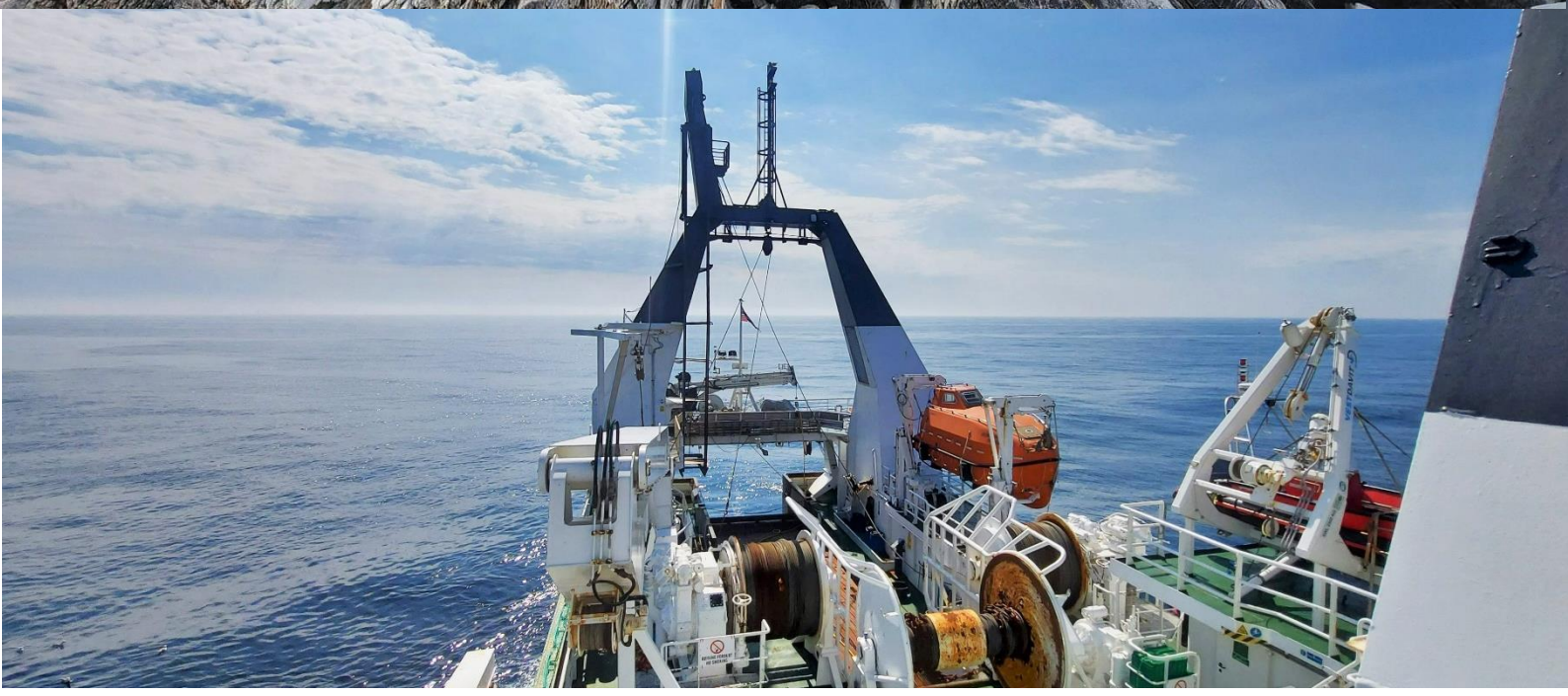
GReAT: Geoscience Research Academy of Tromsø

Annual Meeting November 23rd 2022

Department of Geosciences





Geoscience Research Academy of Tromsø

UiT Norges arktiske universitet

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PROGRAMME FOR THE GReAT MEETING 23.11.2022

				CHAIR OF SESSION
10.00	***10.10***	**Welcome**		
10.10	*10.25*	Stephan Höpfl	Oral presentation	Max Weber and Griselda Anglada-Ortiz
10.25	*10.40*	Frances Cooke		
10.40	*10.55*	Marie Stetzler		
10.55	*11.10*	Przemyslaw Domel		
11.10	***11.25***	**Break**		
11.25	*12.00*	Julian Janocha Christine Lockwood-Ireland Frank Jakobsen Adele Westgård	Poster	
12.00	***13.00***	**Lunch**		
13.00	*13.15*	Marina Galindos Alfarache	Oral presentation	Marie Stetzler and Stephan Höpfl
13.15	*13.30*	Max Weber		
13.30	*13.45*	Griselda Anglada-Ortiz		
13.45	***14.00***	**Break**		
14.00	*14.35*	Marie Bulínová Cornelia Mentzoni Binde Orlando Martinez Freya Sykes	Poster	
14.35	***14.50***	**Prize evaluation committee meet**		
14.50	***15.00***	**Goodbye and prizes**		

PRIZE EVALUATION COMMITTEE

Presentations: Katarzyna Melaniuk and Henry Patton

Posters: Sofia Kjellman and Giuliana Panieri

TECTONIC POSITION AND EVOLUTION OF THE BALSFJORD SERIES IN THE NORTH NORWEGIAN CALEDONIDES

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The Balsfjord Series in Troms and Finnmark, N-Norway is part of a thrust-related nappe stack emplaced during the Ordovician–Silurian Caledonian orogeny. It overlies the Lyngen Magmatic Complex and Reisa Nappe Complex in the E and is overlain by the Nakkedal and Tromsø nappes in the W. Past research on the geological history of the Balsfjord Series was only undertaken locally and the tectonic meaning of this unit is still poorly understood. The structural evolution of the Balsfjord Series is characterized by three sets of deformation structures. This includes original bedding S0 that is boudinaged in low-grade areas and folded in higher-grade regions (F1). These F1 structures are formed together with a penetrative metamorphic foliation S1. A second deformation phase F2 locally folds the metamorphic fabric S1. The latest set of structures is represented by steep F3 folds which become increasingly accentuated closer to the contact of the Balsfjord Series with the Lyngen Gabbro. P-T estimates show that the Balsfjord Series features an inverse metamorphic gradient with conditions increasing from the SE towards the W and NW. Thermodynamic modelling revealed maximum P-T conditions of ~450°C and 6.5 kbar in the lowermost parts of the unit, increasing up to 600 °C and 8 kbar in the uppermost levels. U–Pb dating of the peak mineral assemblage yielded an age of 443±3 Ma. Our observations together with published data from the surrounding units suggest the following tectonic scenario. The uppermost Tromsø and Nakkedal nappes reached their metamorphic peak at ca. 450 Ma. Final exhumation of these units likely occurred during underthrusting and prograde metamorphism of the Balsfjord Series at ~440 Ma. Underthrusting of the Reisa Nappe Complex under the Tromsø+Nakkedal+Balsfjord+Lyngen nappe assembly occurred synchronous, with its uppermost part reaching metamorphic peak conditions also at ~440 Ma, followed by exhumation at ~430 Ma.

SUB-SEABED SEDIMENT DEFORMATION ASSOCIATED WITH EPISODIC SEEPAGE OVER THE LAST 1.2 MA AT VESTNESA RIDGE, EASTERN FRAM STRAIT

Cooke, F.[1], Plaza-Faverola, A.[1], Bunz, S.[1], Knies, J.[2], Sultan, N.[3], Ramachandran, H.[4], Patton, H.[1], Singhroha, S.[1]

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Seafloor hydrocarbon seepage is a natural fluid release process that occurs worldwide on continental shelves, slopes, and at deep oceanic basins. The Vestnesa sedimentary ridge in the eastern Fram Strait hosts a deep-water gas hydrate system that started to be charged with hydrocarbons ~2.7Ma and has experienced seepage along the entire ridge until a few thousand years ago, when seepage activity apparently ceased in the west but persisted in the east. Although it has been documented that faults and fractures play a key role in feeding the seeps with thermogenic gases, the mechanisms controlling seepage periodicity remain poorly understood. Here we integrate high resolution P-cable 3D seismic data and chirp data to investigate the spatiotemporal evolution of fractures and fluid flow features at a scale that has not been attempted before. Multiple seismic attributes reveal two highly fractured intervals and associated small scale fluid flow features (< 20 m diameter) with peak events corresponding to ~0.1 and ~1.1Ma chronostratigraphic periods. These periods of deformation appear associated with buried pockmarks and with the free gas-hydrate interface. We discuss the influence of gas hydrate dynamics and major climatic events over the past 1.2 Ma on sediment deformation and seafloor seepage periodicity at this Arctic deep water oceanic basin. Our results have implications for understanding how changes in eustatic sea level, glacial isostatic loading and sedimentation rates through key climatic periods impacts fracture formation and the control on seepage activity.

METHANE DISSEMINATION AT A MARINE VENTING SITE IN THE CENTRAL BARENTS SEA

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As methane is a greenhouse gas 28 times more powerful than CO_2 over 100 years and an important input to local biogeochemical cycling, it is crucial to determine its fate at marine seepage sites (cold seeps) throughout the water column and potentially to the atmosphere. At cold seeps, bubble characteristics (bubble coating, rising speeds and size distributions) constrain methane transport and hence concentrations through the water column. Using a newly developed device, rising bubbles at a seep site in the central Barents Sea have been recorded. From analyzing these images, bubble characteristics can be constrained. These valuable small-scale results are fed into the bubble analysis plugin (VBALab) of the ESP3 software (M. Veloso; Ladroit et al. 2020). From hydroacoustic data collected in the wider seepage area, it can then estimate gaseous methane fluxes to the water column. Dissolved methane concentrations were investigated from water samples collected at discrete water depths using a CTD-rosette. Results indicate variations in concentrations over 5 orders of magnitude ($3 – 4.9*10^4$ nM) with highest concentrations and steepest gradients in vicinity of bubble streams and throughout the deepest water layers (below 200-250 m depth). In the sea surface layer, methane concentrations are close to the background value in equilibrium with the atmosphere (3.5 nM). Fluxes to the atmosphere are therefore expected to be insignificant.

LOCAL SEISMICITY IN THE FRAM STRAIT CONSTRAINED FROM OCEAN BOTTOM SEISMOMETERS: IMPLICATIONS FOR FLUID FLOW AND METHANE SEEPAGE

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[3] University of Bremen, Faculty of Geosciences, Bremen, Germany
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Tectonic forces lead to faulting and can influence fluid-flow related processes in sedimentary basins. In the Fram Strait, several-kilometers-thick contourite deposits developed over oceanic crust in proximity to the oblique spreading Molloy (MR) and Knipovich Ridge (KR). These sediments are gas charged and are under a complex stress regime resulting from the simultaneous occurrence of mid-ocean ridge spreading and glacial isostacy. The effect of regional faulting and crustal deformation on fluid dynamics and gas release to the ocean remains poorly constrained. Critical information can be inferred from the study of local earthquakes' locations and magnitudes. However, conventional studies using land instrumentation provide incomplete seismological records for deep ocean environments. Observations of weak events are limited due to remoteness of the area and distance to the nearest permanent observatories onshore. We deployed 10 ocean bottom seismometers (OBS) for 11 months close to the northern termination of KR, where Molloy Transform Fault (MTF) intersects from the west and propagates further eastward, beyond the KR ridge valley. OBSs are spread around an area with observed fault-related seepage and sedimentary slumps visible on bathymetric data. Using partially automated routines we built a catalogue of local earthquakes with magnitudes down to ca.1.0 (i.e., improved sensitivity vs land data). Obtained results provide a better delineation of tectonic structures and weakness zones at the ridges' intersection and more robust estimation of oceanic plates' boundaries. We observed local seismicity close to both Vestnesa Ridge crest and shelf break edge, directly in the areas with most abundant seepage reported for the margin. We discuss the potential effect of the documented local seismicity on seepage dynamics and sub-seabed sediment deformation. Direct indications of earthquakes close to gas release sites and strong energy events nearby the spreading ridges suggest that crustal deformation may influence fault-controlled gas release in the Fram strait.

The Upper Carboniferous Hyrnefjellet Formation on Svalbard: An update on the depositional evolution

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The Hyrnefjellet Formation contains the oldest sediments in the Inner Hornsund Trough on Spitsbergen, the largest island of the Svalbard archipelago. The Formation has last been studied in detail during the 1960's and 80's. The Inner Hornsund Trough is one of five Upper Carboniferous rift basins on Svalbard. The onset of rifting of the Upper Carboniferous rift basins coincides with a climatic shift from humid to arid and a regional transgression. The Hyrnefjellet Formation consists of upward coarsening cycles of red mud- and sandstones and conglomerates deposited in a terrestrial alluvial fan setting and grades upwards into the carbonate dominated Treskelodden Formation. In this study we have combined classical sedimentological fieldwork with airborne photogrammetry to investigate the depositional evolution of the Hyrnefjellet Formation. From stratigraphic logging as well as digital outcrop models we were able to identify several syn-sedimentary faults within the Hyrnefjellet Formation.

Reconstruction of bottom current activity north of Svalbard on orbital and millennial-scales during the last 150,000 years.

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

TOWARDS A BETTER UNDERSTANDING OF THE GLACIAL DEVELOPMENT OF THE NE GREENLAND MARGIN

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The configuration of high-latitude continental margins has been modified through the Late Cenozoic by a series of glacial cycles; eroding, reworking and depositing vast amounts of sediments along the shelves and slopes. By studying the sedimentary deposits on glaciated margins, researchers can reconstruct past ice sheet extents, dynamics and responses to climate changes. Studies on the western and southern Greenland shelf have indicated that within the Late Cenozoic, multiple glacial advances reached the shelf edge, depositing thick sequences of glacial debris along the shelf edge and slope, expanding the margins. Yet, partly because of inaccessibility due to rough sea ice conditions, and partly due to spatially low data coverage, only a few and sparce similar studies have been conducted on the NE Greenland shelf, despite it being the widest on the whole of Greenland. Through the last two decades, however, the regional coverage of 2-D seismic data on the NE Greenland shelf has multiplied and may now serve fundamental research pursuing a geological understanding of this region. This ongoing study uses a regional 2-D seismic dataset, acquired by multiple contractors and institutes in the period 1995 – 2014. The aim is to improve our understanding of the Late Cenozoic glacial development of the NE Greenland margin between 75 - 80°N. Regional mapping of key seismic horizons are used to reconstruct major shelf wide glacial advances and respective ice stream configurations. Prograding reflections, interpreted to be of glacial origin, show that several large ice streams reached the NE Greenland shelf edge multiple times during this period. Regional mapping of the prograding reflections suggest a clear change in ice stream location and intensity between various glacial cycles.

LARGE-SCALE CULTURING OF POLAR PLANKTIC FORAMINIFERA FOR GEOCHEMICAL PROXY DEVELOPMENT

Westgård, A.[1], Meilland, J.[2], Chalk, T.B.[3], Sykes, F.E.[1], Chierici, M.[4], Milton, J.A.[5], Kucera, M.[2], Foster, G.L.[5], Ezat, M.M. [1]

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[5] National Oceanography Centre Southampton, University of Southampton, Southampton, England

Past records of cryosphere-ocean-climate interactions provide invaluable context to gain insight into future climate scenarios. However, a lack of robust proxy calibrations remains a challenge in studying Arctic Ocean palaeoceanography. We have conducted culturing experiments on the polar planktic foraminifera (single-celled protist) species *Neogloboquadrina pachyderma* to establish a proxy toolbox for surface ocean hydrographic conditions at high latitudes. We are exploring the potential of element ratios, including Na/Ca, B/Ca and Ba/Ca as proxies for salinity, carbonate chemistry, and e.g., terrestrial freshwater input respectively. We also aim to calibrate the Mg/Ca paleothermometer for polar environments (<7°C). Over two consecutive summers, we collected and cultured ~1500 healthy, juvenile specimens of *N. pachyderma* from the Greenland Sea. They were placed into treatments of independently variable conditions based on a realistic range of past and future conditions. This included treatments for salinity ranging from 29 to 37.5 ‰, temperature from 2 to 7°C, barium from 5 to 42 ng/ml and decoupled carbonate chemistry with pH from 7.65 to 8.35 (total scale) and carbonate ion concentration from 73 to 250 µmol/kg. A barium isotope spike was added to all treatment water. We observed calcification of new chambers, addition of crust (thick outer calcite) and overall low mortality across all treatments. The observations suggest that *N. pachyderma* is resilient to changing conditions, which has implications for future culturing studies as well as the species' response to ongoing ocean warming and acidification. Spring 2022, we analysed trace element abundances of ~300 laboratory grown *N. pachyderma* specimens using Laser Ablation ICP-MS. This produces high-resolution geochemical profiles of the shell wall sufficient for identifying intra-shell geochemical variability which can be used to e.g., distinguish crust and ontogenetic calcite in our proxy calibrations. We clearly identify the presence of the barium-isotope spike in the preliminary data, distinguishing between laboratory- and ocean-grown calcites. This will

significantly improve the applicability of the proxy calibrations as well as our understanding of crust formation in this species.

Preliminary tectonic reconstruction of the Lyngen Magmatic Complex

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The Lyngen Magmatic Complex (LMC) is the lowest unit of the Lyngsfjellet Nappe (Upper Allochthon, North Norwegian Caledonides). The fabrics of the LMC rocks comprise very different strain states - from undeformed to mylonitic. The mineral assemblage of the undeformed rock is gabbro-noritic, formed primarily by An93 plagioclase, enstatite and augite. Deformed fabrics developed successively at lower amphibolite, epidote-amphibolite and greenschist metamorphic grades, i.e. on a retrograde temperature-path. Two deformation events are distinguished in the LMC: (1) an earlier shearing that has produced a N—S-trending vertical foliation with a more or less horizontal stretching lineation, and (2) a thrust contact with the lower nappe series at the base of the meta-gabbro-norite. In this contact region, the earlier vertical foliation is rotated into a flat-lying orientation and displays an ESE-trending stretching lineation.

For electron microprobe (EMP) analysis, we subdivided the samples with deformed fabrics into two groups, based on the orientation of the stretching lineation and foliation observed in the field. The first group of rocks are associated with the N—S oriented stretching lineation, dominant in the northern portion of the LMC (from Lyngstuva to the north side of the Kjosen fjord). The amphibole compositions of these rocks vary from core to rim, showing a trend from pargasitic to actinolitic composition. This trend is consistent with the transition from high- to low-temperature amphibolite/greenschist. U-Pb geochronological analysis of titanite associated with the greenschist grade in meta-gabbro-norite assemblages indicates an age of 485±9 Ma. We interpret this value as a deformation/metamorphic age, because the analysed titanite forms from pargasite breakdown and aligns parallel to the deformed fabric. This deformation age is more or less identical to the crystallization age of the LMC (481±6 Ma, Augland et al., 2014). We therefore interpret that the deformation associated to the N—S oriented stretching lineation and vertical foliation was produced at the sea floor by strike slip movements during the formation of the LMC.

The second group of rocks is associated with a stretching lineation oriented WNW—ESE, dominant in the southern portion of the LMC. This orientation is typical for the nappe structures of the Scandian collisional stage of the Caledonian orogeny and therefore we associate the development of these fabrics with this event. Close to the lower boundary of the LMC we observe garnet-bearing amphibolites. Thermobarometric estimates result in conditions of 650°C and 10kbar. This temperature is in contrast with the Raman spectroscopy values averaging around 530°C for the graphite bearing sediments below the lower contact of the LMC, i.e. sediments between the meta-gabbro-norite and the underlying Reisa nappe. The temperature difference between the N—S and WNW—ESE fabrics indicates re-heating of the meta-gabbro-norite during the second event (i.e., ESE-trending stretching lineation).

An early Cenozoic shelf basin succession – mixed marine deposits from onshore Svalbard (Norway)

Weber, M.[1], Grundvåg, S-A.[1], Laberg, J.S.[1], Rydningen, T.A.[1], Lasabuda, A.P.E.[1,2], Knutsen, S-M.[1,3]

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The early Cenozoic Forlandsundet Graben is a narrow, fault-bounded basin located on the sheared and rifted West Spitsbergen continental margin. Its development is debated and may be linked to a late phase of Eurekan deformation in the Eocene and more importantly opening of the Fram Strait in the early Oligocene. The latter is the only deep-water gateway which connects and allows thermohaline-driven water exchange between the Arctic and Atlantic Oceans. The Fram Strait presumably opened following dextral strike-slip movements, rifting, and subsequent seafloor spreading between Greenland and Svalbard. The Forlandsundet Graben may thus represent its precursor and is a key area to unravel the timing and sequence of events which eventually established the seaway. In this study, we combine sedimentological data from the exhumed basin fill strata of the Forlandsundet Graben with reflection seismic data from West Spitsbergen margin to investigate the tectono-sedimentary evolution of the basin and the nearby margin. Our sedimentological investigations shows that the early basin fill, which is dominated by terrestrial fanglomerates plastered to the inferred basin margin, gradually transitions upwards into fluvio-deltaic sandstones and offshore mudstones, implying a gradual deepening of the basin. The upper part of the basin fill is characterized by a several kilometers thick succession of sandstones and conglomerates deposited by various gravity flows, as well as intercalated hemipelagic mudstone units, collectively recording excessive creation of accommodation space in combination with an immense influx of clastic sediments. Although the establishment of a narrow seaway surely would have promoted interaction between gravity flows and bottom currents, as well as bottom current reworking, we find few compelling evidence of such processes. Here we present preliminary results from two field seasons on Svalbard and seismic interpretation from offshore areas.

OCEAN ACIDIFICATION EFFECTS ON PLANKTIC CALCIFIERS AND BIOLOGICAL PUMP EFFICIENCY

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Anthropogenic activities are causing global environmental changes, such as ocean warming and acidification. Effects of ocean acidification have been observed in different planktic marine calcifiers such as foraminifera, shelled pteropods and coccolithophores. These taxa dominate the pool of inorganic carbon and contribute significantly to the ocean carbon cycle. However, the distribution of these organisms in the Barents Sea (Arctic Ocean), that is considered a hotspot for ocean acidification, is still poorly understood. Thus, to be able to predict the effect of ocean acidification, we need to understand both their seasonal distributions and how their populations have evolved in a pre-industrial environment influenced by natural variations. We have assessed their seasonal changes in abundances and carbon fluxes with samples collected in August, December 2019, and March, May, and July 2021. For each cruise, we repeatedly sampled seven stations along a latitudinal transect in the northern Barents Sea. We have found higher abundances and larger specimens in summer and autumn, compared to late winter, and at the seasonally sea-ice covered stations, therefore we estimated higher carbon export productions. Moreover, we aim to reconstruct the environmental changes over the last thousand years in the northern and southern Barents Sea. To do so, we have analyzed the abundance, size, and species distribution of planktic foraminifera together with $\delta^{13}C$, $\delta^{18}O$ and total organic carbon in the sediment. The age models were built based on ^{210}Pb and extended with ^{14}C dates and suggest that the post-industrial revolution (since 1850) was recorded by the upper half of both cores. In the northern Barents Sea, low concentration of planktic foraminifera (*Neogloboquadrina pachyderma*) contrasts with the higher foraminiferal abundances and biodiversity recorded in the south. For both sites, the abundance of foraminifera decreases towards the recent times and the preservation state of the shells degraded, notably since the start of the industrial revolution.

THE INFLUENCE OF HYDROLOGY ON METHANE PRODUCTION IN SEDIMENTS OF SUBARCTIC LAKES

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Northern lakes are globally significant sources of atmospheric methane (CH_4) and are especially sensitive to environmental changes. Due to ongoing climate change (e.g., increasing mean annual air temperature, changes in precipitation and seasonality), many Arctic and subarctic lakes are at risk of transitioning from a clearwater into a brown-water state. However, little is known about the direct effects of this transition on the CH_4 cycle in lake sediments. Here, we seek to improve our understanding of methane related processes in subarctic lake sediments to help to improve the predictions of future CH_4 emissions from Arctic lakes. Through high-resolution sampling of lake sediment cores, we investigate sediment CH_4-production responses to various hydrology and landscape variables. We collected short lacustrine surface sediment cores (40-60 cm) using a gravity corer from two sets of lakes with different hydrology. One set is located in northern Norway (4 lakes: Troms area); the other, following a precipitation gradient increasing from the coast towards inland in northern Sweden (3 lakes: Abisko area). We explore the potential to predict variability in sediment CH_4 concentrations from different variables (landscape and hydrology factors, sediment depth, total organic carbon (TOC), $\delta^{13}C$-TOC, dissolved inorganic carbon (DIC), $\delta^{13}C$-DIC). Our preliminary results indicate most variability in sediment CH_4 concentration may be related to the groundwater input, however the lowest CH_4 concentration was measured from a glacial meltwater-fed lake. Overall, CH_4 concentration is stable below the upper 30 cm of sediment, whereas in this upper interval, we observe a decrease in CH_4 concentration caused by CH_4 consumption.

HYDROTHERMAL VENTING DRIVING EXTREME GLOBAL WARMING AT THE PALEOCENE-EOCENE BOUNDARY

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The opening of the Norwegian-Greenland Sea during the Paleogene was accompanied by episodic, but extensive and voluminous magmatism along the rift margin. The NE Atlantic conjugate margins now consists of volcanic products such as flood basalt deposits, igneous sill intrusions and other volcanogenic sediments. Periods of increased magmatic activity during the Paleogene appears to coincide with environmental perturbations such as the Paleocene-Eocene Thermal Maximum (PETM), and several studies both onshore and offshore reveal a spatial relationship between igneous sills and vent structures known as hydrothermal vent complexes (HTVCs). HTVCs are conduits formed in response to contact metamorphism of organic-rich sedimentary strata in the sill aureole, leading to the generation of hydrothermal gases and fluids that are eventually released at the paleo-seafloor. The spatiotemporal relationship between sills, vents and global warming events have led researchers to suggest that hydrothermal venting of thermogenic gas may have contributed to the increased temperatures and warmer climate represented by e.g., the PETM. Being the most significant global warming event of the Cenozoic, the exact mechanism driving the PETM must be better constrained. To understand the link between magmatism and periods of global warming, we are analyzing the distribution of extrusive/intrusive magmatic products and the relationship between igneous sills and HTVCs on the Møre and Vøring volcanic margins, offshore Norway. This study relies primarily on interpretation of high-resolution 3D seismic data from the margins (courtesy of TGS and CAGE/UiT), and integration of International Ocean Discovery Program (IODP) drilling data from Expedition 396: Mid-Norwegian Margin Magmatism and Paleoclimate Implications.

MID - LATE CENOZOIC EVOLUTION OF THE NORTHWESTERN AND NORTHERN BARENTS SEA-SVALBARD MARGIN: GREENHOUSE TO PRESENT ICEHOUSE CONDITIONS

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The Northern Barents Sea-Svalbard continental margin and the Yermak Plateau is a key area to study the interplay between tectonic, magmatic, and sedimentary processes that created and shaped the Eurasia Basin. During the early Miocene (23-17 Ma), an important geological event in the evolution of the Arctic Ocean was the opening, deepening, and widening of the Fram Strait, separating what we know today as Greenland and Svalbard. This event allowed for an onset of deep-water exchange between the Arctic and North Atlantic Oceans, creating an influx of warm waters and thus also transport of heat and moisture to the north, allowing for increased precipitation in this area. Consequently, the first ice caps on the northern Barents Sea platform and on Svalbard established and later expanded, eventually reaching the shelf break. These important geological events and their associated major climatic and environmental changes also influence the release of carbon from gas hydrate systems and shallow hydrocarbon accumulations in this region. Repeated cycles of glacial loading and unloading may cause erosion of sealing cap rocks, increased permeability of faults, tilting of reservoirs and development of over-pressurized gas in reservoirs. The aim is to build on and improve the Neogene seismic stratigraphic framework in the high northern latitudes. The improved knowledge of the subsurface will provides insights into the paleo-climatic and paleo-oceanographic evolution of the Eurasia Basin, as well as the timing, causes, effects, and processes related to fluid flow and release of greenhouse gases to the atmosphere. More precisely, this project will focus on the onset of opening of the Fram Strait and through this improve the knowledge of when and how this tectonic setting allowed for a deep-water exchange in this region, thereby creating conditions conductive for the onset of major glaciations.

DEVELOPMENT OF A NEW PROXY METHOD FOR HIGH LATITUDE OCEAN RECONSTRUCTION THROUGH CULTURING EXPERIMENTS ON THE PLANKTIC FORAMINIFERA *G. BULLOIDES*

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Foraminifera are a well-established proxy carrier for palaeoceanographic reconstructions as the elemental and isotopic composition of their calcium carbonate tests, preserved within the marine sediment record may reflect physical and chemical properties of the sea water they were growing in. For example, foraminiferal test Mg/Ca, B/Ca and Na/Ca are often used as proxies for temperature, carbonate chemistry and salinity, respectively. These methods are currently limited in high latitude regions however due to a lack of comprehensive calibrations for (sub)polar species. Although *Globigerina bulloides* is one of the most utilised species for paleoreconstructions in mid-to-high latitudes, the existing temperature calibrations produced for it through culturing experiments have a lower limit of 16°C, which does not cover the full ocean temperature range experienced in temperate to (sub)polar regions. It also has an as of yet unexplored/underdeveloped potential as a proxy for ocean salinity, carbonate chemistry, freshwater input, and nutrient availability.

To this end, we conducted a series of culturing experiments on *G. bulloides* in summer 2022. Over 400 healthy juvenile specimens were collected from the Norwegian Sea (~66.5N, 7E) and placed under one of 11 different culture treatments. Culturing conditions were chosen to reflect changes in temperature (~6-13°C), salinity (~30-37.5 psu), pH (~7.7-8.35), and carbonate ion concentration (~100-250 µmol/kg). Growth and addition of calcite was observed in multiple specimens and will be confirmed by the identification of isotopic spikes. Specimens proved to be surprisingly hardy in culture, with some individuals lasting for 86 days before the experiments had to be artificially terminated. For specimens dying naturally, end of life processes began by a reduction in spine maintenance and density, followed by their complete loss, and rapid deterioration of cytoplasm to just the initial chambers. All specimens died without exhibiting gametogenesis. We are currently in the process of measuring the elemental ratios with LA-ICPMS with the purpose of developing a novel toolbox for high latitude paleoceanographic reconstructions based on *G. bulloides* test geochemistry.