CAGE - Centre for Arctic Gas Hydrate Environment and Climate Report Series, Volume 8 (2020)

To be cited as: Knies, J. et al. (2023). CAGE20-8 Cruise Report: Natural gas seepage and past sea ice variability on the NE Greenland margin. CAGE - Centre for Arctic Gas Hydrate Environment and Climate Report Series, Volume 8. https://doi.org/10.7557/cage.6917
Additional info at: https://septentrio.uit.no/index.php/cage/database

ISSN: 2703-9625
Publisher: Septentrio Academic Publishing Tromsø Norway

R/V Kronprins Haakon

16-November - 30 November 2020

Longyearbyen – Tromsø

20 - 8 CAGE Cruise report

Natural gas seepage and past sea ice variability on the NE Greenland margin

Chief Scientist: Knies, Jochen
Capt. R/V: Hansen, Johnny Peder
Report by: Knies, J., Winsborrow, M., Patton, H., De Schepper, S., Rasmussen, T., Nielsen, T., Silyakova, A., Pau, M., Binde, C., Lockwood-Ireland, C., Steinsland, K., Magann Grant, D. and the CAGE 20-8 Team

Key words: Greenland, Natural Seepage, Methane, Sea ice, Ancient DNA
Cite as: Knies, J. et al., Natural gas seepage and past sea ice variability on the NE Greenland margin, 2020.
47 pages

Outline

1. Introduction and Scientific Objectives

Ice sheets play an important role in the global carbon cycle and improving understanding of how the storage and release of carbon is influenced by their expansion and retreat is vital. Arctic ice sheets covered vast geological carbon reservoirs, and scientists within the Centre for Arctic Gas Hydrate, Climate and Environment, CAGE, (UiT Arctic University of Norway) investigate how past periods of retreat and advance of these ice sheets influenced carbon storage and release, and the key factors that have driven the timing and magnitude of this. During this cruise we will focus on the northeast Greenland continental margin, surveying and sampling the seafloor and shallow subsurface to unravel the history of glacial fluctuations and their influence on carbon reservoirs.

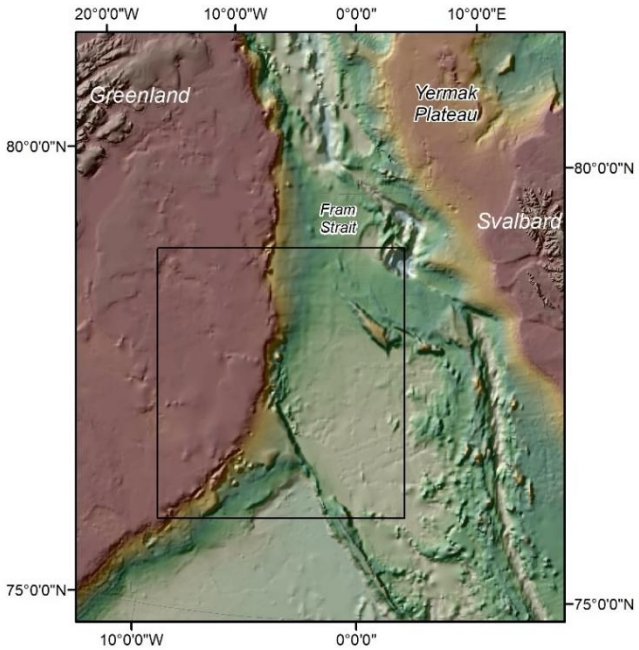

Figure 1. Study area on the NE Greenland margin (rectangle).
The CAGE 20-8 cruise with RV "Kronprins Haakon" investigates landforms and sediments that provide information on how far the Greenland ice sheet has extended across the continental shelf in the past, and how and why it retreated to its current position. We tried to look for

evidence for past and present release of carbon (predominantly methane) in the subsurface and the water column.

Four researchers from NORCE joined the cruise as part of the ERC-funded AGENSI (A Genetic View into Past Sea Ice Variability in the Arctic, #818449, PI De Schepper). This project aims to establish novel proxies for sea ice reconstructions using sedimentary environmental DNA (www.agensi.eu). Because the target area for the CAGE team (see below) is a very relevant study area for the AGENSI project, a joint cruise was set up so that both projects could retrieve study material (surface sediments and sediment cores). The NORCE team also collected water samples, surface sediments and sediment cores for the EEA-Norge NEEDED project (PI De Schepper).

The study area of the cruise is the north east Greenland shelf and slope (see Figure 2). Specific sampling locations was strongly dependent on ice and weather conditions. We faced extreme conditions with storms during beginning and end of the cruise and massive sea ice coverage which often hindered the acquisition of samples and acoustic data.

2. Study Area

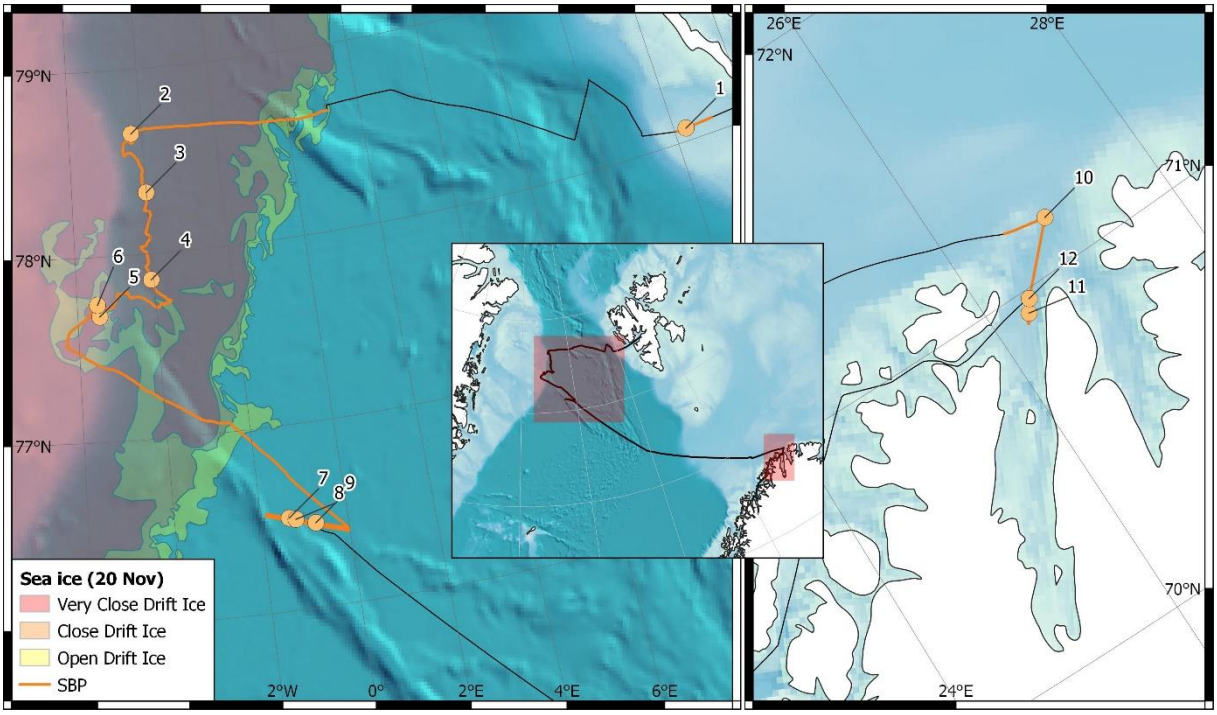

Figure 2. Study area with site locations (orange dots) and sub-bottom profiles (orange lines).

Scientific Party

Jochen Knies	Senior Researcher, CAGE-UiT/NGU (Cruise Leader)
Monica Winsborrow	Senior Researcher, CAGE-UiT (Leader Acoustics)
Asgeir Steinsland	Engineer, IMR (Leader Instruments)
Kristoffer Monsen	Engineer, IMR (Instruments)
Henry Patton	Researcher, CAGE-UiT (Acoustics)
Anna Silyakova	Researcher, CAGE-UiT (Sea ice)
Mauro Pau	Post Doc, CAGE-UiT (Porewater, Coring)
Tine Rasmussen	Professor, CAGE-UiT (Coring)
Tove Nielsen	Senior Researcher, GEUS (Acoustics)
Cornelia Binde	PhD, CAGE-UiT (Acoustics)
Sindre Nygård Larsen	Engineer, IMR (CamPod)
Stijn De Schepper	Research Professor, NORCE (aDNA)
Christine Lockwood-Ireland	PhD, CAGE-UiT (Coring)
Stormer Jensen	Engineer, UiT (Coring)
Jørn Patrick Meyer	Engineer, IMR (CamPod)
Kristin Steinsland	PhD, NORCE (aDNA)
Danielle Magann Grant	PhD, NORCE (aDNA)
Dag Inge Blindheim	Engineer, NORCE (Coring)

3. Equipment and Methods used on board

3.1 Seabird 911 plus CTD

The CTD used on the cruise is the Seabird 911 plus from Seabird Scientific (Fig. 3). The CTD has been used for general oceanography on each station, and also to produce sound velocity profiles to the EM302 multibeam echosounder for bathymetric mapping. The CTD system consists of the Seabird SBE 11 plus deck unit connected to the subsea SBE 9plus CTD. On the CTD we have a 12 bottle SBE32 carousel for water sampling.
The CTD is equipped with the following sensors: 2 x SBE3 Temperature sensors, 2 x SBE4 Conductivity sensors, 2 x SBE43 oxygen sensors, 1x PSA916 Altimeter, 1 x Wet Labs C-Star beam transmissometer, 1x Wet Labs ECO-AFL/FL Fluorometer, and 1 x Biospherical PAR sensor with Surface PAR added. The CTD measures all these parameters at a rate of 44Hz and stores it on the top-side computer. Datalogging has been done with The Seasave v. 7.26.7, and for postprocessing we have used SBE Data processing v. 7.26.7 (Fig. 4). Both these software packages are from Seabird.

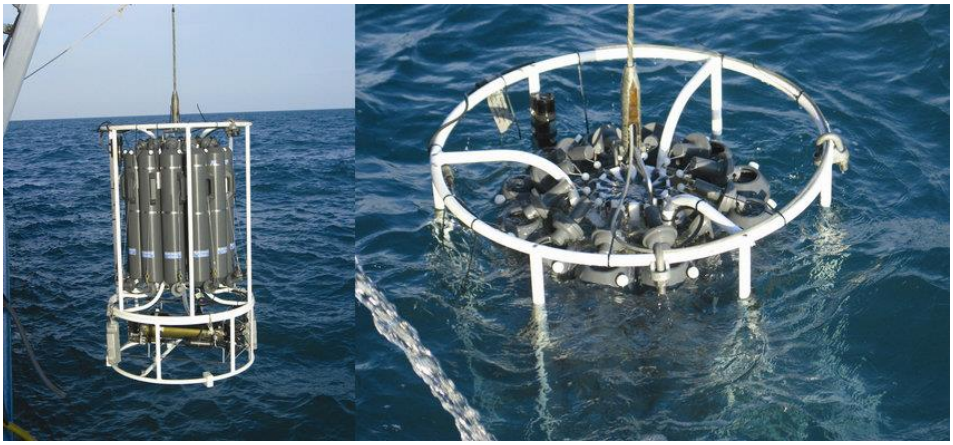

Figure 3. CTD deployment

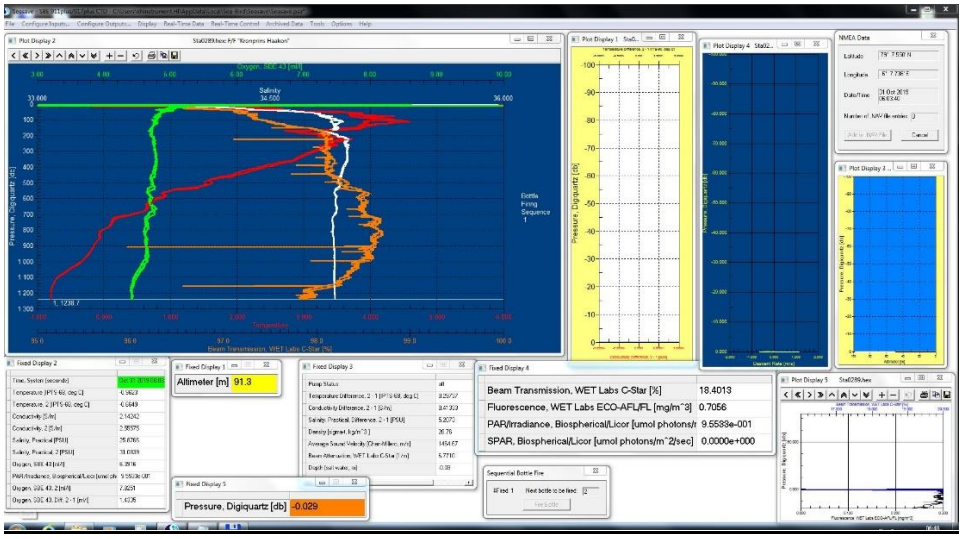

Figure 4. Logging of CTD data using Seasave software

3.2 Kongsberg SBP300 Sub-bottom profiler

For sediment profiling, we have used the Kongsberg SBP300 sub-bottom profiler (Fig. 5). This sub-bottom profiler shares the receiver transducer with the EM302 bathymetric multibeam sonar, but has a separate low frequency transmit transducer. With the transmitter and receiver transducers mounted in a Mills-Cross arrangement this gives a system with very high angular resolution compared to a conventional sub-bottom profiler. The pulse type used for the cruise is a Linear chirp pulse from 2,5kHz to 7 kHz (LFM). The pulse length has been 30ms. Trace length varying between 300ms to 500ms. The system has been set up with logging of raw data as well as real-time logging of SEG-Y files for postprocessing.
The system has been set up with logging of raw data as well as real-time logging of SEG-Y files for postprocessing.

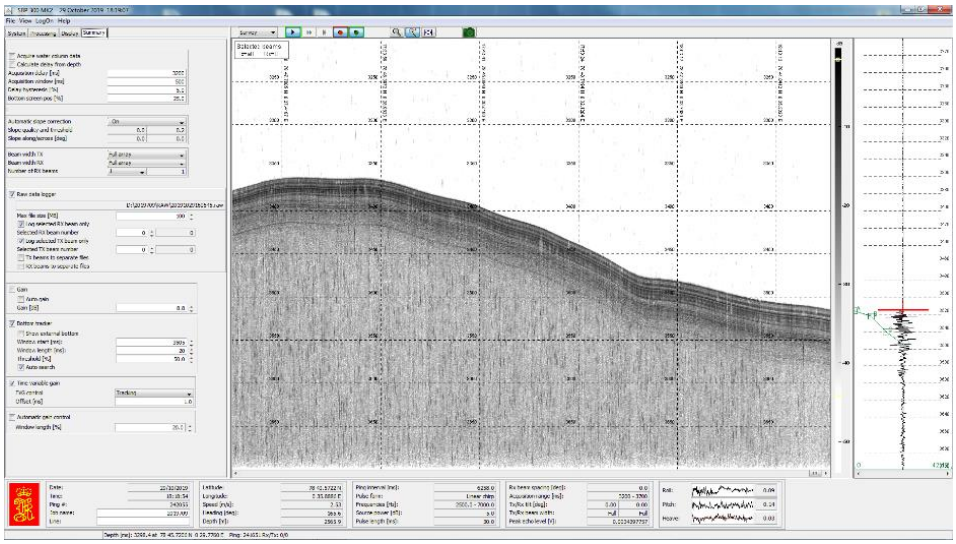

Figure 5. Echogram from SBP300

The data were recorded using the hull-mounted Kongsberg SBP300 MK2 and software system version 1.6.6. The maximum depth of penetration is 40-50m over contourite drifts. The vessel is often ice-breaking and problems with duplicate traces is apparent in data affected by the ice. The chirp pulse form is 'linear chirp up' with 30ms sweep length and frequencies between 2.5 and 7 kHz. The ping rate and bottom tracking is externally controlled by the EM302 multibeam system and varies with depth. Typically, at water depth of 1770 m (e.g. Svyatogor Ridge) a ping interval of 5 seconds is expected. Sample interval is 48 kHz (0.02 ms sample rate with a Nyquist of 24 kHz). The acquisition time window is 500 ms. The vessel velocity is 4-5 knots while surveying and during transits 8 knots. In 1770 m water depth the average trace (ping) interval for a 4.5 knot survey is 2.3m.
The sweep function from the signal is removed using a matched filter based on auto-correlation of the Klauder wavelet. A gain correction is applied, with no AGC or TVG applied prior to the logging of the processed sequence. The vertical resolution is 0.15m, using a sound velocity of 1500 m/s, typical of sea water and shallow sediments. The acquisition processing sequence does not apply the envelope function to the data (instantaneous amplitude) thus, preserves the signal phase of the data, should this be required at a later stage of processing.

The segy data, output from the Kongsberg acquisition system, are further processed using Seismic Unix (SU). Files with the suffix 'processed_UTMXXN' are files output from SU. The XY coordinates are stored in byte positions 73 and 77 and copied to 81 and 85. The data are projected to Universal Transverse Mercator zones (UTM), for which, 31X and 33X are the two zones used for the data acquired. The UTM zone number can be found in byte position 21 (CDP).

The data are logged with varying delay recording time (delrt) to reduce file size in acquisition. The data are shifted back to a constant delay recording time in SU. The range of the minimum and maximum time values are expanded, only when a partial display of data is found in the acquisition window, in the initial output ('raw' segy). Instantaneous amplitude is applied to the processed segy data. This improves the signal-to-noise ratio. The final output has no phase information and displays positive amplitudes only. This is the standard for interpretation of chirp data.

3.3 EM302 Multibeam sonar data

Surveying of the sea bottom and water column is done using EM302 system by Kongsberg. Its operating frequency is 30 Khz and it generates swaths of data covering the width up to 5,5 times the water depth. The output for each line consists of two files:

- File with extension *all contains datapoints corresponding to seabottom
- File with extension *wcd stores all the information recorded for the watercolumn

Processing of the data is performed using QPS software: Qimera and FMMidwater.

Bathymetry
The data is loaded line by line to the project in Qimera. Each part of the line is visually inspected in 3D view and all the data points that deviate from the general trend are being removed. They correspond to part of recordings affected by noise and majority of them are located at the edges of the profile. When the manual cleaning process is done, automatic spline-based filter with varying degree of intensity is applied to segments of each line, with intensity chosen based on the quality of data in the given area of seafloor. Final lines are then converted into surfaces that can be exported as a datapoints for mapping and interpretation.

Water column
Processing of water column information is done in FM Midwater. After import and conversion to internal format all the information from beams is stacked to produced single beam of data for a given position. All of these beams are then displayed next to each other to produce side view of the water column and the sea bottom, which makes it easier to distinguish signal noise and potential gas flares sightings. In this view, all lines are inspected, position by position, with simultaneous check of data recorded for each beam. High-pass frequency filter is also applied individually for each line in order to alleviate parts of the noise present in the data. During CAGE 20-8, no gas flares were spotted in the water column.

3.4 Sediment Coring

Multicorer (UiT)
A multicorer (MUC) built by KC Denmark A/S with six transparent plastic core liners of 60 cm length was deployed at most stations (Fig. 6). The multicore was attached to the winch rope and lowered through the water column at 1m/s. When the MUC reaches the seafloor, a weight of ~400 kg pushes the cores into the sediments. When retracted from the sediments, arms with spatulas close the bottom of each core. The MUC and sediment cores were immediately heaved and brought on board and the bottom of each core was secured with plastic caps. Cores were labelled and subsampled according to a subsampling scheme. When enough cores were recovered, one was kept intact as an archive and stored in a cooling container at 4°C.

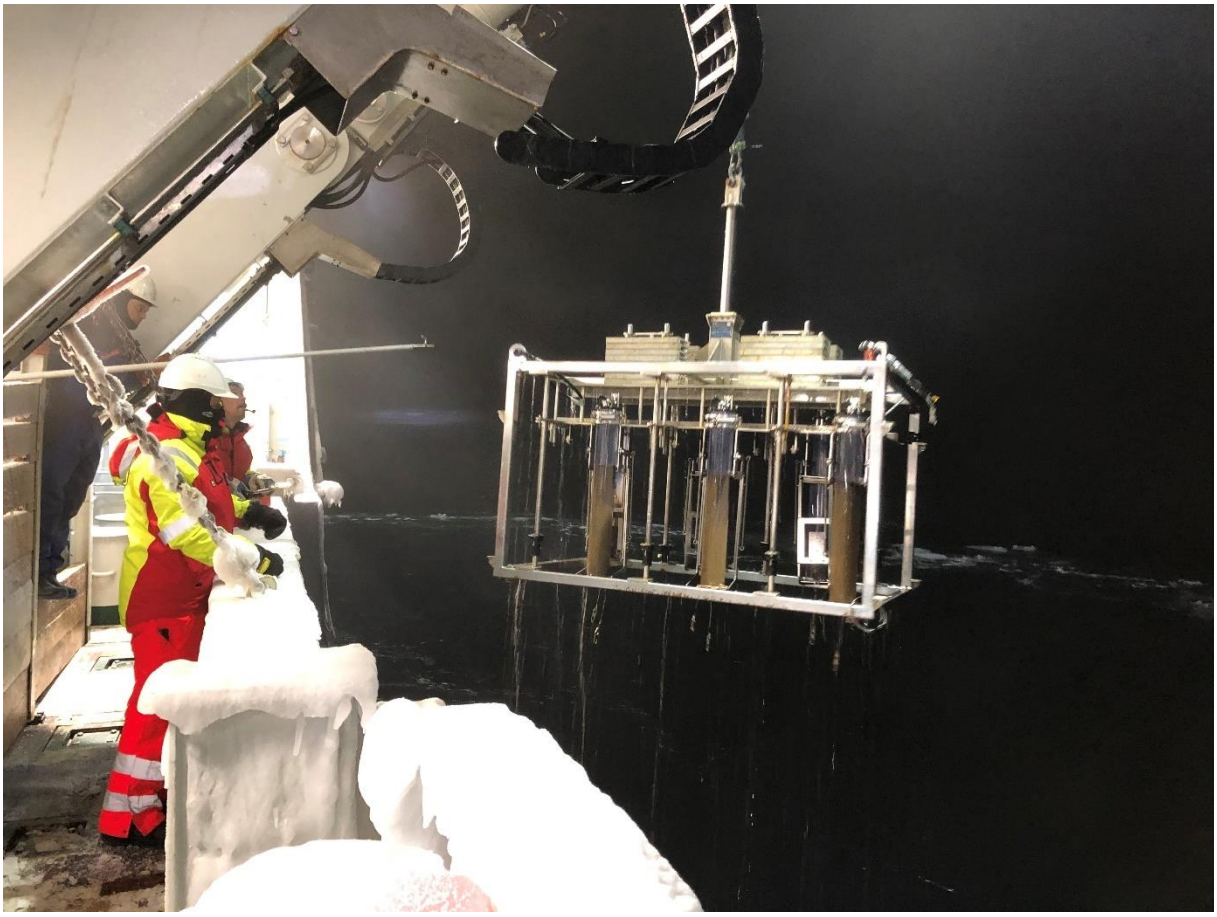

Figure 6. The multicorer (UiT).

Gravity Corer (UiT)

A gravity corer (GC) with a total weight of ~1000 kg was used, which consists of a 6 m long steel barrel with an inner diameter of 11 cm, a steel-mantled led weight at the top, and a core head with a core catcher at the bottom (Fig. 7).

For each deployment, a 5.95 m black plastic liner (pipe) with an outer diameter of 11 cm and inner diameter of 10 cm was inserted into the steel barrel and the core head and catcher was mounted. The gravity core was lifted horizontally by two slings attached to a crane while hooked up to the traction winch rope (see section on Calypso corer). The weight was transferred from the crane slings to the traction winch rope and the corer was rotated to its vertical orientation and was released from the crane slings. The gravity core was lowered through the water column at 1m/s and further through the sediments by its own weight. The core was left in the sediments for a few minutes, in order for attached temperature sensors to have time to equilibrate (see section on temperature sensors), before it was retrieved back to the ship with a reversed launch procedure. After retrieval, the plastic liner was manually cut into sections of up to 100 cm length, while taking care of the plastic sawdust. The section ends were secured with plastic caps and the sections were labelled. Pore water was extracted from selected core sections (see section on pore water) and all sections were stored in a cooling container at +4ºC.

Figure 7. The gravity corer (UiT)

3.5 Water sampling and filtering for environmental DNA (eDNA)

Following a specific protocol, we filtered water using Sterivex filters (0.22 µm) at three different depths (5, 100 and 15m above seafloor). For each depth, 5 replicates were taken, each filtering 5L of sea water. Water samples were sometimes filtered immediately after recovery from Niskin bottles. If timing did not allow that, filtering took place the next day. Carboys with seawater were then stored cool at 4 degC, and covered with black plastic bags (dark). These filters will be analyzed in onshore labs for metabarcoding (DNA) of eukaryotes.

3.6 Surface Sediment DNA sampling CAGE 20-8

At all coring stations, one or two cores were dedicated to the AGENSI project for sedimentary DNA, IP_{25}, and palynology sampling of the surface sediment (0-1cm). The methodology for sedimentary DNA sampling onboard KPH utilized several separate laboratories to minimize the potential for cross-contamination. Cores sampled for the AGENSI project were sampled in lab #311 Ecotoxicology Lab, while samples for the NEEDED project were sampled in the education lab.

Benthos Lab

1. Before MUC was deployed, clear plastic liners were rinsed with a chlorine solution and sealed with a plastic film to prevent contact with inner liner. Immediately before deployment the plastic film was removed with care to avoid contact with inner liner. As MUC arrived back on deck, 110 size (pre-bleached) yellow caps were added to secure the MC. Technicians avoided contact with inner portion of cap when securing the sediment.

2. AGENSI team member transported MC to the benthos lab for cleaning. The capped core was rinsed with water, moved to a pre-bleached portion of workbench, and cleaned with a chlorine solution. Once cleaned the core was only handled by individuals wearing gloves, without leaning the core on clothing. The core was transported from deck-through the hangar and directly to waiting individual in Lab 311 (Environmental Toxicology Lab).

AGENSI- Ecotoxicology Lab

3. Prior to the core arriving in ZONE 1, all work surfaces and instruments were cleaned with a chlorine solution. While in ZONE 1, hairnets, particle mask, safety glasses, and paper suit were worn to avoid cross-contamination. Once the core was delivered (transport personnel DID NOT enter ZONE 1), it was placed in a sink and cleaned with a chlorine solution (with a minimum of 10 minutes contact time). At this time the core was also labelled following cruise convention.

4. MC was drained using a sterile tube. Each multicore was sampled for marine snow (loose sediment at the surface-water interface, typically ~20mL collected using sterile pipette), and surface sediment at 0-1cm depth. DNA sampling was completed first using sterile spoons with a 0.5cm depth. Samples stored in 50mL falcon tubes and secondary containment in a labelled plastic bag. Bench controls, an open Eppendorf tube placed on bench, were used during sampling and stored in secondary containment bag with sample. Biomarker IP_{25} and palynology designated samples were then taken- no plastic used to sample or store biomarker samples. After sampling, stored DNA samples at -20˚, IP_{25} at -20˚, and palynology a 4˚.

If the multicore was only surface sampled, the core was sealed with a portion of *OASIS* green foam that was prepared with a bleached fishing line. The cap was added, taped, and stored in 4˚ cooling container.

5. After preparing the core with *OASIS*, cap, and tape, the work area in lab 311 was cleaned using a chlorine solution.
6. Cores kept for AGENSI were kept in cool storage 4 ˚ out by the benthos lab for remainder of the cruise.

NEEDED- Education Lab

7. Five cores were sampled at the surface (0-1cm) in 50mL falcon tubes for the NEEDED project.
8. The education lab was used to sample the NEEDED cores, but all sampling material was prepared in lab 311 to avoid contamination.
9. As before the cores were cleaned with 10% bleach solution and drained via siphoning. The cores were then placed on the UiT extruder. The surface was sampled using DNA methods (sterile instruments, PPE, and sampling the center of the core careful to not take sediment in contact with the core liner).
10. After sampling the sediment was fully extruded and discarded.
11. The core liners were cleaned with water and then with bleach ready for the next multicore cast.
12. All NEEDED DNA samples were stored at -20 ˚.

Notes:

- Chlorine solution for all DNA subsampling was 10% and prepared with milliQ water. Each cleaning/sampling was accompanied by a freshly made solution to ensure no reduction in potency.
- Multicore top pictures were also taken for most stations.

4. Station Description

See the exact location of each superstation in the log files (Chapter 6). Below, we briefly show each locations and short information for each sample site. CTD data are not reported here. The data can be downloaded at Norwegian Maritime Data Center and CAGE-UiT on request (Fabio.sarti@uit.no).

4.1 Superstation CAGE 20-8-KH-01

Site Location

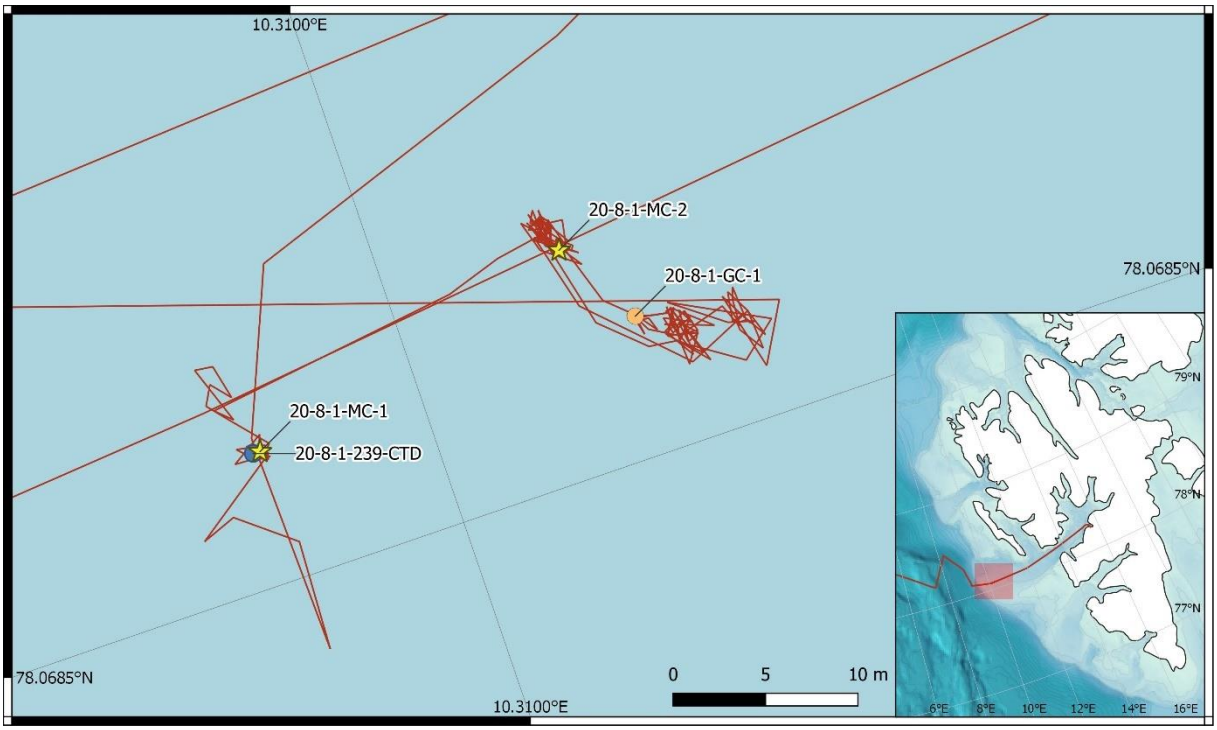

Figure 8. Location of superstation CAGE 20-8-KH-01 on the western Isfjorden shelf.

Acoustics

Multibeam bathymetry, water column, and sub-bottom profiles were acquired at superstation 1. Sub-bottom profiles were acquired to identify the subsurface sediment distribution (Fig. 9). The sub-bottom profiles show limited penetration and very little sedimentary cover at the sea surface.

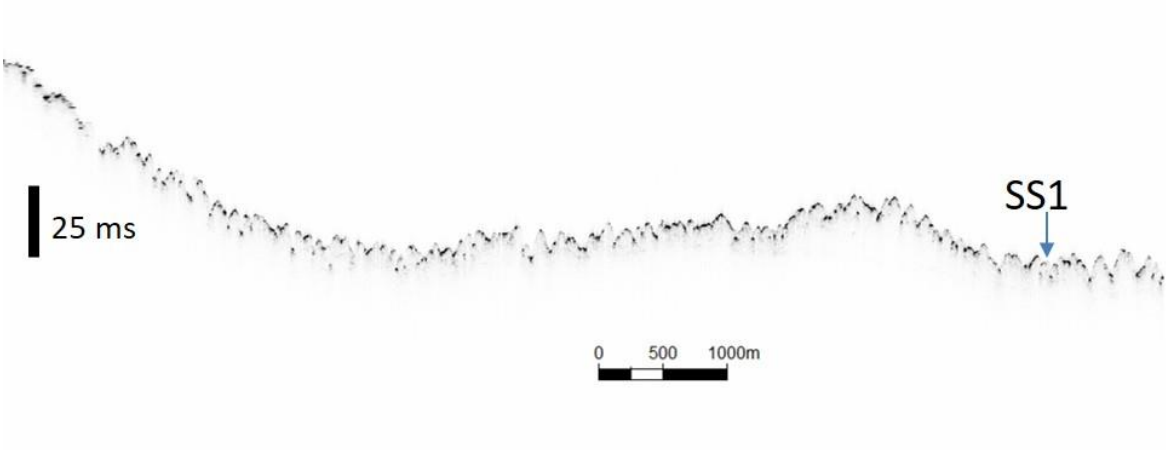

Figure 9. Sub-bottom profile at Superstation CAGE 20-8-KH-01 and the position of sampling (SS1).

Multicorer

MC01 (218 m water depth)
We reached this station on the Svalbard shelf (Isfjorden) on 18/11/2020. The first cast of the cruise resulted in 2 core liners with sediment (A=44 cm; B=28.2 cm). The longest core has been kept at 4˚C as an archive (AGENSI), while the shorter core was immediately sampled for DNA, biomarkers and palynology (0-1 cm).

MC02 (218 m water depth)
The second cast resulted in 6 core liners with sediment. The surface (0-1 cm) of cores A-E were sampled for DNA (5 replicates from the same station. One section (F=37 cm) was kept as an archive for Tromsø (Tine L. Rasmussen).

Multicorer resumen table						
ship	**KH**	**station**	**KH-1**	**core**	**CAGE20-8-KH-1-MC01**	
n. sec		**length**		**Date**	**18/11/2020**	
Lat. N	78.0685644	**Long. E**	10.3096017	**Water depth**	218	

Cores	Analysis/Core length	Notes
F	/	Core liner empty
E	/	Core liner empty
D	/	Core liner empty
C	/	Core liner empty
B	28.2 cm	Sampled 0-1 cm for DNA, palynology and biomarkers (AGENSI)
A	44 cm	ARCHIVE AGENSI

Multicorer resumen table						
ship	**KH**	**station**	**KH-1**	**core**	**CAGE20-8-KH-1-MC02**	
n. sec		**length**		**Date**	**18/11/2020**	
Lat. N	78.06860967	**Long. E**	10.3104181	**Water depth**	218	

Cores	Analysis/Core length	Notes
F	37 cm	ARCHIVE Tine Rasmussen, stored frozen
E	28 cm	Sampled 0-1 cm for DNA (NEEDED)
D	29 cm	Sampled 0-1 cm for DNA (NEEDED)
C	31.5 cm	Sampled 0-1 cm for DNA (NEEDED)
B	29 cm	Sampled 0-1 cm for DNA (NEEDED)
A	32 cm	Sampled 0-1 cm for DNA (NEEDED)

Table 1. Summary table for CAGE-20-8-KH-01-MC01 and MC02

Gravity Corer

Gravity Coring resumen table									
ship	**KPH**	**station**	**1**	**core**	**CAGE20-8-KH-01-GC01**				
n. sec	**3**	**length**	**190 cm**	**Date**	**18.11.2020**				
Lat. N	**78.0685**		**Long. E**	**10.3105**	**Water depth**	**220**			
sec from bottom	**sec from top**	**length (cm)**	**top sec depth bsf**	**bot. sec depth bsf**	**lithology at section bottom**	**WC**	**S S**	**HS**	**note**
C	1	33	0	33					
B	2	57	33	90					
A	3	100	90	190	Till, dark, sharp gravel				Bottom of core
					CC not taken				

Table 2. Summary table for CAGE 20-8-KH-01-GC01

Superstation CAGE 20-8-KH-02

Site Location

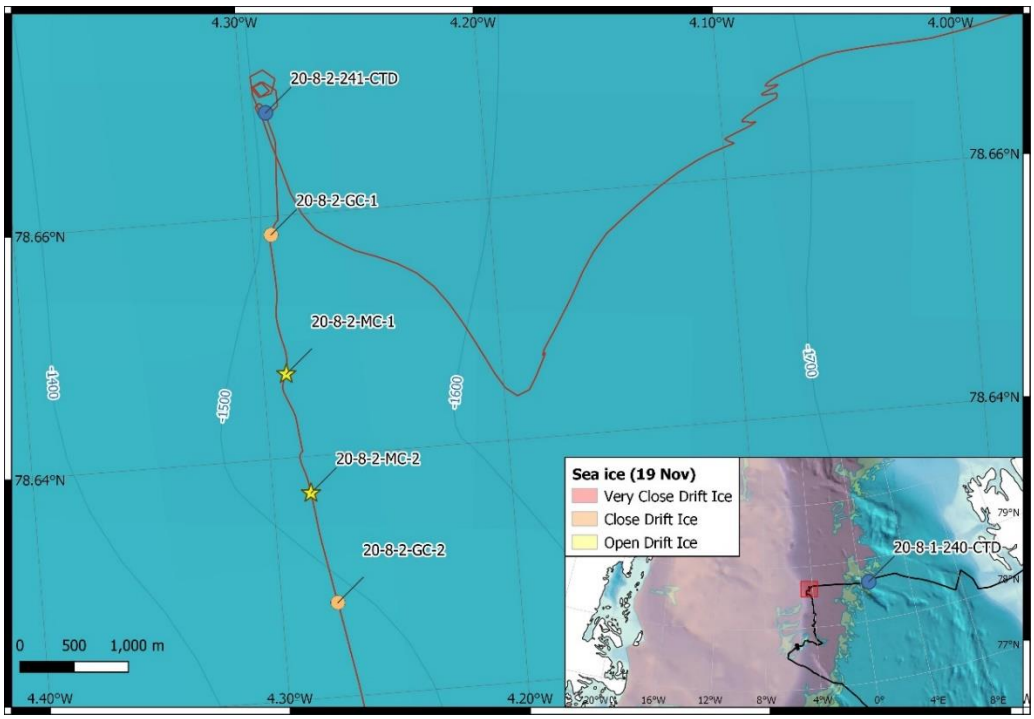

Figure 10. Location of superstation CAGE 20-8-KH-02 on the NE Greenland margin.

Acoustics
Multibeam bathymetry, water column, and sub-bottom profiles were acquired at superstation 2. Sub-bottom profiles were acquired to identify the subsurface sediment distribution (Fig. 11). The sub-bottom profile shows a thin sedimentary drape above a transparent package.

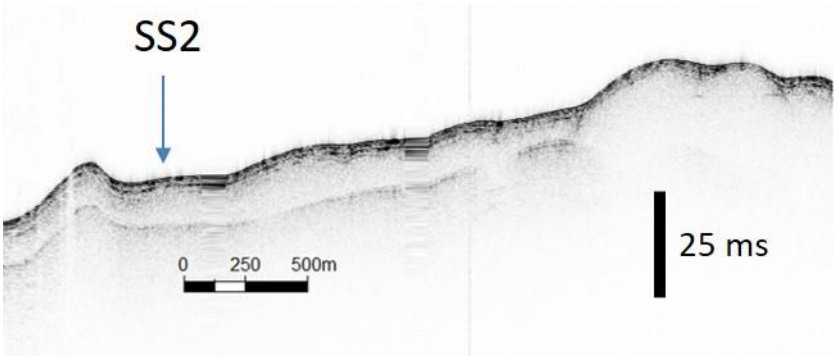

Figure 11. Sub-bottom profile at Superstation CAGE 20-8-KH-02 and the position of sampling (SS2).

Multicorer

This station was in the middle of sea ice, we reached it on 20/11/2020. There was a considerable drift over this site (ocean current at 1-1.5 knots), and the boat drifted with the sea ice while sampling.

MC01 (1475 m water depth)
We reached the second station on 20/11/2020. On the first cast, four core liners contained sediment. Core A (52.2 cm) and C (50.3 cm) were kept as archives from AGENSI. The surface sediment (0-1 cm) of Core B was sampled DNA, biomarkers and palynology. The surface sediment (0-1 cm) of Core D was sampled for DNA. The surface of core D contained gravel and stones of different sizes.

MC02 (1488 m water depth)
All six cores contained sediment. Core D contained a large black dropstone. Several cores contained gravel at the surface. One core contained a large calcareous fossil at the surface. Core A was kept as an Archive for Tromsø (Tine L. Rasmussen). Core B is an Archive for Jochen Knies. Both archives were stored frozen. In four cores (C-F), we sampled 0-1 cm for DNA.

Multicorer resumen table						
ship	**KH**	**station**	**KH-2**	**core**	**CAGE20-8-KH-2-MC01**	
n. sec		**length**		**Date**	**20/11/2020**	
Lat. N	**78.6469**	**Long. E**	**-4.29051**	**Water depth**	**1475 m**	

Cores	Analysis/Core length	Notes
F	/	Core liner empty
E	/	Core liner empty
D	29.5	Sampled 0-1 cm for DNA (NEEDED); * sampled sediment surface contained a lot of gravel, stones, including a large red stone
C	50.3	Archive AGENSI
B	44	Sampled 0-1 cm for DNA, palynology and biomarkers
A	52.2	Archive NEEDED Bergen
* Note: Sampling of B, C and D was done in educational lab onboard KH		
* Note: there was considerable drift of the ship during the deployment of the MCs - details in cruiselogger		

Multicorer resumen table						
ship	**KH**	**station**	**KH-2**	**core**	**CAGE20-8-KH-2-MC02**	
n. sec		**length**		**Date**	**20/11/2020**	
Lat. N	**78.63697078**	**Long. E**	**-4.28422817**	**Water depth**	**1488**	

Cores	Analysis/Core length	Notes
F	30.0 cm	Sampled 0-1 cm for DNA (NEEDED)
E	38.5 (picture)	Sampled 0-1 cm for DNA (NEEDED)
D	31.5 cm	Sampled 0-1 cm for DNA (NEEDED)
C	40 cm	Sampled 0-1 cm for DNA (NEEDED); large black dropstone
B	Black mainly gravel sized rocks at surface and also a larger stone (>2 cm diameter)	ARCHIVE Jochen Knies, sotred frozen
A	Large calcareous fossil at surface	ARCHIVE Tine Rasmussen, stored frozen
* Note: there was considerable drift of the ship during the deployment of the MCs - details in cruiselogger		

Table 3. Summary table for CAGE-20-8-KH-02-MC01 and MC02

Gravity Corer

Gravity Coring resumen table										
ship	**KPH**	**station**	**2**	**core**	**CAGE20-8-KH-02-GC01**					
n. sec	**3**	**length**	**418 cm**	**Date**	**19.11.2020**					
Lat. N	**78.6584**		**Long. E**	**-4.2922**	**Water depth**	**1484**				
sec from bottom	**sec from top**	**length (cm)**	**top sec depth bsf**	**bot. sec depth bsf**	**lithology at section bottom**	**WC**	**SS**	**HS**	**note**	
C	1	119	0	119						
B	2	149	119	268	sand & shelly layer at the bottom					
A	3	150	268	418	reddish clay				Bottom of core	
					CC not taken					

Gravity Coring resumen table										
ship	**KPH**	**station**	**2**	**core**	**CAGE20-8-KH-02-GC02**					
n. sec	**3**	**length**	**289 cm**	**Date**	**20.11.2020**					
Lat. N	**78.6277**		**Long. E**	**-4.2766**	**Water depth**	**1487**				
sec from bottom	**sec from top**	**length (cm)**	**top sec depth bsf**	**bot. sec depth bsf**	**lithology at section bottom**	**WC**	**SS**	**HS**	**note**	
C	1	89	0	89						
B	2	100	89	189						
A	3	100	189	289	Till, dark, sharp gravel				Bottom of core	
				CC	11 cm: stiff grey clay oriented in bag					

Table 4. Summary table for CAGE 20-8-KH-02-GC01 and GC02

Superstation CAGE 20-8-KH-03

Site Location

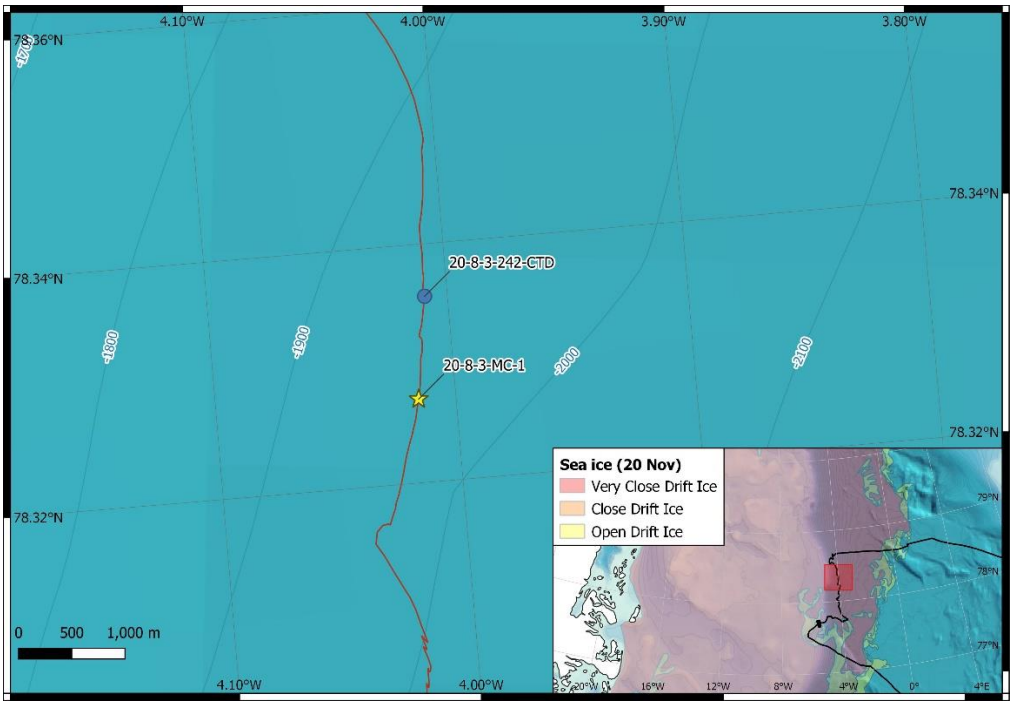

Figure 12. Location of superstation CAGE 20-8-KH-03 on the NE Greenland margin

Multicorer

This station was in the middle of sea ice, we reached it on 20/11/2020.

MC01 (1942 m water depth)
All cores contained some sediment, but not more than ca. 30 cm. For five cores (A,B, D, E, F) we sampled the top 0-1 cm for DNA. Core C was sampled for DNA, biomarkers and palynology. Sampling some cores was difficult, due to soupy sediments at the surface. Sediment contains many forams.

Multicorer resumen table							
ship	KPH	station	KH-3	core	CAGE20-8-KH-3-MC01		
n. sec		length		Date	20.11.2020		
Lat. N	78.327		Long. E	-4.0155	Water depth	1942	

Cores	Analysis/Core length	Notes
F		NEEDED
E	20 cm	NEEDED
D		NEEDED
C		AGENSI
B	11.2 cm; very loose top layer, material in water column could not extrude the sediment - ice conditions caused distrubance at surface-ocean interface	NEEDED
A	29.5 cm; many forams, very soupy, difficult to sample	NEEDED

Table 5. Summary table for CAGE-20-8-KH-03-MC01

Superstation CAGE 20-8-KH-04

Site Location

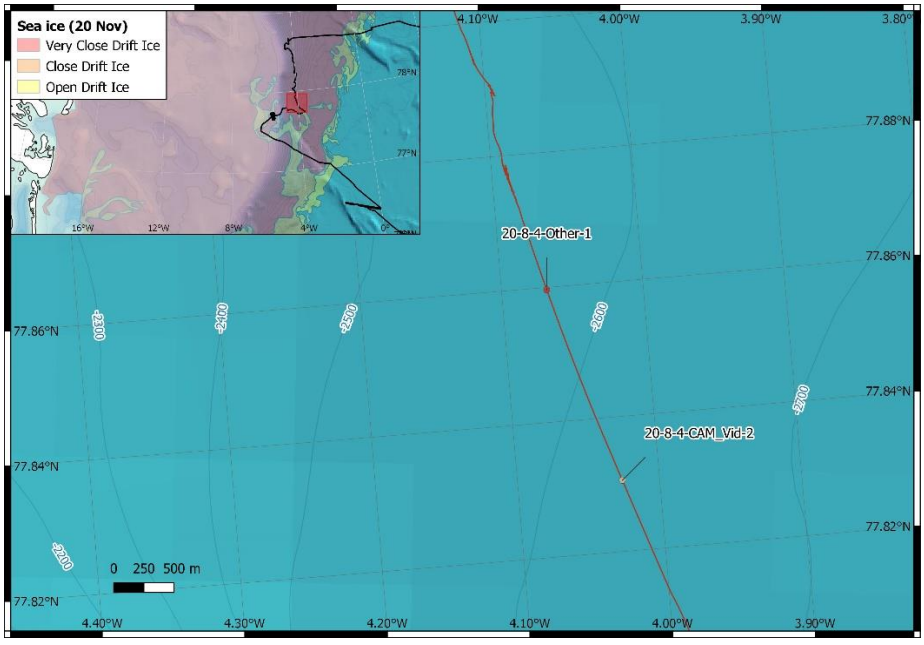

Figure 13. Location of superstation CAGE 20-8-KH-04 on the NE Greenland margin

Sea ice station

On Ice: A. Silyakova (PI), Henry Patton (assist), Christin Lockwood-Ireland (polar bear guard).

Date: 21.11.2020, 10:52 – 13:45
Location: 77.5180 **N** 04.0437 **W**, air T -12.80
Ice thickness 90-150 cm;
Purpose of the station: Extract ice cores from the floe to investigate CH_4 content (1st core), DNA content, Stijn De Schepper (2nd core), physical properties (3rd core);
Each core was cut into 10-20 cm pieces, and melt in dark laboratory for further sampling of melt water;
Liquid subsamples of the 1st core are brought ashore to analyse for CH_4 concentrations at UiT's gas laboratory;
Melt water of 2nd core run through filtration and further DNA analysis of the filter in Bergen.
3rd core is brought ashore to store in the freezer as archive for further investigations of crystalline structure in 2021;

Figure 14. 15: CAGE 20-8-KH-04-Other (Sea ice station)

CamPod

The CamPod video system was lowered at 2500 m, 50 m above the seafloor, before the signal on the high-resolution camera was lost. Inspection afterwards revealed a failure in the transformation system. The CamPod was out of function for the rest of the cruise.

Figure 15. CAGE 20-8-KH04 – CamPod video system is lowered through the Moonpool.

Superstation CAGE 20-8-KH-05

Site Location

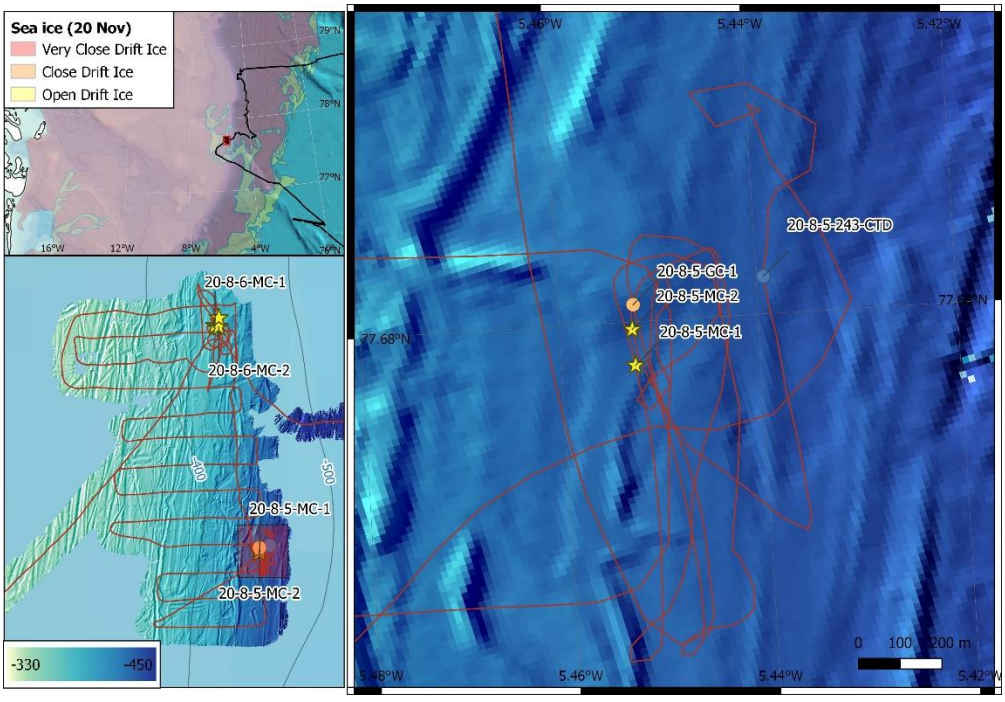

Figure 16. Location of superstation CAGE 20-8-KH-05 on the NE Greenland margin

Acoustics
Multibeam bathymetry, water column, and sub-bottom profiles were acquired at superstation 5. Sub-bottom profiles were acquired to identify the subsurface sediment distribution (Fig. 17). The sub-bottom profile shows a thin sedimentary drape above a transparent package. Iceberg ploughmarks dominate the sea surface.

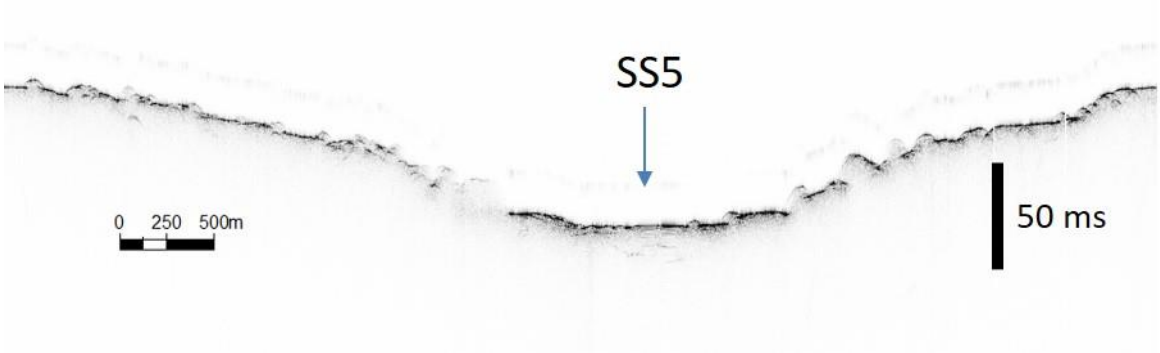

Figure 17. Sub-bottom profile at Superstation CAGE 20-8-KH-05 and the position of sampling (SS5).

Multicorer

MC01 (434 m water depth)
The first cast came up empty.

MC02 (432 m water depth)
Two liners were lost at this station, but four contained sediments. Core A (52 cm) was kept as an archive for Tine L. Rasmussen, and the core was split on the ship. Cores B were sampled for DNA, biomarkers and palynology (AGENSI). Core C was sampled at 0-1 and 1-2 cm for G. Panieri (following her protocol), and additional sediment was taken (0-1) for AGENSI. Core D (45.5 cm) is kept as an AGENSI archive, stored at 4 ˚C.

Multicorer resumen table						
ship	KH	station	KH-5	core	CAGE20-8-KH-5-MC01	
n. sec		length		Date	22.11.2020	
Lat. N	77.679	Long. E	-5.452	Water depth	434	

Cores	Analysis/Core length	Notes
F	/	empty liner
E	/	empty liner
D	/	empty liner
C	/	empty liner
B	/	empty liner
A	/	empty liner

Multicorer resumen table						
ship	KH	station	KH-5	core	CAGE20-8-KH-5-MC02	
n. sec		length		Date	22.11.2020	
Lat. N	77.679	Long. E	-5.452	Water depth	432	

Cores	Analysis/Core length	Notes
F	/	liner lost
E	/	liner lost
D	45.5 cm; brown grey mud, containing sand and small/large gravel	AGENSI archive
C	20.5 cm; lithology as above	Sampled 0-1 cm for DNA, palynology and biomarkers
B	28 cm; litholgy as above	Sampled 0-1 cm for DNA, palynology and biomarkers
A	52 cm; lithology as above	Archive Tine Rasmussen; core was split on the ship

Table 6. Summary table for CAGE-20-8-KH-05-MC01 and MC02

Gravity corer

Gravity Coring resumen table										
ship	**KPH**	**station**	**5**	**core**	**CAGE20-8-KH-05-GC01**					
n. sec	**2**	**length**	**173 m**	**Date**	**22.11.2020**					
Lat. N	**77.6803**		**Long. E**	**-5.4524**	**Water depth**	**431**				
sec from bottom	**sec from top**	**length (cm)**	**top sec depth bsf**	**bot. sec depth bsf**	**lithology at section bottom**		**WC**	**SS**	**HS**	**note**
B	1	82	0	75						7 cm sponge
A	2	100	75	173	glacial clay, sand at the at the bottom, shell					Bottom of core, 2 cm sponge

Table 7. Summary table for CAGE-20-8-KH-05-GC01

Superstation CAGE 20-8-KH-06

Site Location

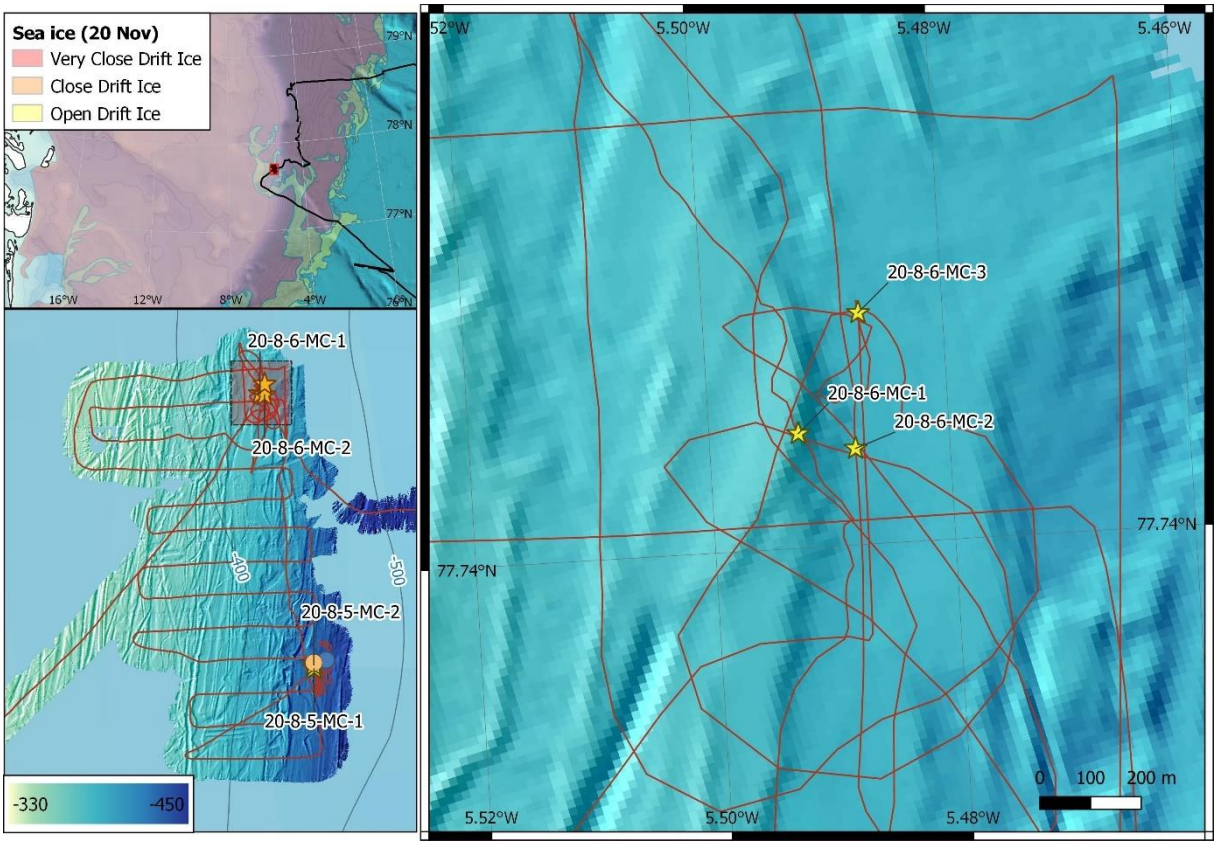

Figure 18. Location of superstation CAGE 20-8-KH-06 on the NE Greenland margin

Acoustics

See the profile above at Superstation 5 for comparison. Similar setting for Superstation 6

Multicorer

MC01 (383 m water depth)
The multicorer was operated through the moonpool. The safety was not removed from the piston, so no sediment was recovered.

MC02 (393 m water depth)
Four liners were broken off at the top. This is likely related to the ship drifting to fast (1-1.5 knots) with the ice at the time the MC went into the sediment.
Core A contained 28 cm, and was sampled for AGENSI (DNA, biomarkers and palynology) at 0-1 cm. In Core B, the water was murky. Needed settling, and was then kept as Archive for Tromsø (Tine L. Rasmussen).

Multicorer resumen table							
ship	**KH**	**station**	**KH-6**	**core**	**CAGE20-8-KH-6-MC01**		
n. sec		**length**		**Date**	**22.11.2020**		
Lat. N	**77.742**		**Long. E**	**-5.492**	**Water depth**	**383**	

Cores	Analysis/Core length	Notes
F	/	Safety was not removed from MC --> no recovery
E	/	as above
D	/	as above
C	/	as above
B	/	as above
A	/	as above

Multicorer resumen table							
ship	KH	station	KH-6	core	CAGE20-8-KH-6-MC02		
n. sec		length		Date	22.11.2020		
Lat. N	77.741		Long. E	-5.488	Water depth	393	

Cores	Analysis/Core length	Notes
F	/	liner broken off at top
E	/	liner broken off at top
D	/	liner broken off at top
C	/	liner broken off at top
B	murky water - no immediate recovery measurement possible	Archive Tine Rasmussen
A	28 cm	AGENSI, sampled 0-1 cm

Table 8. Summary table for CAGE-20-8-KH-06-MC01 and MC02

Superstation CAGE 20-8-KH-07

Site Location

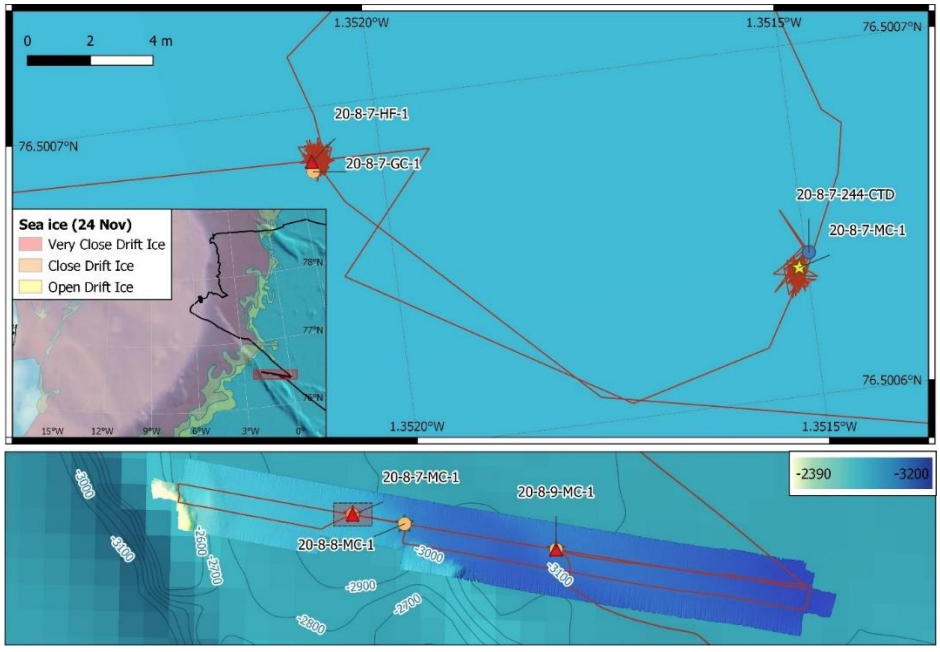

Figure 19. Location of superstation CAGE 20-8-KH-07 on the Greenland Ridge

Acoustics

Multibeam bathymetry, water column, and sub-bottom profiles were acquired at superstations 7, 8, and 9 (Figs. 20, 23, 25). Sub-bottom profiles were acquired to identify contouritic deposits across the Greenland Ridge. The sub-bottom profile shows an undisturbed, laminated sequence across the ridge.

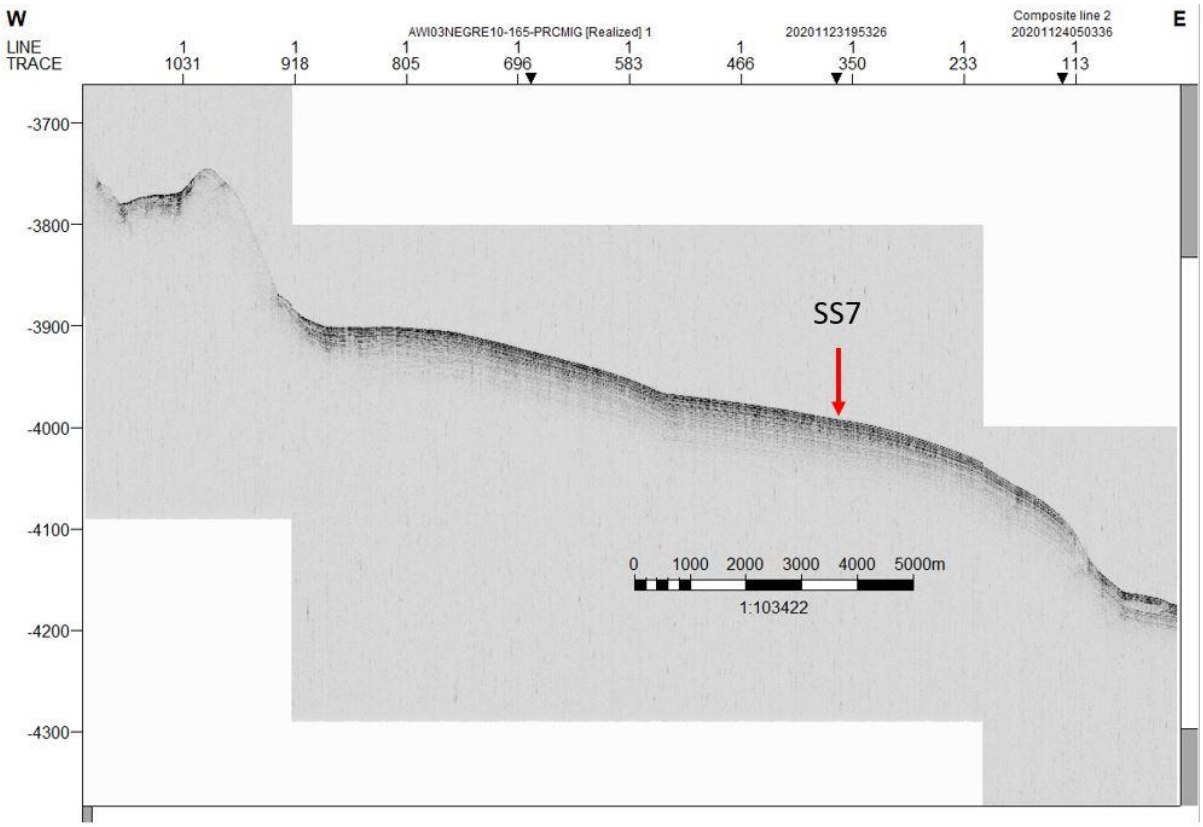

Figure 20. Sub-bottom profile at Superstation CAGE 20-8-KH-07 and the position of sampling (SS7).

Heat probe

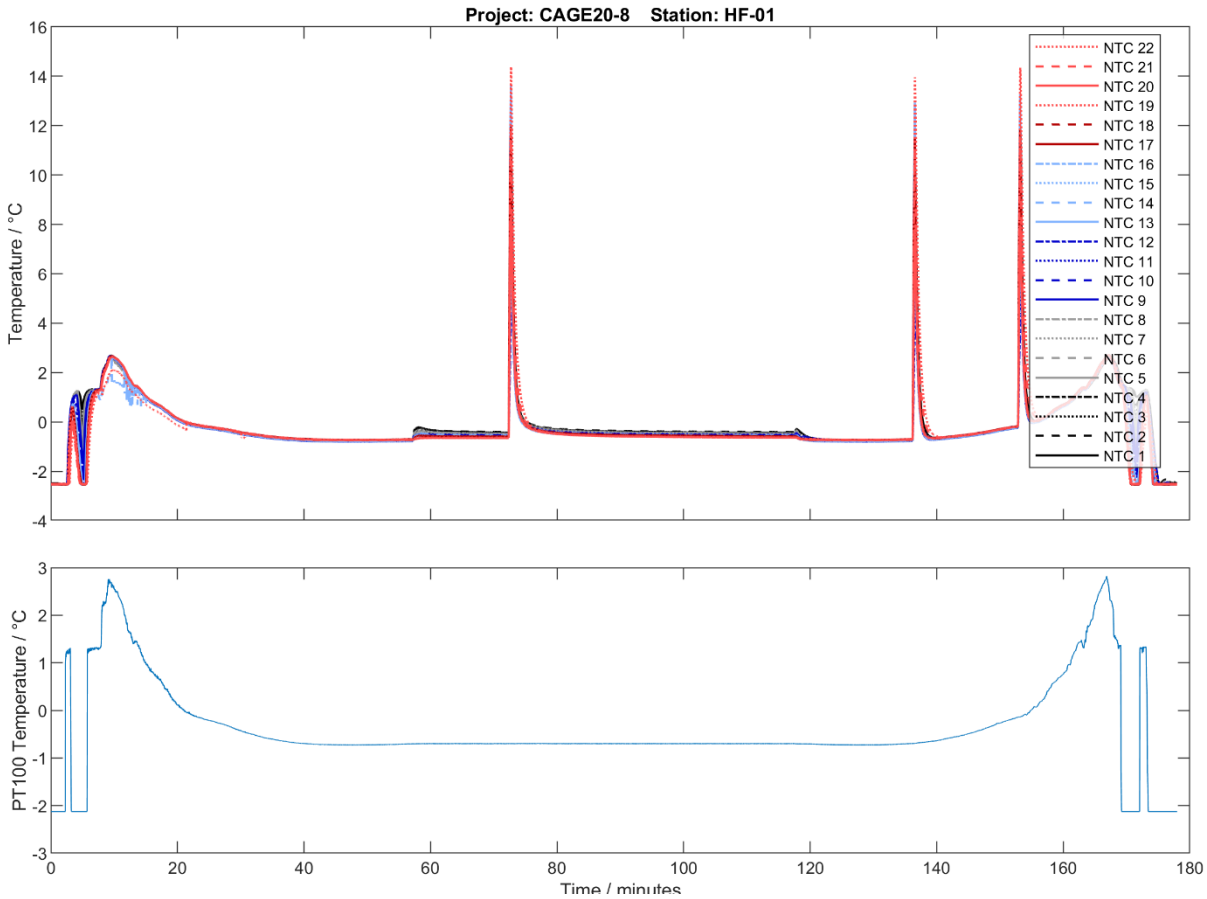

Figure 21: Heat probe results for CAGE 20-8-KH-07- HF

Multicorer

MC01 (2944 m water depth)
A very successful cast, which returned 6 full multicores, each containing more than 50 cm of sediment. The sediment was brown-grey mud with forams in the upper part. The surface layer can be soupy.
Core A was sampled for AGENSI (DNA, biomarkers and palynology) and was kept as archive (4˚C). Core B, C, D, E were sampled for DNA (0-1 cm). We collect two samples from B, to get to 5 replicates. Core E was kept for Tine L. Rasmussen, after 0-1 cm sample (50 ml) was taken for DNA. Core F was kept as an untouched archive for Tromsø (Tine L. Rasmussen).

Multicorer resumen table							
ship	KH	station	KH-7	core	CAGE20-8-KH-7-MC01		
n. sec		length		Date	23/11/2020		
Lat. N	76.500		Long. E	-1.3515	Water depth	2944	

Cores	Analysis/Core length	Notes
F	58.5 cm; brown grey mud with forams in the upper part	Archive TLR
E	57 cm; brown grey mud with forams in the upper part	Archive TLR, after sampling 0-1 cm for NEEDED
D	54.5 cm; brown grey mud with forams in the upper part	NEEDED 0-1 cm
C	57.8 cm; brown grey mud with forams in the upper part	NEEDED 0-1 cm
B	~56 cm; brown grey mud with forams in the upper part	NEEDED 0-1 cm (2 samples)
A	56 cm; brown grey mud with forams in the upper part	AGENSI 0-1 cm; sampled for biomarkers, palynology and DNA

Table 9. Summary table for CAGE-20-8-KH-07-MC01

Gravity corer

Gravity Coring resumen table							
ship	KPH	station	7	core	CAGE20-8-KH-07-GC01		
n. sec	5	length	447 cm	Date	24.11.2020		
Lat. N	76.500		Long. E	-1.3520	Water depth	2944	

sec from bottom	sec from top	length (cm)	top sec depth bsf	bot. sec depth bsf	lithology at section bottom	WC	SS	HS	note
E		45	0	45	redish clay on top				inkl. 7 cm oasis on top
D		100	45	145	redish clay on top				
C		100	145	245	redish clay on top				
B		100	245	345	redish clay on top				
A		102	345	447	gray stiff clay at bottom, redish clay on top				bottom of core
CC					core cutter and catcher in bage 17 cm oriented				

Table 10. Summary table for CAGE-20-8-KH-07-GC01

Superstation CAGE 20-8-KH-08

Site Location

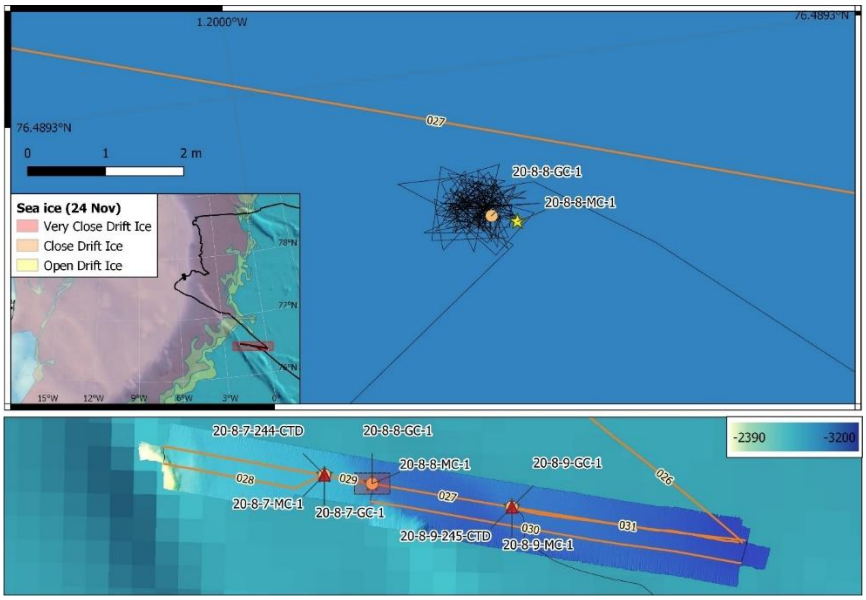

Figure 22. Location of superstation CAGE 20-8-KH-08 on the Greenland Ridge

Acoustics

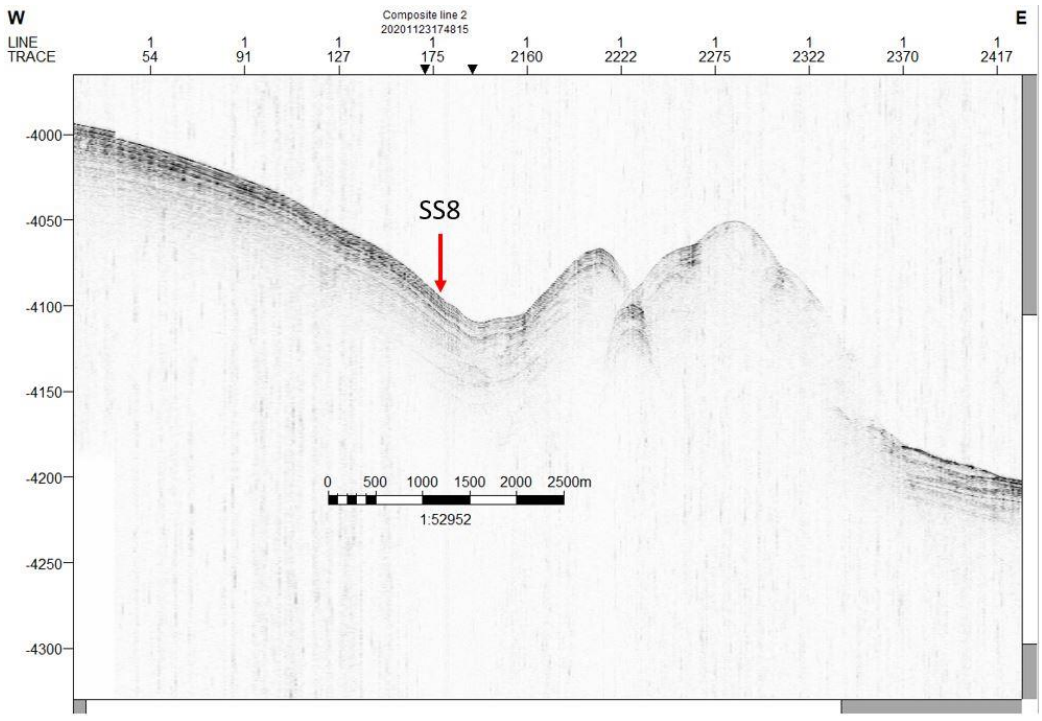

Figure 23. Sub-bottom profile at Superstation CAGE 20-8-KH-08 and the position of sampling (SS8).

Multicorer

MC01 (3024 m water depth)
A very successful cast, which returned 6 full multicores, each containing more than 50 cm of sediment, and several with >60 cm. The sediment was brown-grey mud with forams in the upper part. The longest core (64.5 cm) was kept as archive for Tromsø (Tine L. Rasmussen). Core B was sampled for AGENSI (DNA, biomarkers and palynology) at 0-1 cm. Core B was then kept as archive in cool storage (4˚C). Core C-F were sampled (0-1 cm) for DNA. At core D and E we took 2 samples for DNA at 0-1 cm. Core F fell in the sink, and afterwards needed to settle. After sampling (0-1 cm) for DNA, the core was kept as archive for Tromsø (Tine L. Rasmussen).

Multicorer resumen table							
ship	KH	station	KH-8	core	CAGE20-8-KH-8-MC01		
n. sec		length		Date	24/11/2020		
Lat. N	76.489		Long. E	-1.1998	Water depth	3024	

Cores	Analysis/Core length	Notes
F	57.5 cm; brown grey mud with forams at surface and down to > 10 cm	MC fell, murky waters that needed settling; NEEDED 0-1 cm
E	54.6 cm; as above	NEEDED 0-1 cm (2 samples)
D	52.5 cm; as above	NEEDED 0-1 cm (2 samples)
C	60.2 cm; as above	NEEDED 0-1 cm
B	61 cm; as above	AGENSI 0-1 cm, sampled for biomarkers, palynology and DNA
A	65.5 cm; as above	Archive TLR

Table 11. Summary table for CAGE-20-8-KH-08-MC01

Gravity corer

Gravity Coring resumen table									
ship	KPH	station	8	core	CAGE20-8-KH-08-GC01				
n. sec	5	length	3056 m	Date	24.11.2020				
Lat. N	76.489		Long. E	-1.1998	Water depth	3056			

sec from bottom	sec from top	length (cm)	top sec depth bsf	bot. sec depth bsf	lithology at section bottom	WC	S S	HS	note
E		56.5	0	56.5	redish clay on top				inkl. 7 cm oasis on top
D		102	56.5	158.5	redish clay on top				
C		102	158.5	260.5	redish clay on top				
B		101	260.5	361.5	redish clay on top				
A		100	361.5	461.5	gray stiff clay at bottom, redish clay on top				bottom of core
CC					core cutter and catcher in bage 25 cm oriented				

Table 12. Summary table for CAGE-20-8-KH-08-GC01

Superstation CAGE 20-8-KH-09

Site Location

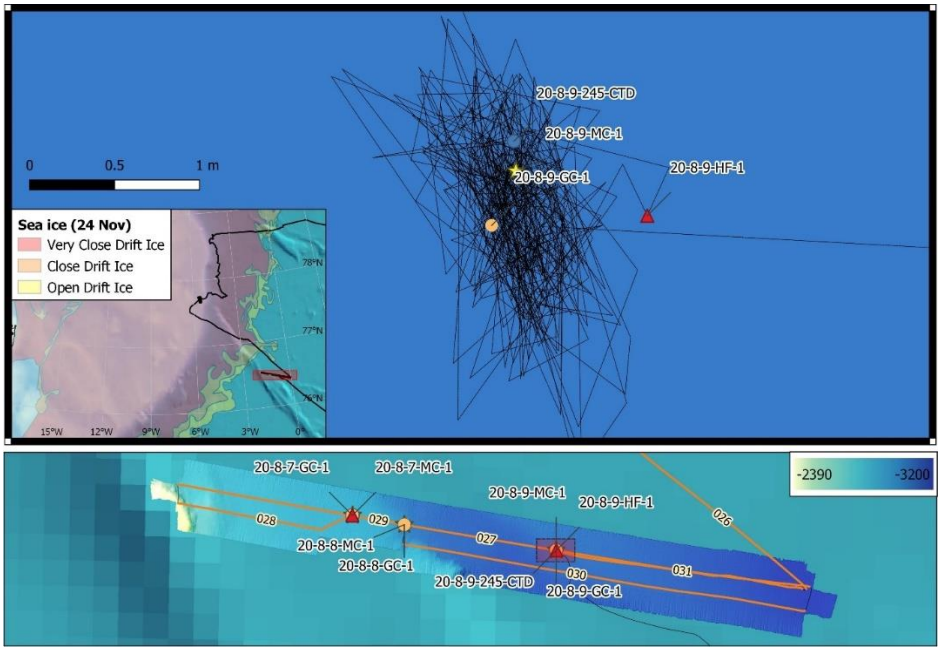

Figure 24 Location of superstation CAGE 20-8-KH-09 on the Greenland Ridge

Acoustics

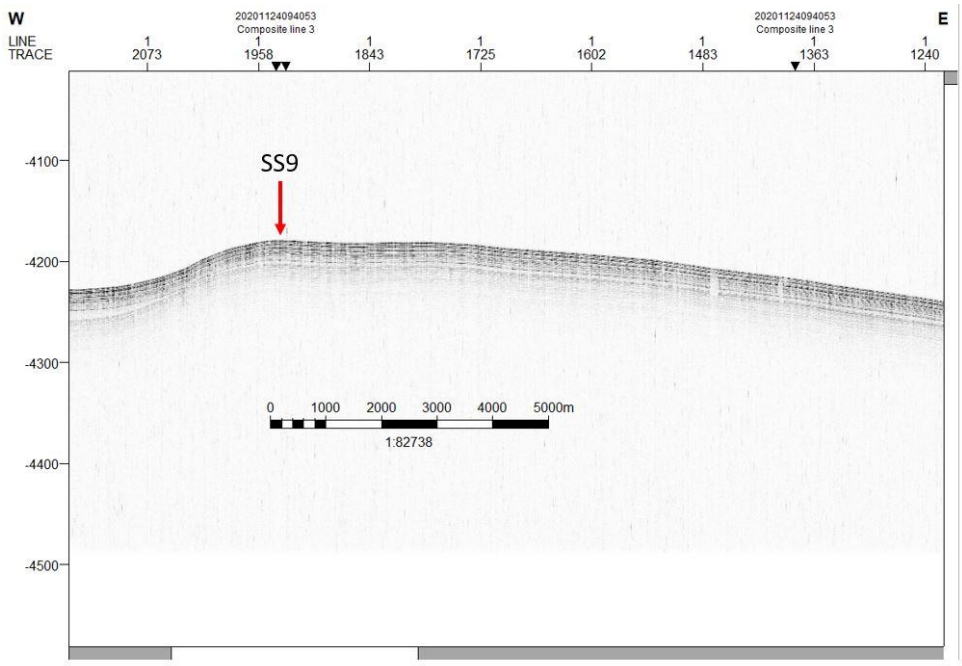

Figure 25. Sub-bottom profile at Superstation CAGE 20-8-KH-09 and the position of sampling (SS9).

Heat probe

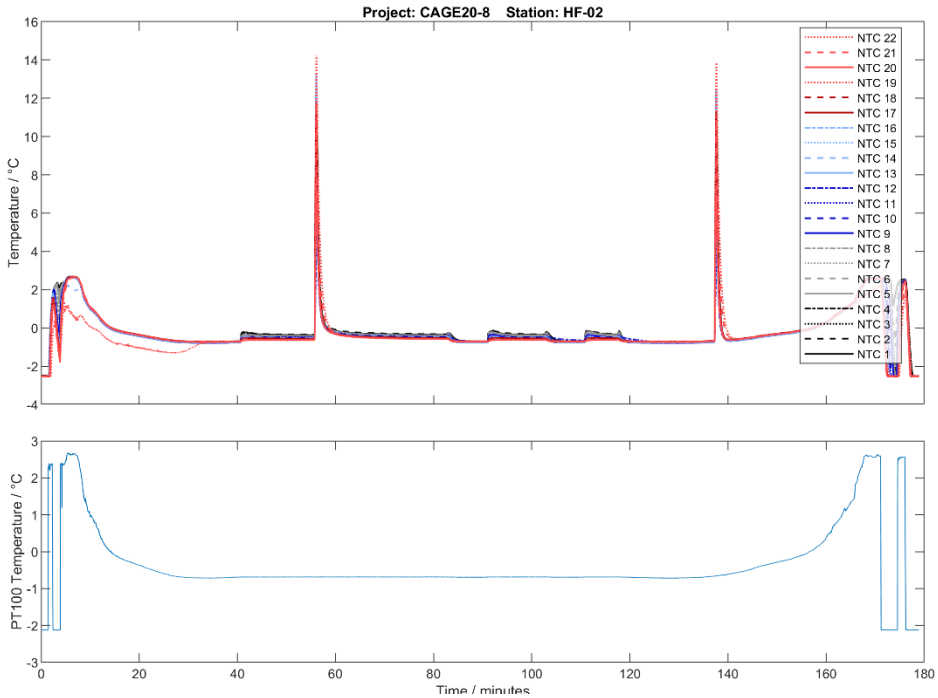

Figure 26. Heat probe results for CAGE-20-8-KH-09-HF

Multicorer

MC01 (3081 m water depth)
Again a very successful cast, with all six liners recovering >60 cm sediment. Sediment was brown-grey mud with forams visible in the upper part, comparable to KH-7 and KH-8. Core A was sampled for AGENSI (DNA, biomarkers and palynology) at 0-1 cm. Core A was then kept as archive in cool storage (4˚C). Cores B-E were sampled (0-1 cm) for DNA. Core B has two samples for DNA. Core F was kept as archive by Tine Rasmussen, after sampling 50 ml from 0-1 cm for DNA. Core F was kept as an untouched archive for Tromsø (Tine L. Rasmussen).

Multicorer resumen table						
ship	KH	station	KH-9	core	CAGE20-8-KH-9-MC01	
n. sec		length		Date	24/11/2020	
Lat. N	76.456		Long. E	-0.755	Water depth	3081

Cores	Analysis/Core length	Notes
F	66.3 cm; brown grey mud with forams visible in upper part	Archive TLR
E	63 cm; as above	NEEDED 0-1 cm; remainder of the MC stored as archive for TLR
D	61 cm; as above	NEEDED 0-1 cm
C	63.2 cm; as above; contained large (7.5 cm) drop stone at ca. 45 cm below top	NEEDED 0-1 cm
B	64.5 cm; as above	NEEDED 0-1 cm (2 samples)
A	61 cm; as above	AGENSI 0-1 cm, sampled for biomarkers, palynology and DNA

Table 13. Summary table for CAGE-20-8-KH-09-MC01

Gravity corer

Gravity Coring resumen table										
ship	KPH	station	9	core	CAGE20-8-KH-09-GC01					
n. sec	5	length		Date	24.11.2020					
Lat. N	76.456		Long. E	-0.7551	Water depth	3081				
sec from bottom	sec from top	length (cm)	top sec depth bsf	bot. sec depth bsf	lithology at section bottom	WC	S S	HS	note	
E		47	0	47					inkl. 10 cm oasis on top	
D		100.5	47	147.5						
C		100.5	147.5	248						
B		100	248	348						
A		100.5	348	448.5					bottom of core	
CC					core cutter and catcher in bage 29 cm in 2 bags oriented					

Table 14. Summary table for CAGE-20-8-KH-09-GC01

Superstation CAGE 20-8-KH-10

Site Location

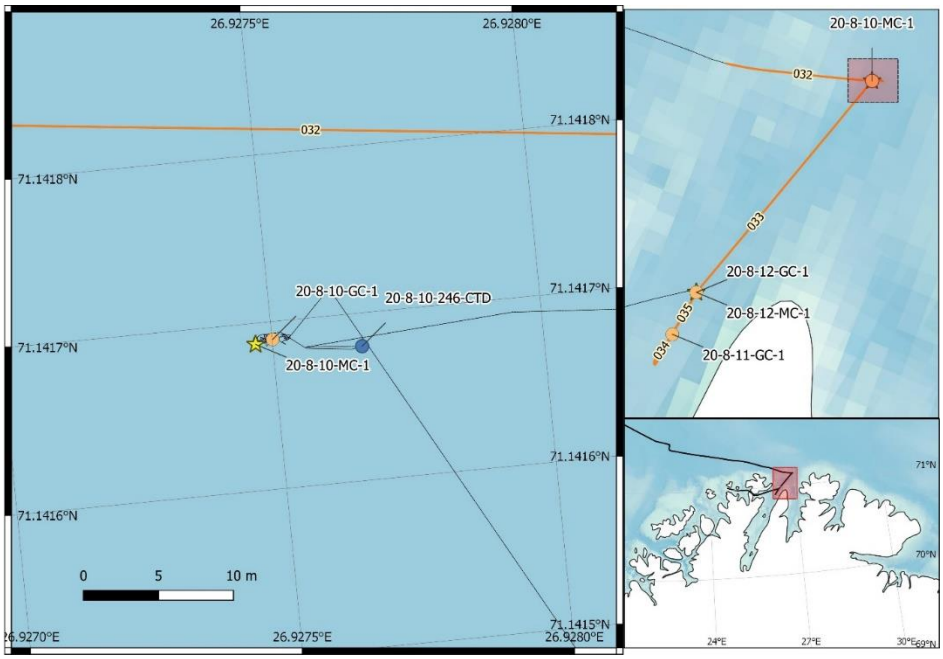

Figure 24. Location of superstation CAGE 20-8-KH-10 in the outer Porsangerfjorden

Acoustics

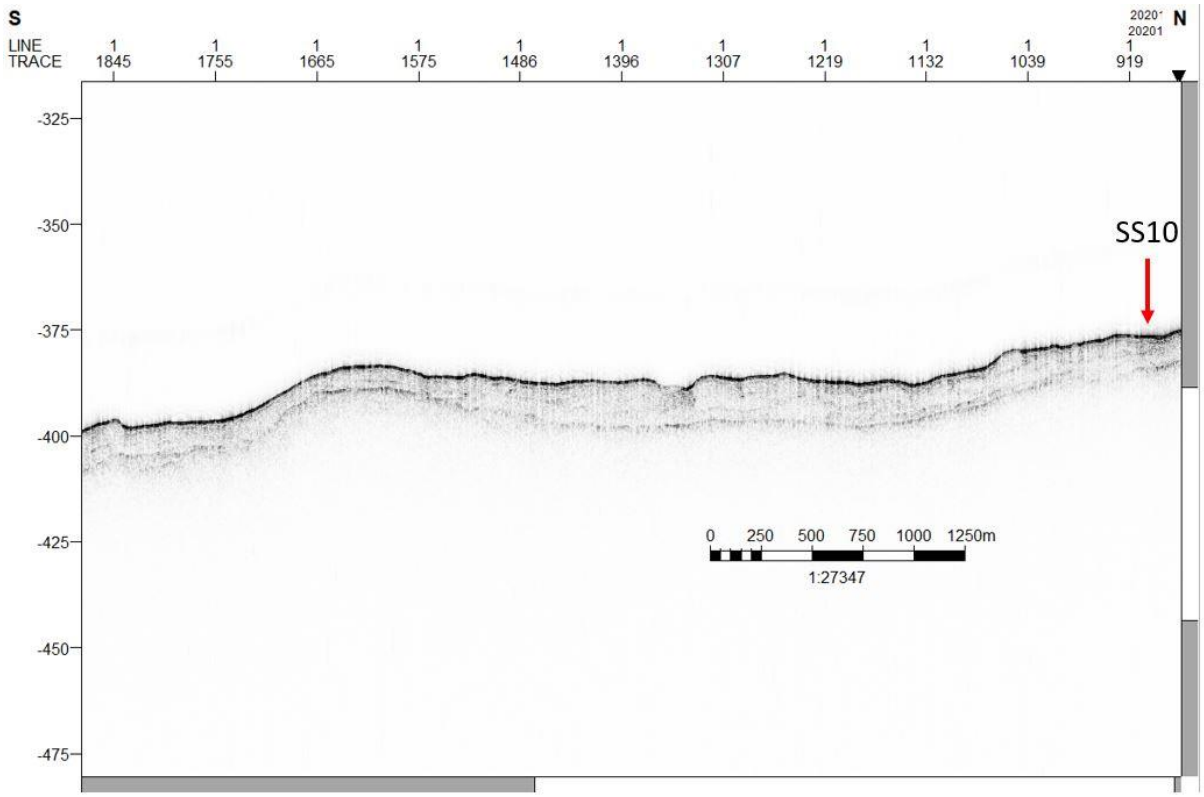

Figure 25. Sub-bottom profile at Superstation CAGE 20-8-KH-10 and the position of sampling (SS10).

Multicorer

MC01 (284 m water depth)
Successful recovery of 5 cores. The sediment surface contained of stones (>2 cm) and sand, which gradually transitioned into silty sand. Core A (46 cm) was then kept as archive (Bergen, AGENSI) in cool storage (4˚C). Core B was sampled for AGENSI (DNA, biomarkers and palynology) at 0-1 cm. Core C was sampled (0-1 cm) for DNA, Core D and E were also sampled for DNA (0-1 cm) and two samples were taken in each core. Core liner F came up empty.

Multicorer resumen table						
ship	**KH**	**station**	**KH-10**	**core**	**CAGE20-8-KH-10-MC01**	
n. sec		**length**		**Date**	**27/11/2020**	
Lat. N	**71.14168735**	**Long. E**	26.927	**Water depth**	**284**	

Cores	Analysis/Core length	Notes
F	/	Empty core liner
E	24 cm	NEEDED 0-1 cm (2 samples)
D	42 cm	NEEDED 0-1 cm (2 samples)
C	36 cm	NEEDED 0-1 cm
B	42 cm	AGENSI 0-1 cm, sampled for biomarkers, palynology and DNA
A	46 cm	NEEDED Archive

Table 15. Summary table for CAGE-20-8-KH-10-MC01

Gravity corer

Gravity Coring resumen table						
ship	**KPH**	**station**	**10**	**core**	**CAGE20-8-KH-10-GC01**	
n. sec	**2**	**length**	**259**	**Date**	**27.11.2020**	
Lat. N	**71.1416**	**Long. E**	**26.9275**	**Water depth**	**283**	

sec from bottom	sec from top	length (cm)	top sec depth bsf	bot. sec depth bsf	lithology at section bottom	WC	SS	HS	note
B		109	0	109					5 cm oasis incl
A		150	109	259	gray clay with clasts				bottom of core, 7 cm oasis incl
CC					21 cm core catcher + cutter (gravel + clay)				for Bergen

Table 16 Summary table for CAGE-20-8-KH-10-GC01

Superstation CAGE 20-8-KH-11

Site Location

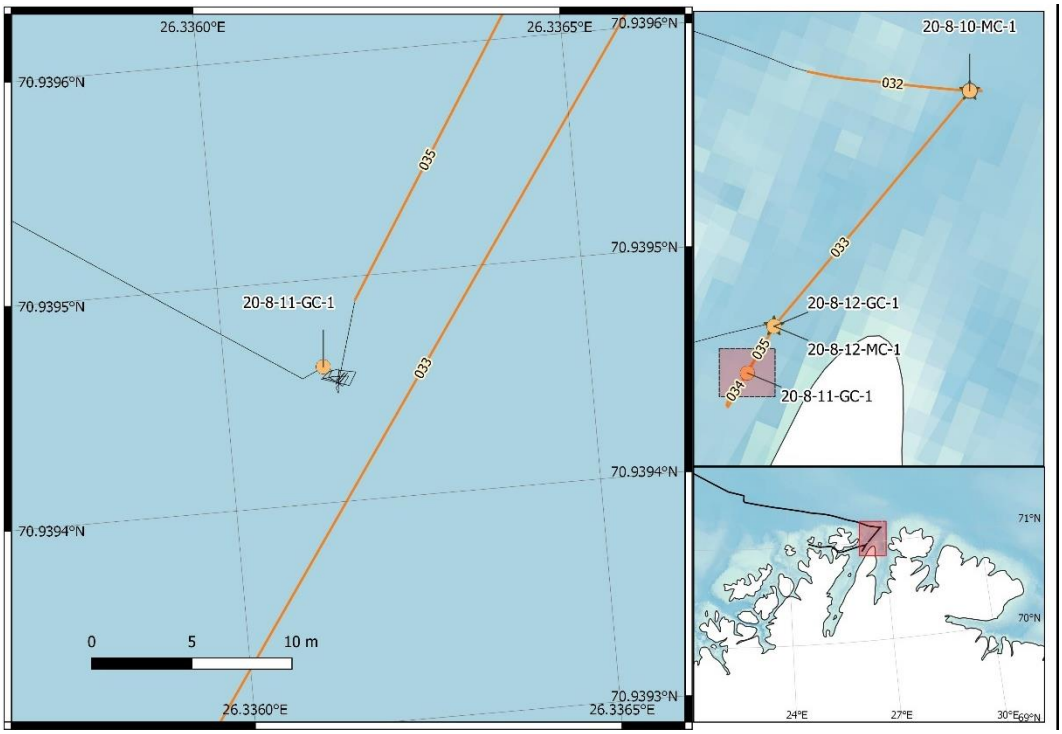

Figure 24. Location of superstation CAGE 20-8-KH-11 in the central Porsangerfjorden

Acoustics

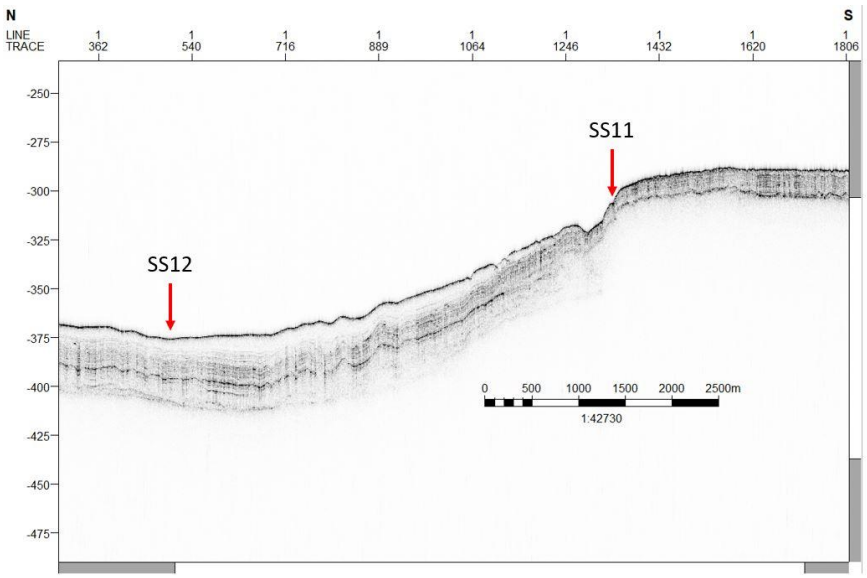

Figure 25. Sub-bottom profile at Superstation CAGE 20-8-KH-11 and the position of sampling (SS11).

Gravity corer

Gravity Coring resumen table										
ship	**KPH**	**station**	**11**	**core**	**CAGE20-8-KH-11-GC01**					
n. sec	**6**	**length**	**585**	**Date**	**27.11.2020**					
Lat. N	**70.9394**		**Long. E**	**26.3361**	**Water depth**	**241**				

sec from bottom	sec from top	length (cm)	top sec depth bsf	bot. sec depth bsf	lithology at section bottom	WC	S S	HS	note
F		85	0	85					
E		100	85	185					
D		100	185	285					
C		100	285	385					
B		100	385	485					
A		100	485	585	fine gray clay				bottom of core
CC					core cutter and catcher in tube: 16 cm				

Table 17. Summary table for CAGE-20-8-KH-11-GC01

Superstation CAGE 20-8-KH-12

Site Location

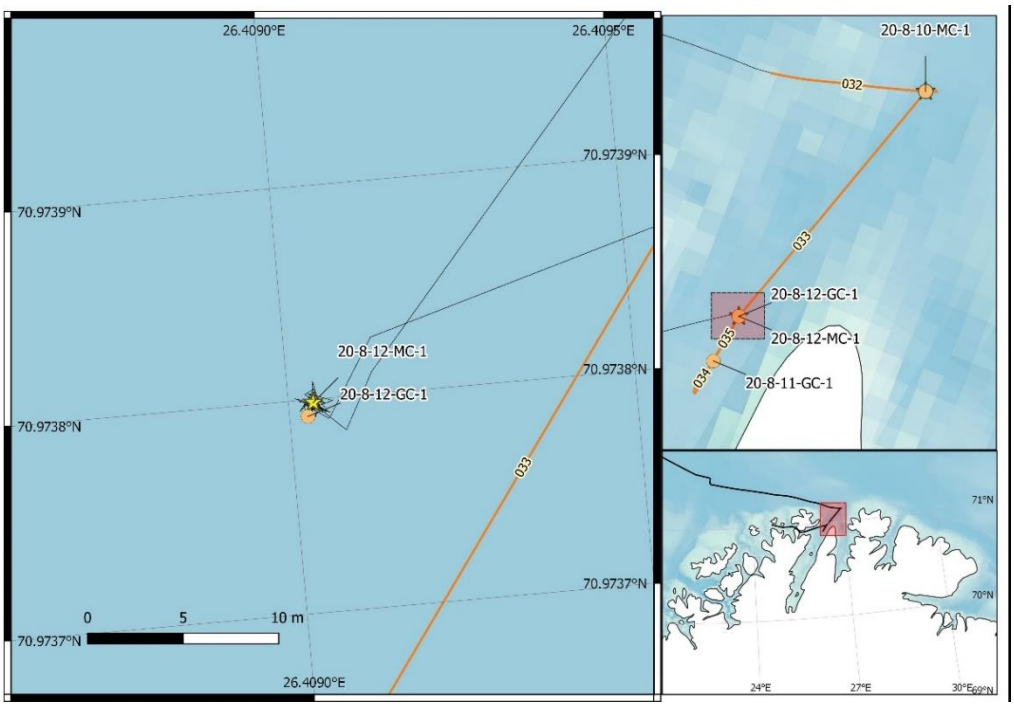

Figure 24. Location of superstation CAGE 20-8-KH-12 in the central Porsangerfjorden

Acoustics

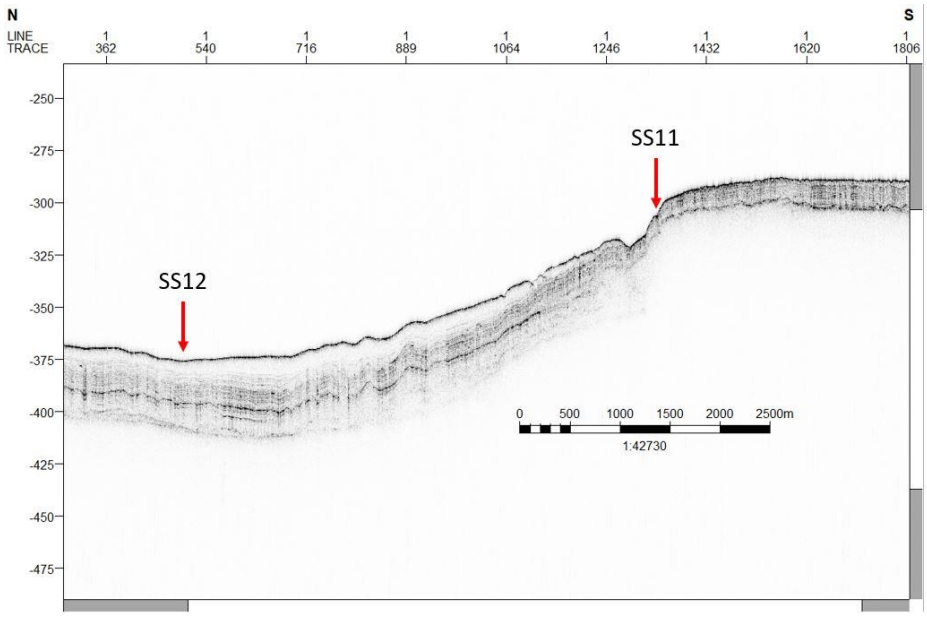

Figure 25. Sub-bottom profile at Superstation CAGE 20-8-KH-12 and the position of sampling (SS12).

Multicorer

The cast with the Bergen multicore (4 cores), collected 4 cores with sediments. The sediment appeared olive/greenish grey. We kept one core as Archive (A: 39 cm), while core B was sampled for AGENSI (DNA, biomarkers and palynology) at 0-1 cm. Core C and D were not used – we looked for a particular worm in this core (Tine Rasmussen), but did not find it.

Multicorer resumen table						
ship	**KH**	**station**	**KH-12**	**core**	**CAGE20-8-KH-12-MC01**	
n. sec		**length**		**Date**	**27/11/2020**	
Lat. N	**70.97379848**	**Long. E**	26.409	**Water depth**	**285**	

Cores	Analysis/Core length	Notes
F	/	
E	/	
D	not measured; greenish grey fine mud	not used/kept
C	35 cm; as above	not used/kept
B	37 cm	AGENSI 0-1 cm, sampled for biomarkers, palynology and DNA
A	39 cm	AGENSI Archive

Table 18. Summary table for CAGE-20-8-KH-12-MC01

Gravity corer

Gravity Coring resumen table										
ship	**KPH**	**station**	**12**	**core**	**CAGE20-8-KH-12-GC01**					
n. sec	**4**	**length**	**589**	**Date**	**27.11.2020**					
Lat. N	**70.9737**		**Long. E**	**26.409**	**Water depth**	**284**				

sec from bottom	sec from top	length (cm)	top sec depth bsf	bot. sec depth bsf	lithology at section bottom	WC	S S	HS	note
D		139	0	139					
C		150	139	289					
B		150	289	439					
A		150	439	589	fine gray clay				bottom of core
CC					core for Bergen & Jochen				

Table 19. Summary table for CAGE-20-8-KH-12-GC01

5. Logs

Map ID	Latitude		Longitude		Equipment	Water Depth [m]
20-8-1-239-CTD	**78.06856468**	**N**	**10.30958512**	**E**	**SBE 911 Plus CTD**	**219**
20-8-1-MC-1	**78.0685644**	**N**	**10.30960172**	**E**	**Multicorer**	**219**
20-8-1-MC-2	**78.06860967**	**N**	**10.31041808**	**E**	**Multicorer**	**219**

20-8-1-GC-1	**78.0685675**	**N**	**10.31053745**	**E**	**Gravity Corer**	**220**
20-8-1-240-CTD	**78.63202982**	**N**	**0.688194367**	**E**	**SBE 911 Plus CTD**	**2651**
20-8-2-241-CTD	**78.66854308**	**N**	**-4.290399983**	**W**	**SBE 911 Plus CTD**	**1495**
20-8-2-GC-1	**78.65847308**	**N**	**-4.292218083**	**W**	**Gravity Corer**	**1484**
20-8-2-MC-1	**78.64691583**	**N**	**-4.290510783**	**W**	**Multicorer**	**1475**
20-8-2-MC-2	**78.63697078**	**N**	**-4.284228167**	**W**	**Multicorer**	**1486**
20-8-2-GC-2	**78.62778482**	**N**	**-4.2766592**	**W**	**Gravity Corer**	**1487**
20-8-3-242-CTD	**78.3355958**	**N**	**-4.009502733**	**W**	**SBE 911 Plus CTD**	**1933**
20-8-3-MC-1	**78.32702798**	**N**	**-4.015574067**	**W**	**Multicorer**	**1942**
20-8-4-Other-1	**77.859644**	**N**	**-4.068143**	**W**	**Sea ice coring**	**2645**
20-8-4-CAM_Vid-1	**77.83055033**	**N**	**-4.0262842**	**W**	**CAMPOD Video Platform**	**2645**
20-8-5-243-CTD	**77.68080647**	**N**	**-5.439257983**	**W**	**SBE 911 Plus CTD**	**441**
20-8-5-MC-1	**77.67906588**	**N**	**-5.452594083**	**W**	**Multicorer**	**434**
20-8-5-GC-1	**77.68036087**	**N**	**-5.452481933**	**W**	**Gravity Corer**	**431**

20-8-5-MC-2	**77.67983742**	**N**	**-5.452711217**	**W**	**Multicorer**	**432**
20-8-6-MC-1	**77.7420212**	**N**	**-5.4925648**	**W**	**Multicorer**	**383**
20-8-6-MC-2	**77.74169965**	**N**	**-5.487873733**	**W**	**Multicorer**	**393**
20-8-6-MC-3	**77.74409137**	**N**	**-5.48700035**	**W**	**Multicorer**	**391**
20-8-7-244-CTD	**76.50064058**	**N**	**-1.351495833**	**W**	**SBE 911 Plus CTD**	**2944**
20-8-7-MC-1	**76.50063655**	**N**	**-1.351509867**	**W**	**Multicorer**	**2944**
20-8-7-HF-1	**76.5006845**	**N**	**-1.35208435**	**W**	**Heat Flow Probe**	**2944**
20-8-7-GC-1	**76.50068158**	**N**	**-1.352084133**	**W**	**Gravity Corer**	**2944**
20-8-8-GC-1	**76.48928267**	**N**	**-1.1998822**	**W**	**Gravity Corer**	**3024**
20-8-8-MC-1	**76.48928162**	**N**	**-1.199870017**	**W**	**Multicorer**	**3024**
20-8-9-245-CTD	**76.45675205**	**N**	**-0.75511445**	**W**	**SBE 911 Plus CTD**	**3081**
20-8-9-MC-1	**76.45675048**	**N**	**-0.755114967**	**W**	**Multicorer**	**3081**
20-8-9-GC-1	**76.45674782**	**N**	**-0.755122067**	**W**	**Gravity Corer**	**3081**
20-8-9-HF-1	**76.45674718**	**N**	**-0.755087067**	**W**	**Heat Flow Probe**	**3081**

20-8-10-246-CTD	**71.14168008**	**N**	**26.92766417**	**E**	**SBE 911 Plus CTD**	**284**
20-8-10-MC-1	**71.14168735**	**N**	**26.92746857**	**E**	**Multicorer**	**284**
20-8-10-GC-1	**71.14168937**	**N**	**26.92750098**	**E**	**Gravity Corer**	**283**
20-8-11-GC-1	**70.93946083**	**N**	**26.3361355**	**E**	**Gravity Corer**	**241**
20-8-12-GC-1	**70.97379222**	**N**	**26.40902635**	**E**	**Gravity Corer**	**284**
20-8-12-MC-1	**70.97379848**	**N**	**26.40903568**	**E**	**Multicorer**	**285**

Table 20. CAGE 20-8 Site locations