystem responses in key regions such as mid-to high-paleolatitudes are currently underrepresented in paleoclimate archives.

The International Continental Scientific Drilling Program (ICDP) *SVALCLIME-P2P* proposal seeks to conduct systematic coring of Svalbard's nearly continuous Permian to Paleogene succession. Numerous hyperthermal and mass extinction events occurred during the Phanerozoic, including three coincident with circum-Arctic LIPs: a) The End Permian Mass Extinction and the Siberian Traps, b) Cretaceous Oceanic Anoxic Events and the High Arctic LIP (HALIP), c) the Paleocene-Eocene Thermal Maximum and the North Atlantic Igneous Province (NAIP). Svalbard hosts a high-fidelity, mid- to high-paleolatitude sedimentary record that may provide essential insights into global climate dynamics across this time period. Drilling a high-resolution paleoclimate archive will allow for the investigation of environmental and biotic responses to large-scale igneous activity and other climate perturbations at local, regional, and global scales. This will help improve our understanding of the paleolatitudinal gradients in climatic responses to global warming over geological time, such as a polar amplification to warming. Furthermore, we will investigate the mechanics shaping intrusions in sedimentary strata and their greenhouse gas potential from HALIP sills exposed around Svalbard. Finally, studying Svalbard's deep biosphere provides a key opportunity to explore the taxonomic and metabolic diversity of Arctic microbial communities and their interactions with geological and chemical properties, including lithologies variably affected by HALIP intrusions.

The paleoclimatic record of IODP Exp-403, Eastern Fram Strait Paleo-Archive

R. G. Lucchi[1], K. St. John[2], T. Ronge[3], M. A. Barcena[4], S. De Schepper[5], L. Duxbury[6], C. Gebhardt,[7] A. Gonzalez-Lanchas[8], G. Goss[9], N. Greco[10], J. Gruetzner[11], L. Haygood[12], H. Katrine[13], M. Iizuka[14], I. Kapuge[15], O. Libman-Roshal[16], Y. Liu[17], B. Reilly[18], Y. Rosenthal[19], Y. S. Sakai[20], S. Kumar A. V.[21], Y. Zhong[22], and the JOIDES Resolution Exp403 technical support team

[1]National Institute of Oceanography and Applied Geophysics - OGS, Sgonico -Trieste, Italy, [2]James Madison University, Harrisonburg, United States of America, [3]Texas A&M University, Integrated Ocean DrillingProgram, College Station, United States of America, [4]University of Salamanca, Salamanca, Spain, [5]NORCE Norwegian Research Centre,Climate & Environment, Bergen, Norway, [6]Institute for Marine andAntarctic Studies, Battery Point, Australia, [7]Alfred Wegener Institut - AWI, Bremerhaven,, Germany, [8]University of Oxford, Oxford, United Kingdom, [9]Yale University, New Haven, United States of America, [10]National Center for Ecological Analysis and Synthesis, Santa Barbara, United States of America, [11]Alfred Wegener Institut - AWI, Bremerhaven, Germany, [12]Oklahoma State University, Stillwater, United States of America, [13]NorwegianPolar Institute, Tromsø, Norway, [14]The National Institute of AdvancedIndustrial Science and Technology (AIST), Higashi, Japan, [15]Universityof Delaware, Newark, United States of America, [16]Montclair State University, Montclair, NJ, United States of America, [17]the First Institute of Oceanography, State Oceanic Administration (FIOA), Qingdao, China, People's Republic of, [18]Lamont-Doherty Earth Observatory, Palisades, United States of America, [19]Rutgers University, New Brunswick, NJ, United States of America, [20]Kyoto University, Kyoto, Japan, [21]Central University of Kerala, Kasaragod, India, [22]Southern University of Science and Technology, Shen Zhen, China, People's Republic of

The Fram Strait deep gateway connecting the North Atlantic and Arctic Oceans is a key area for paleoclimatic reconstructions and elucidating the relationships between ocean and ice sheet dynamics during past climate transitions. Such information is highly valuable to better constrain predictive models of future global changes. IODP Expedition 403 was motivated by the necessity of retrieving continuous, high-resolution depositional sequences containing the record of the paleoceanographic characteristics of the warm, northward flowing West Spitsbergen Current (WSC) and the cryosphere evolution of the paleo-Svalbard Barents Sea Ice Sheet (SBSIS). Over 5 km of sediment record was recovered by drilling 6 sediment drift sites located along the (S to N) pathway of the WSC, and at (E to W) proximal to distal settings relative to the paleo-SBSIS terminus. The initial age models based on microfossils and paleomagnetic reversals indicate recovery of expanded Pleistocene to latest Pliocene sequences in the proximal margin area containing the information of the paleo-SBSIS onset and dynamics, while in the distal settings the recovered 600+ m sequences extend into to the mid-Pliocene and the early Pliocene/late Miocene climatic transitions. Preliminary comparisons between lithologies and well-established lithofacies from shallow piston cores of the western Svalbard margin, suggest that the Exp-403 site records can be used to constrain the history of shelf edge glaciation, paleo-meltwater events, iceberg calving events, and warm periods dominated by persistent bottom current flow.

Scientific Drilling on Arctic Margins: Past Achievements & future Opportunities

T7-2

Towards a refined seismic stratigraphy for the Svyatogor Ridge (Fram Strait): Preliminary Results from Core-Log-Seismic Integration at IODP Expedition 403 Site U1620

J. Gruetzner[1], C. A. Gebhardt[1], A. Plaza-Faverola[2], S. Bünz[2], W. Geissler[1], R. G. Lucchi[3], K. E. K. St. John[4], T. Ronge[5], S. Adukkam Veedu[6], M. A. Barcena-Pernia[7], S. De Schepper[8], A. González-Lanchas[9], K. Husum[10], L. C. Duxbury[11], G. Goss[12], N. M. Greco[13], L. Haygood[14], M. Iizuka[15], A. K. I. U. Kapuge[16], A. R. Lam[17], O. Libman-Roshal[18], Y. Liu[19], L. R. Monito[20], B. T. Reilly[21], Y. Rosenthal[22], Y. Sakai[23], Y. Suganuma[24], Y. Zhong[25], the JOIDES Resolution Expedition 403 Technical Support Team

[1]*Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Bremerhaven, Germany,* [2]*UiT The Arctic University of Norway, Tromsø, Norway,* [3]*National Institute of Oceanography and Applied Geophysics - OGS, Trieste, Italy,* [4]*James Madison University, Harrisonburg, United States of America,* [5]*Texas A&M University, Integrated Ocean Drilling Program, College Station, United States of America,* [6]*Central University of Kerala, Kasaragod, India,* [7]*University of Salamanca, Salamanca, Spain,* [8]*NORCE Norwegian Research Centre and Bjerknes Centre for Climate Research, Bergen, Norway,* [9]*University of Oxford, Oxford, United Kingdom,* [10]*Norwegian Polar Institute, Tromsø, Norway,* [11]*Institute for Marine and Antarctic Studies, University of Tasmania, Battery Point, Australia,* [12]*Yale University, New Haven, United States of America,* [13]*National Center for Ecological Analysis and Synthesis, Santa Barbara, United States of America,* [14]*Oklahoma State University, Stillwater, United States of America,* [15]*The National Institute of Advanced Industrial Science and Technology, Higashi, Japan,* [16]*University of Delaware, Newark, United States of America,* [17]*Binghamton University, Binghamton, United States of America,* [18]*Montclair State University, Montclair, United States of America,* [19]*The First Institute of Oceanography, State Oceanic Administration, Qingdao, China, People's Republic of,* [20]*University of Florida, Gainesville, United States of America,* [21]*Lamont-Doherty Earth Observatory, Palisades, United States of America,* [22]*Rutgers University, New Brunswick, United States of America,* [23]*Kyoto University, Kyoto, Japan,* [24]*Institute of Polar Research, Tokyo, Japan,* [25]*Southern University of Science and Technology, Shenzhen, China, People's Republic of*

The opening and subsequent widening of the Fram Strait, the only deep-water connection between the Arctic and Atlantic oceans had fundamental consequences for the global ocean circulation and paleoclimate evolution as well as for sedimentation processes in the adjacent ocean basins and along the continental margins.

The primary goal of the International Ocean Discovery Program (IODP) Expedition 403 (Eastern Fram Strait Paleo-Archive, June to August 2024) was to reconstruct the variability of the West Spitsbergen Current (WSC) and its influence on climate changes, particularly during key climate transitions since the late Miocene. Over 5 km of sediments were recovered at 7 sites located along the pathway of the WSC.

Here we focus on Site U1620 drilled into a contouritic sediment drift on the Svyatogor Ridge. The drift is lying over young (<10 Ma) oceanic crust at the northwestern flank of the ultraslow-spreading Knipovich Ridge. It is at a distal location (~130 km) from the western margin of Svalbard and therefore shows a reduced (yet discernable) continental impact on the sedimentation. On the other hand, the paleoceanographic signal by the WSC is enhanced. The complex tectonic history and the presence and migration of methane gas are additional factors to be considered. Prior to Exp. 403, the seismostratigraphic model for the Svyatogor Ridge relied on age data from quite remote drill sites and especially the correlation across the Molloy Transform Fault was not possible.

We present an updated seismostratigraphy for the last ~3.5 Ma based on core-log-seismic integration at Site U1620 where the composite record consists of 3 holes with excellent recovery and a maximum penetration of 616 m. Core and downhole bulk density data were edited and combined. Since reliable P-wave velocity data at Site U1620 could only be obtained for the uppermost 15 m a velocity model was constructed based on data from Sites U1618 (IODP) and 909 (ODP) and used for the calculation of synthetic seismograms. Based on accurate travel-time to depth conversion we identify prominent reflectors and link them to major changes in

other physical properties (e.g., natural gamma radiation), chemical composition (e.g., major elements from XRF core scanning) and sedimentological parameters (e.g., grain size). Together with the preliminary shipboard age model this will aid first reconstructions of long-term changes in oceanic circulation and ice rafting.

T7-3

Changing sedimentation rates at Svyatogor Ridge yield insights into regional paleoceanographic, paleoclimatic, and depocenter evolution: IODP Expedition 403, Site U1620

K. St John[1], R. Lucchi[2], T. Ronge[3], J. Gruetzner[4], A. González-Lanchas[5], B. Reilly[6], Y. Zhong[7], S. De Schepper[8], K. Husum[9], M. Barcena-Pernia[10], Y. Rosenthal[11], S. Adukkam Veedu[12], C. Gebhardt[4], G. Goss[13], N. Greco[14], A. K. I. U. Kapuge[15], A. Lam[16], Y. Suganuma[17], O. Libman-Roshal[18], L. Monito[19], Y. Sakai[20], L. Duxbury[21], L. Haygood[22], M. Iizuka[23], Y. Liu[24], and the JOIDES Resolution Exp-403 technical support team

[1]*James Madison University, Geology and Environmental Science, Harrisonburg, United States of America,* [2]*National Institute of Oceanography and Applied Geophysics, Trieste, Italy,* [3]*Texas A&M University, Integrated Ocean Drilling Program, College Station, United States of America,* [4]*Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Bremerhaven, Germany,* [5]*University of Oxford, Oxford, United Kingdom,* [6]*Lamont-Doherty Earth Observatory, Palisades, United States of America,* [7]*Southern University of Science and Technology, Shenzhen, China, People's Republic of,* [8]*NORCE Norwegian Research Centre and Bjerknes Centre for Climate Research, Bergen, Norway,* [9]*Norwegian Polar Institute, Tromsø, Norway,* [10]*University of Salamanca, Salamanca, Spain,* [11]*Rutgers University, New Brunswick, United States of America,* [12]*Central University of Kerala, Kasaragod, India,* [13]*Yale University, New Haven, United States of America,* [14]*National Center for Ecological Analysis and Synthesis, Santa Barbara, United States of America,* [15]*University of Delaware, Newark, United States of America,* [16]*Binghamton University, Binghamton, United States of America,* [17]*Institute of Polar Research, Tokyo, Japan,* [18]*Montclair State University, Montclair, United States of America,* [19]*University of Florida, Gainesville, United States of America,* [20]*Kyoto University, Kyoto, Japan,* [21]*University of Tasmania, Institute for Marine and Antarctic Studies, Battery Point, Australia,* [22]*Oklahoma State University, Stillwater, United States of America,* [23]*The National Institute of Advanced Industrial Science and Technology, Higashi, Japan,* [24]*The First Institute of Oceanography, State Oceanic Administration, Qingdao, China, People's Republic of*

International Ocean Discovery Program (IODP) Expedition 403 (Eastern Fram Strait Paleo-Archive, June to August 2024) recovered the longest sediment core records from the Vestnesa and Svyatogor Ridge sediment drift sites, to date (Lucchi et al., 2024, IODP Exp.403 Prelim. Report). Insights into regional paleoceanographic and paleoclimatic histories, the interplay between the plate motion north and south of the Molloy Transform Fault (MTF), and related changes in the development of the Svyatogor Ridge sediment drift can be gleaned directly from Site U1620 shipboard data. Preliminary sedimentation rate estimates at the Svyatogor Ridge indicate a major decrease at ca. 2 Ma. Notably, this timing also coincides with the hypothesized tectonic separation of the Svyatogor Ridge from the Vestnesa Ridge by lateral sliding of the MTF that offset the Svyatogor Ridge to the west (Johnson et al., 2015, Geology 43), away from the main path of the West Spitsbergen current (WSC). The high sedimentation rates at Site U1620 prior to 2 Ma were more than double that for the (presumably) contiguous Vestnesa Ridge (Site U1618) to the North, suggesting that the Svyatogor Ridge was a more important depocenter than previously assumed. A second decrease in Site U1620 sedimentation rates at approximately 1 Ma was also observed at other Expedition 403 sites (U1618, U1619), and regionally at several ODP sites (Sites 908, 909, and 911; Thiede et al., 1995, ODP Exp 151 Sci. Results). Given that Site U1620 was already likely displaced from the main path of the West Spitsbergen Current (WSC) by 2 Ma, the decrease in sedimentation rates at 1 Ma was likely related to other large scale controls on sediment supply; whether this shift is linked to a change in the speed of WSC and/or to a change in terrigenous input to the marine system as glacial cyclicity shifted from 41 to 100 ky cycles during the Mid Pleistocene Transition (MPT), is to be determined. This decrease in sedimentation rates is concurrent with an uphole shift from clay-rich to siltier lithologies at U1620, which may suggest a change in the WSC velocity and/or further shifted position. There are fewer isolated large clasts (i.e., dropstones) after this point as well, which may instead favor an explanation tied to glacial dynamics.

T7-4

Deglacial history at the southeastern margin of the Laurentide Ice Sheet: The sedimentary record of Lake Melville, Canada

S. Kowalski[1], **C. Ohlendorf**[1], J. Matthiessen[2], C. Gebhardt[2]

[1]*University of Bremen, GEOPOLAR, Institute of Geography, Bremen, Germany,*

[2]*AWI Bremerhaven, Geosciences, Bremerhaven, Germany*

One major driving force of rapid global climate change is a shift in the Atlantic Meridional Overturning Circulation (AMOC). In the light of the current debate about a collapse of the AMOC already in the 21st century, it is crucial to find precedents of such an event in paleoclimate records. AMOC stability is controlled to a large extent by the strength of deep-water formation. During the last deglaciation, meltwater drainage events occurring at the SE margin of the Laurentide Ice Sheet (LIS) influenced deep-water formation in the Labrador Sea. Lake Melville (LM), situated at the former LIS margin, was one of the meltwater drainage pathways. Therefore, the deglacial history of the SE LIS is stored in the sediments of eastern LM.

Three LM cores were correlated to a composite profile with a length of 20.35 m which, based on AMS ^{14}C and paleomagnetic dating, reaches back to >11.2 ka cal BP (extrapolated basal age 13.2 ka cal BP). The analysis of sedimentological and XRF core scanning data using cluster and principal component analysis distinguishes five different intervals. These were used to develop a conceptual model that visualizes the retreat of the LIS across Lake Melville at its SE margin. LM initially was a subglacial lake fully covered by floating ice until 11.4 ka cal BP. Homogenous fine-grained sediments of this interval probably originate from meltwater plumes laden with glacial flour. Afterwards, westward recession of ice occurred during which LM developed from a lake partly covered by the LIS (11.4 – 8.0 ka cal BP) to a proglacial lake with the LIS margin situated to the west of the lake. Accordingly, sediments changed from laminated ice-proximal and homogenous ice-distal sediments to fine grained, moderately mottled, minerogenic sediments. Ice retreat was interrupted by two phases of ice stillstand or re-advance dated to 9.4 ka cal BP and 8.2 ka cal BP. Complete retreat of the LIS from the LM catchment was dated to 6.0 ka cal BP and is characterized by fine grained, mottled sediments with higher abundance of benthic organisms.

Our results show that, unlike previously thought, sediments of glacial times or even older interglacial times could be preserved in LM. Retrieval of these sediments may thus enable us to investigate older phases of LIS ice retreat. Our reconstruction of the LIS retreat history will increase our understanding of the timing and rates of change that are to be expected when a melting ice sheet impacts ocean circulation.

T7-5

NorthGreen – Northeast Greenland Glaciated Margin, IODP[3] Proposal

L. Perez[1], N. T. NorthGreen Team[2]

[1]*Geological Survey of Demark and Greenland - GEUS, Near Surface Land and Marine Geology, Aarhus, Denmark,*

[2]*Geological Survey of Demark and Greenland - GEUS, Aarhus, Denmark*

The Greenland Ice Sheet is identified as a tipping point element within the Earth's climate system, which under the current trend of CO_2 emissions is at risk of becoming unstable, possibly leading to a complete meltdown. Its contribution to global sea-level rise during last centuries has been a prelude to the increasing ice sheet runoff exacerbated by polar amplification. Thus, understanding the long-term stability of the Greenland Ice Sheet is critical for anticipating future climate and sea-level scenarios. While coupling between the ice sheet, ocean and sea ice is readily observable today in Northeast Greenland, geological records of past conditions and ice sheet dynamics for illuminating long-term trends are lacking.

Deep ocean records from the Nordic Seas have previously provided insights into the Cenozoic ice-ocean-tectonic evolution of the northern North Atlantic. There are, however, outstanding questions related to the past evolution and dynamics of the Greenland Ice Sheet, where the Northeast Greenland continental margin forms a missing piece of the puzzle. NorthGreen aims to cover this knowledge gap by drilling the prograded shelf margin of Northeast Greenland which is associated with major trough-mouth fans and contourite accumulations. The scientific objectives are: (1) Illuminate the timing and environmental conditions at the onset of glacial expansion; (2) understand the dynamics of the Greenland Ice Sheet during abrupt changes in atmospheric and oceanographic conditions; and (3) investigate the effects of regional tectonic and oceanographic changes on the polar cryospheric evolution. To accomplish these objectives, NorthGreen

proposes to drill twelve sites along transects crossing the Northeast Greenland continental shelf and slope. The sites are located within the Norske Trough and on the glaciated bank areas immediately south of the trough. Norske Trough represents one of the main outlets of the Northeast Greenland ice stream, which currently drains 20% of the Greenland Ice Sheet. Thus, the targeted sedimentary sequences contain high-resolution information that is directly linked to the early evolution and variability of the Greenland Ice Sheet as well as the control factors of its dynamics and their interaction through time. The region is densely covered by seismic data and several shallow core sites exist, facilitating the identification of drilling targets and development of the experimental design.

T7-6
Riksriggen – the research infrastructure for scientific core drilling to 2.5 km

J.-E. Rosberg[1], **H. Lorenz**[2]
[1]*Lund University, Engineering Geology, Lund, Sweden,*
[2]*Uppsala University, Department of Earth Sciences, Uppsala, Sweden*

Riksriggen is the Swedish national research infrastructure for scientific drilling. As such it is available to the scientific community at cost price as a research collaboration for the use in scientific projects – also outside Sweden. *Riksriggen* was used in high-profile drilling projects supported by the International Continental Scientific Drilling Program (ICDP): several up to 2.5 km deep boreholes through metamorphic, sedimentary and crystalline bedrock in the Collisional Orogeny in the Scandinavian Caledonides (COSC) project (Sweden), several hundred of meters of core drilling in unstable and partly overpressured formations in the EGER project (Czech Republic). Otherwise the infrastructure is usually used in smaller national projects. *Riksriggen*'s services include expert support from the project idea to the operational phase. With the SVALCLIME projects (Deep-time Arctic climate archives: high-resolution coring of Svalbard's sedimentary record), the research infrastructure is in the process of taking the step into the Arctic.

Riksriggen's central piece of equipment is a modern wire-line core-drilling rig that complies with safety and environmental regulations. The Atlas Copco (now Epiroc) Christensen CT20C drill rig can handle three common hole/core sizes P, H, and N (123/85 mm, 96/63 mm and 76/48 mm hole/core diameter, respectively) and has a depth capacity of around 1050 m, 1600 m, and 2500 m, respectively. The rig is crawler mounted and complemented with all required in-hole equipment for wireline core drilling. The infrastructure includes a mud cleaning and mixing system, cementing equipment, fishing tools, well heads, a blow-out preventer (BOP), and a workshop container. For downhole investigation, a geophysical borehole measurement (logging) system and an advanced hydraulic testing system with single/straddle wireline packers in all three dimensions can be supplied. Where access by road is possible, the *Stress trailer* can be deployed, which is a unique state-of-the-art instrument for measuring the state of stress in boreholes. Data management follows ICDP rules and procedures (moratorium, open data) and is conducted in close collaboration with the ICDP Operational Support Group.

This presentation aims at introducing the *Riksriggen* research infrastructure to the Arctic geosciences community and at initiating discussion on potential collaborations based on ideas for scientific drilling in the (high) Arctic.

Topical Session 8 – Talks

Open Session

Cenozoic continental margin growth off Svalbard (European Arctic) – implications for the evolution of ocean currents and ice sheets as seen from the GoNorth program and beyond

J. S. Laberg[1], O. Martinez[1], M. Weber[1], C. T. Kollsgård[1], F. W. Jakobsen[1], A. P. E. Lasabuda[2], A. Minakov[2], T. A. Rydningen[1], S.-A. Grundvåg[1], M. Winsborrow[1], A. Plaza-Faverola[1], M. Forwick[1]

[1]*UiT The Arctic University of Norway, Department of Geosciences, Tromsø, Norway,* [2]*University of Oslo, Oslo, Norway*

In this presentation, our focus is on two major paleoclimatic events of the European Arctic, i.e., the onset and evolution of 1) the pattern of inflow of sea water into the Arctic Ocean through the Fram Strait gateway, and 2) the large-scale glaciations in the European Arctic. For this, we use available 2D seismic data, including data acquired by the GoNorth program in 2022 and 2024, integrated with old (ODP) and new (IODP) scientific boreholes, as well as results from numerical modelling and outcrop investigations onshore Svalbard.
Our working hypothesis is that there have been major changes in the pattern of inflow of sea water into the Eurasian part of the Arctic Ocean during its opening, from mainly entering the western part of the ocean basin, to a gradually more important input into the eastern part. Being a moisture source, we infer that this circulation pattern may also have had an influence on the location of the initiation of ice growth. We discuss the timing of the pattern of inflow of sea water, and their potential influence on the ocean circulation in the broader Arctic Ocean.
The continental margin surrounding Svalbard is dominated by trough-mouth-fans in front of the major fjord systems, interpreted to be depocenters of glacigenic sediments from ice streams drained from ice domes in the catchment areas on Spitsbergen. Further south and east, an order of magnitude larger trough-mouth-fans relate to deposition from ice streams drained from the interior of the Barents Sea Ice Sheet. Although much less studied, also the NE sector of the Greenland continental margin shows the characteristics of a glaciated continental margins including large, overdeepened troughs. For the onset of large-scale glaciations in the northern hemisphere, our hypothesis is that these ice sheets (the Svalbard/northern Barents Sea and NE sector of the Greenland Ice Sheet) started to reach the marine realm sometime after the establishment of the Fram Strait gateway as they are overlying (and interbedded with) contouritic deposits, possibly diachronous events as will be further discussed.

Natural geological seepage offshore Northeast Greenland, Arctic Ocean

C. Böttner[1], F. W. Jakobsen[2], S. Gupta[3,4], M. Winsborrow[2], T. Nielsen[5], K. J. Andresen[1], O. J. S. Millinge[6], M. R. Asif[6], M. B. W. Fyhn[5], J. Hopper[5,7], S. Planke[8,9], R. Myklebust[10], M.-S. Seidenkrantz[1]

[1]*Aarhus University, Department of Geoscience, Aarhus, Denmark,* [2]*UiT The Arctic University of Norway, iC3: Centre for ice, Cryosphere, Carbon and Climate, Department of Geosciences, Tromsø, Norway,* [3]*University of Malta, Marine Geology and Seafloor Surveying, Msida, Malta,* [4]*GEOMAR Helmholtz Centre for Ocean Research Kiel, Kiel, Germany,* [5]*Geological Survey of Denmark and Greenland (GEUS), Copenhagen, Denmark,* [6]*Aarhus University, Department of Electrical and Computer Engineering, Aarhus, Denmark,* [7]*University of Copenhagen, Department of Geosciences and Natural Resources, Copenhagen, Denmark,* [8]*Volcanic Basin Energy Research (VBER), Oslo, Norway,* [9]*University of Oslo, Department of Geoscience, Oslo, Norway,* [10]*TGS, Oslo, Norway*

Rising concentrations of greenhouse gases in the atmosphere since preindustrial times cause the Arctic to warm at a faster pace compared to the rest of our planet. This is known as Arctic amplification and causes an exacerbation of climatic effects such as melting of the ice sheets or warming of bottom water temperatures in the ocean. In the ocean, these changes of environmental conditions may also increase greenhouse gas emissions from natural geologic sources including the gas hydrate reservoir. However, the distribution and contribution of natural geologic methane sources in the Arctic Ocean is poorly constrained, especially around Greenland. Here, we present a large geoscientific data set that comprises of 60,000 km of seismic data, 880 km^2 of bathymetric and water column imaging data, 192 sediment cores and synthetic aperture radar data (Sentinel-1) that span over the entire Northeast Greenland Shelf. Our data set documents extensive hydrocarbon seepage from the sub-seafloor through the water column and to the sea surface. Seepage is primarily focused along permeable beds, but also occurs where faults dissect the sedimentary strata. The seepage is sourced from deep petroleum systems within Northeast Greenland Shelf and is likely continuous since the Last Glacial Maximum. We use an advanced multi-physics gas-hydrate model which shows that the dissociation of gas hydrates beneath the shelf has modulated the flow of fluids and created two distinct pulses of methane release since the Last Glacial Maximum. Our new widespread discoveries of seafloor seeps in Northeast Greenland close a significant gap regarding to fluid flow in the Arctic Ocean, with wide implications for the carbon cycle of the Arctic. The seepage has been favored by the highly erosive Quaternary cycles and continuous ice retreat from the marine realm. The link between glacial retreat and fluid flow is important to understand as it will drive further fluid release glaciated margins worldwide.

New mud volcanoes discovered in the Arctic, Western Barents Sea

R. Mattingsdal[1], C. Argentino[2], G. Panieri[2]

[1]*Norwegian Offshore Directorate, Harstad, Norway,* [2]*UiT The Arctic University of Norway, Tromsø, Norway*

Until 2023, only one mud volcano (MV) was known in Norwegian waters, the Håkon Mosby MV at ~1200 m water depth on the slope west of the Barents Sea at 72 degrees north. During the AKMA3 expedition in May 2023, led by UiT The Arctic University of Norway, the Borealis MV was discovered on the western Barents Sea shelf at only 390 m water depth. Then, in May 2024 the EXTREME24 expedition, also led by UiT The Arctic University of Tromsø, discovered as many as ten new MVs at 440-480 m water depth on the westernmost parts of the Barents Sea shelf. The Borealis MV is characterized by a cluster of craters on the seafloor ~500 m in diameter, ~20 m deep, with an active gryphon (~ 7 m in diameter and 2 meters high) expelling warm fluids, gas and traces of oil. A cluster of acoustic gas columns visible on multibeam echosounder (MBES) water column data are associated with the MV, some even reaching the sea surface. The Borealis MV is located 110 km ENE of the Håkon Mosby MV in the eastern parts of the Sørvestsnaget Basin. Here, prograding Plio-Pleistocene sediments are sub-cropping at the Upper Regional Unconformity (URU) and are covered by a ~300 m thick horizontally layered Quaternary package. Below the seafloor-craters 3D-seismic data indicates a 500-600 m wide seismic chimney rooted at a shallow gas anomaly at URU-level. Bright spots indicating shallow gas are also present at several levels in the overlying Quaternary package around the seismic chimney. The ten new MVs discovered in 2024 forms a MV complex located in the northern Sørvestsnaget Basin, ~112 km NNE of the Håkon Mosby MV and ~71 km NW of the Borealis MV, along a 65 km long bathymetric transect. These MVs are all characterized as flat-topped seafloor mounds, 200-900 m wide and 2-12 m high. On seismic data all these MVs have very distinct shallow seismic chimneys rooted from the infilling in a buried Pleistocene mega-slide just below URU-level, and they are covered by ~350 m of horizontally layered Quaternary sediments. The seafloor locations of these MVs are all vertically above just west of the buried old slide scar headwall, clearly indicating a relationship. The seismic data from the MV complex show little evidence of seismic bright spots, and no acoustic gas flares were observed in the MBES water column data. However, ROV-investigations confirmed an active mud volcano system with seafloor chemosynthetic habitats, carbonate crusts and fluid flow features.

Geologic Controls on Marine Terminating Glaciers

M. O'Regan[2], M. Jakobsson[2], K. Faehnrich[3], E. V. Sørensen[4], J. R. Ineson[4], J. R. Hopper[1], L. Mayer[5]

[1]*GEUS, Univ. of Copenhagen, Copenhagen, Denmark,* [2]*University of Stockholm, Stockholm, Sweden,*
[3]*University of Adelaide, Adelaide, Australia,* [4]*GEUS, Copenhagen, Denmark,*
[5]*University of New Hampshire, Durham, NH, United States of America*

To first order, the stability of marine outlet glaciers is controlled by bed topography and the strength of underlying substrates. These are strongly influenced by the nature of the subsurface geology, including both the lithology as well as the structural development of a region. In North Greenland, recent mapping of the fjord systems has discovered a number of bathymetric sills that play a strong role in the evolution of the outflow glaciers, not just in terms of how they interact with the solid earth, but also in controlling the oceanographic boundary condition by restricting or enhancing inflow of warmer waters. The geology of northern Greenland is dominated by the east-west Franklinian Basin, an Ediacaran to Silurian extensional basin characterized by carbonate-dominated shelf sedimentation in the south and deposition of siliciclastics in deep-water environments to the north. The shelf - deep-water basin boundary was controlled by two east-west structures, namely the Harder Fjord Fault Zone (Ediacaran - earliest Ordovician) and the Navarana Fjord escarpment (Early Ordovician - Early Silurian). The basin was subsequently modified and exposed by the Ellesmerian Orogeny (~400-260 Ma) and Eurekan (~53-34 Ma) that resulted in intense deformation and metamorphism in northernmost North Greenland flanked to the south by a fold and thrust belt that coincides broadly with the shelf-basin transition and passes farther south into undeformed shelf strata. Previous work in Sherard Osborn Fjord has documented the presence of two significant east-west trending bathymetric sills that have played an important role in stabilizing Ryder Glacier's ice tongue by impeding the inflow of warmer Atlantic waters. These sills occur within the depositional and tectonic transition zone and can be directly correlated with major structural and lithological features in the bedrock. In this presentation we review the geological development of northern Greenland and its potential impact on the glacial development of the margin with focus on the newly mapped Victoria Fjord and implications for other parts of Greenland's glaciated margins.

Assessing coastal hazard impacts in Arctic Alaska

N. Nieminski[1], K. Horen[1], J. Christian[2]

[1]*Alaska Division of Geological & Geophysical Surveys, Anchorage, Alaska, United States of America,*

[2]*Alaska Division of Geological & Geophysical Surveys, Fairbanks, Alaska, United States of America*

Arctic Alaska's isolated and extreme environment has led to limited data that document its amplified coastal hazards due to climate change. Yet Alaska's coastal communities are becoming increasingly more vulnerable to flooding and erosion associated with likely escalating frequency and severity of storms and high tides. Furthermore, impacts of these facotrs are compounded by sea ice retreat and permafrost degradation. Although local and statewide hazard mitigation decisions require a defined understanding of current and projected risk, most rural Alaskan communities lack the baseline data, historical storm records, and/or assessments of storm impacts necessary to develop well-informed adaptation strategies. To investigate the effect of climate change in Arctic Alaska, the state's Division of Geological & Geophysical Surveys (DGGS) is implementing new methods to identify historical storms and to augment opportunities for community-led data collection that will increase the temporal resolution of data and help guide future activities aimed at hazard assessment, mitigation, and adaptation. The DGGS recognizes the value of including local and traditional knowledge for flood and erosion risk assessment to ensure that community-specific concerns and observations are documented in each assessment. The DGGS is also developing online tools to make the data more accessible and useful to remote community members. Efforts of community-based monitoring and collection of repeat elevation data in the Arctic communities of Point Lay, Wainwright, Point Hope, Utqiagvik, and Kaktovik are aimed at continuing to monitor and quantify the staggering volumes of land loss due to erosion and to helping evaluate the efficacy of various mitigation efforts such as the use of sandbags, riprap, engineered rock revetment, and nature-based solutions. Furthermore, when placed in the context of longer-term temperature, weather, and sea ice data, this work provides insights into to the possible future impacts of emergent Arctic storm events and may help guide the development of erosion mitigation strategies that can ensure the resilience of Arctic Alaska's coastal communities facing a changing climate.

Fossil woods of Larix Miller from Paleogene fossil plant „Lagerstätten" of the Canadian Arctic Archipelago – insights into high latitude paleoenvironment

M. Dolezych, LePage, B. A.[2], Reinhardt, L.[3]

[1]*Senckenberg Natural History Collections Dresden, Palaeobotany, Dresden, Germany*,

[2]California Department of Public Health, Richmond, CA, USA

[3]Federal Institute for Geosciences and Natural Resources, Hannover, Germany

The occurrence of the *Larix* wood, *Piceoxylon laricinoides* (Høeg) Dolezych in the late Paleocene Mount Lawson Formation of the Split Lake area (Ellesmere Island) is the earliest known fossil wood species of *Larix*. The fossil material was recovered from a fossil forest which is composed of coal bearing fine-clastic accumulations.
The fossil *Larix* wood, *L. altoboralis* LePage *et* Basinger *emend.* Jagels, LePage *et* Jiang was recovered from the middle Eocene Buchanan Lake Formation, Eureka Sound Group, in the area of the Geodetic Hills, Axel Heiberg Island. This fossil wood is preserved in a sandy facies near the top of Rickett's Upper Coal Member.

The structure of these fossil wood specimens is most comparable to the wood of the living genus *Larix*. The similarities are seen in the following: the woods are coniferous with distinct growth rings, an abrupt transition from the early- to the late wood, rare occurrence of axial parenchyma, uniseriate and biseriate bordered pits, high rays, thick- and pitted horizontal and tangential ray walls, piceoid cross-field pits, vertical resin ducts with more than 9 epithelial cells, and a majority of the ray tracheid pit borders were of "*Larix* type". These descriptions fit into the genus *Piceoxylon* Gothan 1905. Therefore, we propose a combination in *Piceoxylon altoborealis* (LePage *et* Basinger *emend.* Jagels, LePage *et* Jiang 2001) *comb. nov.*

Further evidence that the woods have an affinity to *Larix* is provided by the assigned findings of seed cones, leaves, and twigs bearing short shoots of *Larix altoborealis* LePage et Basinger in large numbers.

The described wood has, in particular because of its autochthonous origin, a potential for palaeoecological reconstruction, inter alia, as these fossils represent constituents of vegetation growing under high latitude conditions at high latitude.

Tracing thermal fluid systems at Woodforden area, Svalbard, Norway: a hydro- and gas isotope study

H. Kämpf[1], S. Niedermann[2], K. Senger[3]
[1]*GFZ German Research Centre for Geosciences, 3.2, Potsdam, Germany,*
[2]*GFZ German Research Centre for Geosciences, 3.1, Potsdam, Germany,*
[3]*The University Centre in Svalbard, Department of Arctic Geology, Longyearbyen, Norway*

The world´s northernmost onshore thermal spring systems are located along the N-S trending Breibogen Fault Zone in NW Spitsbergen. The springs occur at three main locations, called the Troll, Jotun and Gygrekjelda complexes. The springs exhibit temperatures of 19.1 to 24.4°C. The target area contains three Quaternary subglacial volcanic complexes, which testifies to recent magmatism associated with the same fault zone. Especially, the isotope ratios serve as natural tracers to address the proposed mode of hydrothermal convection system along the Breibogen Fault Zone feeding the thermal springs.
We have visited all spring systems in July 2023, conducting detailed mapping of the sites using drone-based photogrammetry and sampling of water and gas samples.
The isotope composition (H-2, O-18) of mineral and thermal water, compared to surface and seawater samples, suggests meteoric precipitation as a main source. $^{3}He/^{4}He$ ratios were measured since they are the best tool to trace the mantle-crust fluid mix of gas. The air-normalized $^{3}He/^{4}He$ ratios of gas samples from Troll and Jotun range from 0.34 to 0.49 Ra, at negligible atmospheric He contributions ($^{4}He/^{20}Ne$ = 500 – 1000). This means that the mantle-derived He fraction (in relation to the Subcontinental Lithospheric Mantle signature of 6.1 Ra) amounts to between 5.6 and 8%. The $^{40}Ar/^{36}Ar$ ratio of gas samples from Troll and Jotun is ~305 and the carbon isotopic ratio ($\delta^{13}C$) of CO_2 ranges from -8.9 to -13.7‰.
The results imply that mantle-derived fluids do play a role at the Breibogen Fault Zone, but not the dominant one. Regarding the origin of gases of the thermal fluid system, we assume a mixing of air from melted permafrost ice, a crustal gas component and ascending gas from a magma source in near surface depth. The thermal springs at the Breibogen Fault Zone are interesting examples to understand convection of fluid systems in general. At the thermal spring sites the fluid migration is directed from depth to surface (up gradient fluid flow; indication: mantle-derived He fraction). In areas between the thermal springs the water is migrating to depth (down gradient fluid flow; indication: meteoric origin of thermal water).

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