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R/V Helmer Hanssen

2 - 20 August 2022
Longyearbyen – Tromsø
In collaboration with the Norwegian Petroleum Directorate and HOTMUD

CAGE22-6 cruise report

GEO-3144/8144 Teaching Cruise: Geologically controlled hydrocarbon seepage in Hopendjupet and the wider Barents Sea

Chief Scientists: Pavel Serov and Henry Patton
Capt. R/V: Hans R. Hansen

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Key words: gas flares, oil slicks, acoustics, methane, seismic
Cite as:

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1. Participant list and shifts

Name	Position (Institution)	Shift	GEO-3144/8144 enrolled
Pavel Serov	Researcher (CAGE, UiT)	2	
Henry Patton	Researcher (CAGE, UiT)	1	
Adriano Mazzini	Researcher (CEED, UiO)	1	
Rune Mattingsdal	Geologist (NPD)	1	
Grace Shephard	Researcher (CEED, UiO)	1	
Frances Ann Cooke	PhD (CAGE, UiT)	2	
Victor Cesar Martins de Aguiar	PhD (CIRFA, UiT)	2	✓
Villads Dyrved Holm	MSc (UiT)	2	✓
Giulia Alessandrini	PhD (Bologna University)	1	✓
Juan Camilo Meza Cala	PhD (CEED, UiO)	1	✓
Paula Luerssen	BSc (University of Kiel)	2	✓
Stormer Alexander Jensen	Chief engineer (UiT)	08:00-16:00; 20:00-00:00	
Reidar Kaasa	Engineer (UiT)	16:00-20:00; 00:00-08:00	

Work was organized into two 12 hour-long shifts. Shift 1: 08:00-20:00 Shift 2: 20:00-08:00 (TOS time). We departed from Longyearbyen on 02.12 at 20:00, transiting to Hopendjupet via stations in Storfjordrenna and Spitsbergenbanken. We left the Hopendjupet study area during the evening of 11.08.22, visiting Hopen/Spitsbergenbanken, Nordflaket and Bjørnøyrenna, and arriving into port in Tromsø at 08:00 on 20.12.22

2. Cruise objectives

The CAGE 22-6-HH cruise is organized by the Centre of Excellence (SFF) CAGE -Centre for Arctic Gas Hydrates, Environment and Climate and hosts UiT´s Arctic Marine Geology and Geophysics (GEO-8144 and GEO-3144) field course for PhD and Master students (5 ECTS). The cruise is supported by, and carried out in close collaboration with, NPD – the Norwegian Petroleum Directorate, and the INTPART project HOTMUD based at Centre for Earth Evolution and Dynamics (CEED) the University of Oslo. The cruise is also a part of the UNESCO Training Through Research program (formerly, The Floating University) and in the framework of this project is also coded as TTR22.

The main scientific objectives of the cruise are to investigate:

- geological controls on fluid-flow dynamics on an uplifted, repeatedly glaciated, and eroded Northern Norwegian Barents Sea shelf and,
- the fate of the released hydrocarbons in the water column, on the sea surface, and in the atmosphere.

Over the last ~50 Myrs, the Norwegian sector of the Barents Sea experienced 1.7 – 2.6 km of preglacial and glacial erosion (Laberg et al., 2012; Lasabuda et al., 2021). Removal of this overburden and the degradation of caprocks can promote fluid migration from natural geological reservoirs, resulting in hydrocarbon seeps at the seafloor. Previous research cruises (CAGE 18-1, CAGE 19-2, CAGE 20-2, CAGE 21-4, CAGE 21-6) and remote sensing Synthetic Aperture Radar (SAR) data have mapped oil slick emission spots and extensive gas leakage from the seafloor closely associated to eroded structures across Sentralbanken High (Hopendjupet), Storbanken High, and Kong Karls Platform, all of which have hydrocarbon potential. However, the existing seismic data (both in terms of coverage and resolution) have not revealed whether hydrocarbon leakage occurs through faulted, partially and/or completely eroded caprock. It is also not clear whether the reservoir properties vary significantly across the eroded structures, leading to variable magnitudes of fluid release. Moreover, the role of gas hydrate as a potential sealing mechanism for these shallow petroleum systems has not been investigated.

Across the Northern Norwegian Barents Sea, the large-scale and persistent sources of methane and heavier hydrocarbon gases at the seafloor produce significant gas fluxes, a fraction of which may bypass the microbial oxidation "filter" in the water column and reach the atmosphere. Moreover, oil-coated gas bubbles, such as the ones previously observed with an ROV during the CAGE 21-6 cruise, have been hypothesized to slowdown the dissolution of gas bubbles and increase their potential to carry methane to the higher levels of the water column (Leifer et al., 2009). The strength of the seafloor methane source at glacially eroded hydrocarbon-bearing structures of the Northern Norwegian Barents Sea and its high potential to produce oil-coated bubbles indicate a necessity to quantify sea-air fluxes of methane.

Interpretations of the SAR images of the Northern Norwegian Barents Sea throughout 2021-2022 by NPD and K-SAT has revealed large and persistent oil slicks originating from natural geological sources on the seafloor. These slicks can be a natural laboratory for investigating how meteorological and oceanographic conditions shape non-anthropogenic oil slicks. Visual observations of the slicks and *in-situ* oceanographic and meteorological data collected simultaneously with satellite SAR images will be important to verify remote sensing data interpretations and models.

The cruise tasks:

- Collect high-resolution 2D seismic data at selected locations
- Collect 3D seismic data in Hopendjupet area
- Map gas seeps at new areas within Spitsbergenbanken and extend gas seep mapping in Hopendjupet
- Collect oceanographic (CTD, ADCP) and meteorological data simultaneously with satellite SAR data acquisition
- Collect water and air samples at sampling locations of CAGE 21-6 cruise and at new locations suggested based on meteorological data
- Collect gas hydrate samples
- Collect sediment samples for collaborative projects (biomarker, microplastics, and benthic foraminifera analyses)
- Collect water samples and multibeam water column data above abandoned boreholes in the Southern Barents Sea
- Additional educational and active training-based activities

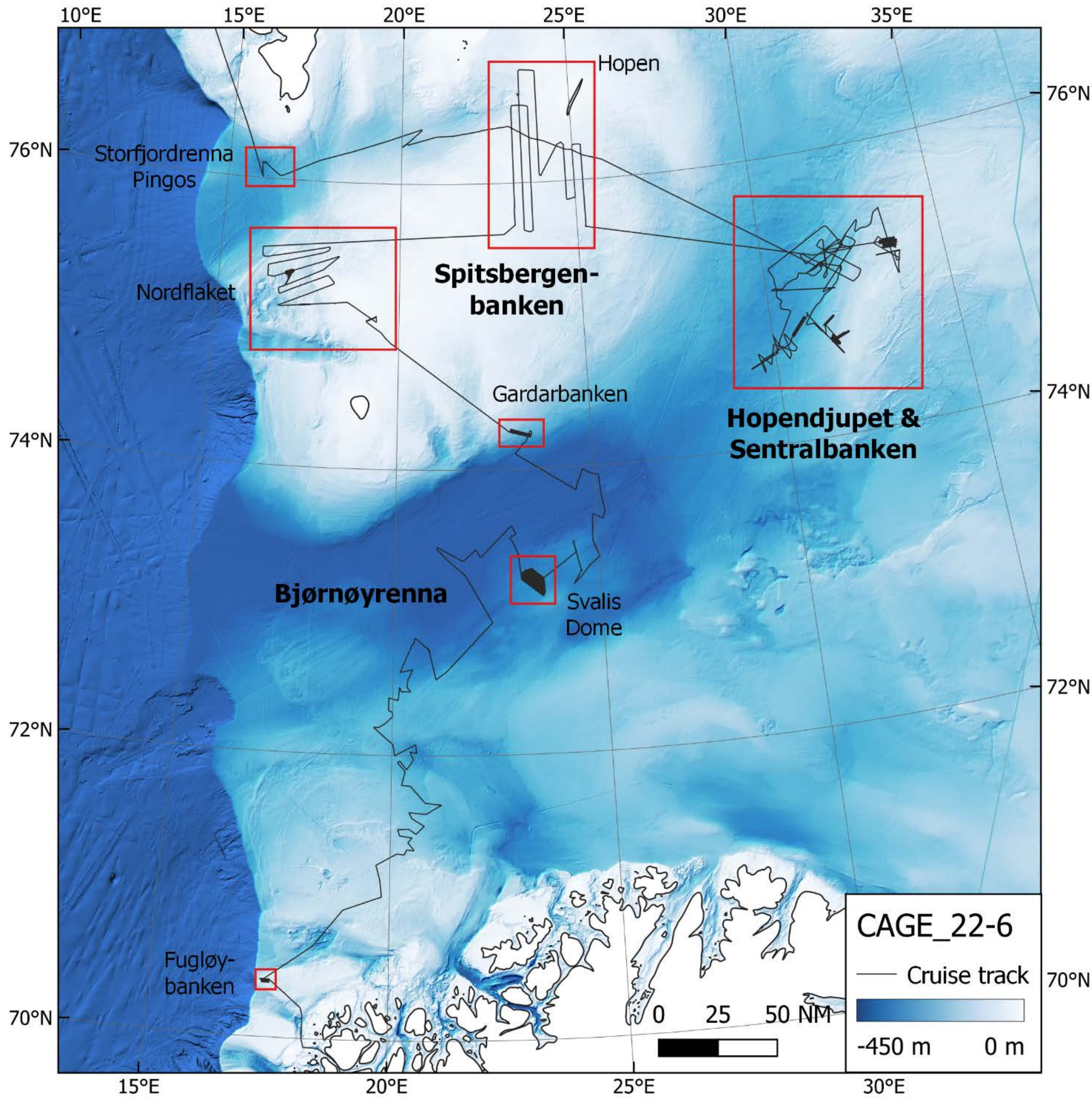

Figure 1: The main study areas investigated during the CAGE-22-6-HH cruise.

3. Equipment and methods

3.1. Singlebeam echosounder EK60

Single beam echosounders are a common instrument, installed on all types of ships. Their primary purpose is to estimate the depth of the seafloor. In a single beam echosounder, the transducer projects a sound pulse through water in a controlled direction and the reflected wave is received. The depth is calculated from the travel time of the sound pulse. R/V Helmer Hanssen has a keel-mounted Simrad EK 60 single beam echosounder with transducers at three different frequencies, 18 kHz, 38 kHz, and 120 kHz. The 18 kHz transducer can be used for depths up to 10 km whereas 38 kHz and 120 kHz can only be used for depths up to 2 km and 500 m, respectively.

Single beam echosounder profiles were acquired across an intense area of gas seepage in the Hopendjupet seep area, using a frequency of 38 kHz and replicating acquisition lines taken during the CAGE21-6 cruise. Apart from during this profile acquisition, the EK60 was switched off in order to reduce interference and increase resolution in the EM302 water column data.

3.2. Multibeam echosounder EM302

Multibeam echosounders use a swath of beams giving off-track depth. Basic components of a multibeam system are two linear transducer arrays with separate units for transmitting and receiving. Echosounders measure the two-way travel time that a sound wave initiated by the transmitter needs to reach the seafloor and be reflected back to the receiver. The time-depth conversion is done based off a sound velocity profile of the water column, which can be calculated from a CTD cast.

R/V Helmer Hanssen is equipped with the hull-mounted Kongsberg Simrad EM302 multibeam echosounder system. The nominal sonar frequency of the sound waves is 30 kHz with an angular coverage sector of up to 150° and 432 beams per ping. The ping rate adjusts automatically depending on the water depth, typically ranging between 0.5 and 2 Hz on shelf areas. In extremely shallow waters e.g., <50 m around Hopen, the ping rate exceeded 5 Hz. The achievable swath width on the seafloor depends on the water depth and the selected opening angle.

During CAGE 22-6-HH we used the EM302 multibeam echosounder to acquire seafloor bathymetric data and for identifying locations and the relative strength of free gas release from the seafloor. The system was used with a 60°/60° opening angle. The echosounder was typically operated using an internal trigger, with the single beam echosounder EK60 and subbottom profiler (CHIRP) switched off. The QPS Qimera software was used to process and generate gridded bathymetric data.

Gas seep mapping was done in the QPS FMMidwater software. The acquired data in *.all and *.wcd file formats were converted to the generic water column format (*.gwc). *.gwc files were visualized in fan view and stacked view. Locations of the gas flares were determined manually by observing the data in a fan view and retrieving coordinates of the gas flare initiation points using the geopicking tool. Flare locations were plotted on the maps and used for planning seismic data acquisition, sediment and water sampling. Along the seismic lines, the outlines of the gas flares were cropped (Figure 2B), then plotted in Petrel or Fledermaus (Figure 2C).

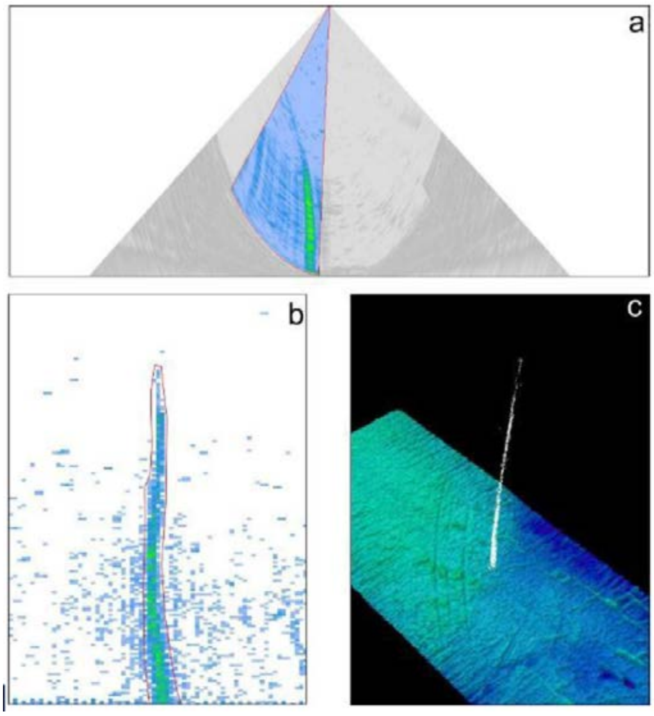

*Figure 2: Gas flare cropping workflow. a – limiting the beam span to a size of a flare. b – outlining flare contours and exporting the content of the selected volume in *.ascii format. c – importing the flare volumes to QPS Fledermaus, Petrel, etc. software.*

3.3. 2D seismic

Source: During 2D seismic acquisition, typically two GI (Generator-Injector) air guns were used as the seismic source. The air gun generates seismic waves by releasing compressed air into the water. A compressor supplies air at a maximum pressure of 170 bar to the air gun. We reduced the seismic source to one GI gun to test the effectiveness of source noise removal in the processing. Shooting rate, sampling rate and other acquisition parameters for each line is listed in the line-log.

Streamer: The streamer used during 2D data acquisition is 300 m long with 96 channels separated by 3.125 m. The streamer is composed of twelve 25 m long P-Cable Sections.

Operation: The streamer is towed behind the ship at a distance of 70 m from an arm at ~10.5 m from the centre of the boat. The arm is fixed 2m in front of the aft of the ship on the port side. The air gun is towed at a distance of 34 m behind the ship at ~2m depth.

See Figure 3 for geometry of the survey, Table 1 for acquisition parameters and Table 2 for seismic processing flow.

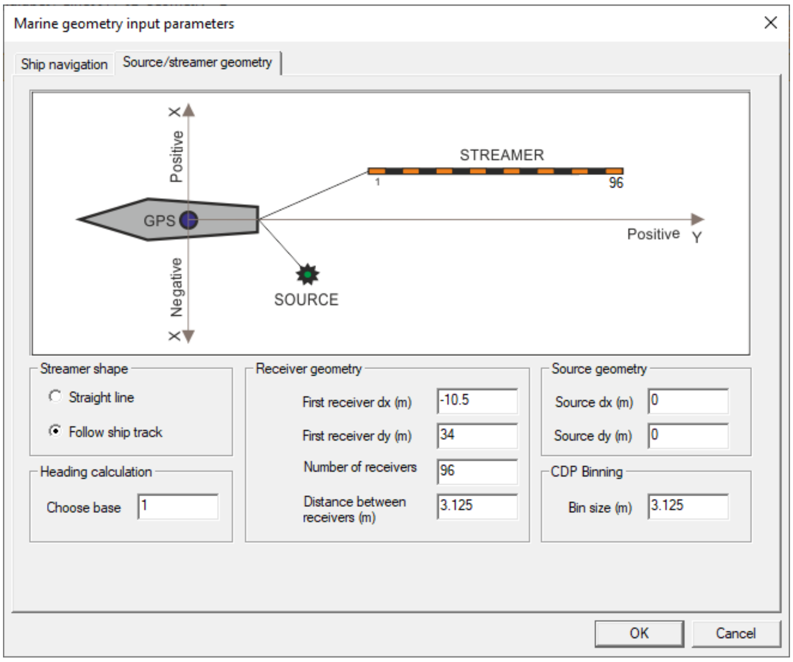

Figure 3: Geometry of the 2D seismic survey. The gun position is used as a reference point for streamer geometry calculation.

Table 1: Seismic acquisition parameters of seismic lines acquired during CAGE22-6 cruise

2D survey parameters	
Deployment/recovery	0.5 h
Survey speed	4-5 kt
Source	1 mini GI (30/30 in^3) & 1 mini GI (15/15 in^3) (1 or 2 guns)
Shooting rate	4-5 s
Shooting pressure	140-170 bar
Source towing depth	1.5 – 2.0 m
Dominant frequency (bandwidth)	140-180 Hz (20-400 Hz)
Positioning	GPS transponder on gun raft
Streamer length	320 m
Active section	300 m
Across track position relative to gun	10.5 m to port
Number of channels	96 (8 channels per section)
Receiver group spacing	3.125 m
Streamer towing depth, 2ION DigiCourse Depth birds	2.0-3.0 m
Sampling rate/interval	4000 Hz / 0.25 ms
Recording length	3 s

We processed 13 out of 17 2D seismic lines collected from the Hopendjupet and Storbanken areas. Lines 4, 7-8 and 12 revealed errors in acquisition and will be processed after the cruise. The raw data were processed using the RadExPro 2020.1 software. The seismic processing flow, as listed in Table 2 below, includes (1) geometry assignment after processing navigation files (using Rowan's python code), (2) filtering (simple band-pass), and spherical divergence, (3) denoise (burst removal, debubble and F-X filtering), (4) NMO correction, (5) post stack Kirchhoff Migration, and (6) post-migration conditioning, (zero phase butterworth filtering).

Figure 4 and Figure 5 show stacked sections for processing steps 3- 6. Low penetration is expected in the area because the bedrock may be eroded down to the Triassic, which is particularly hard.

Table 2: Seismic processing flow for seismic lines acquired during CAGE22-6

Seismic Processing Flow	
SEG-D import and geometry assignment	Input of SEG-D files Geometry assignment and offset calculation
Filtering in the shot gathers	Filtering of bad channels: Band-pass filter of 15/20/450/500 Hz Spherical divergence Burst noise removal
Wavelet extraction	Extraction of source signature
Deconvolution (debubble)	Apply bubble filter (CDP gathers)
NMO and stacking	NMO (1450 m/s) Ensemble stack
Denoise (stack)	F-X filtering
Migration	Post Stack Kirchhoff Migration (constant velocity of 1500 m/s, aperture 300m)
Post-migration	Butterworth filtering (zero-phase, 60-500 Hz) Top Mute (above the seafloor)
SEG-Y output	IBM floating point CDP_X,4R, IBM, 181/CDP_Y, 4R, IBM, 185 Coordinate system: WGS84-UTM35N

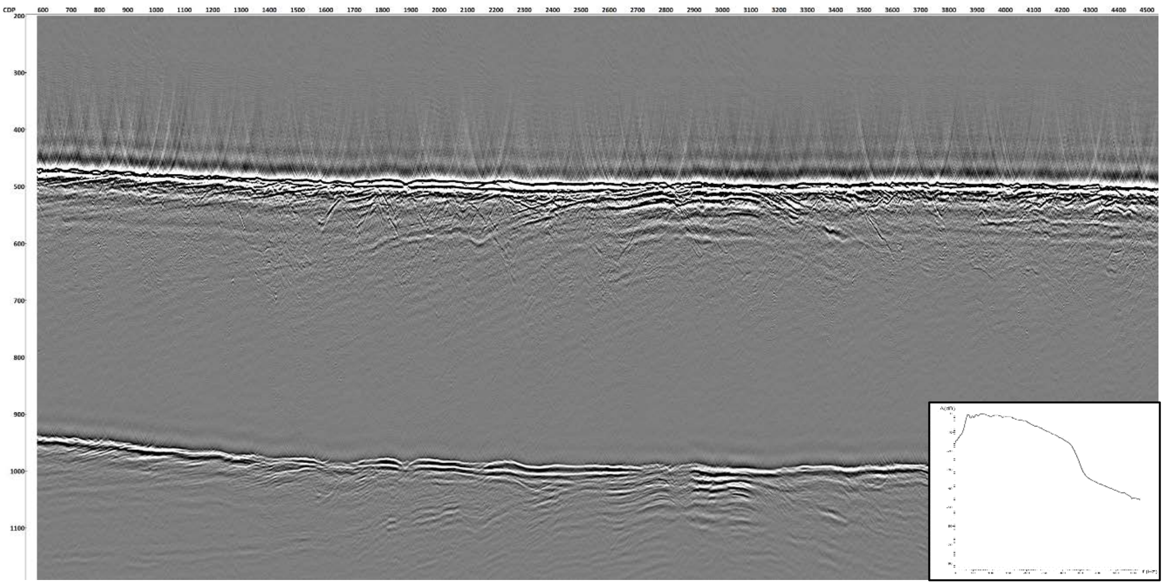

Figure 4: Burst removal and migration

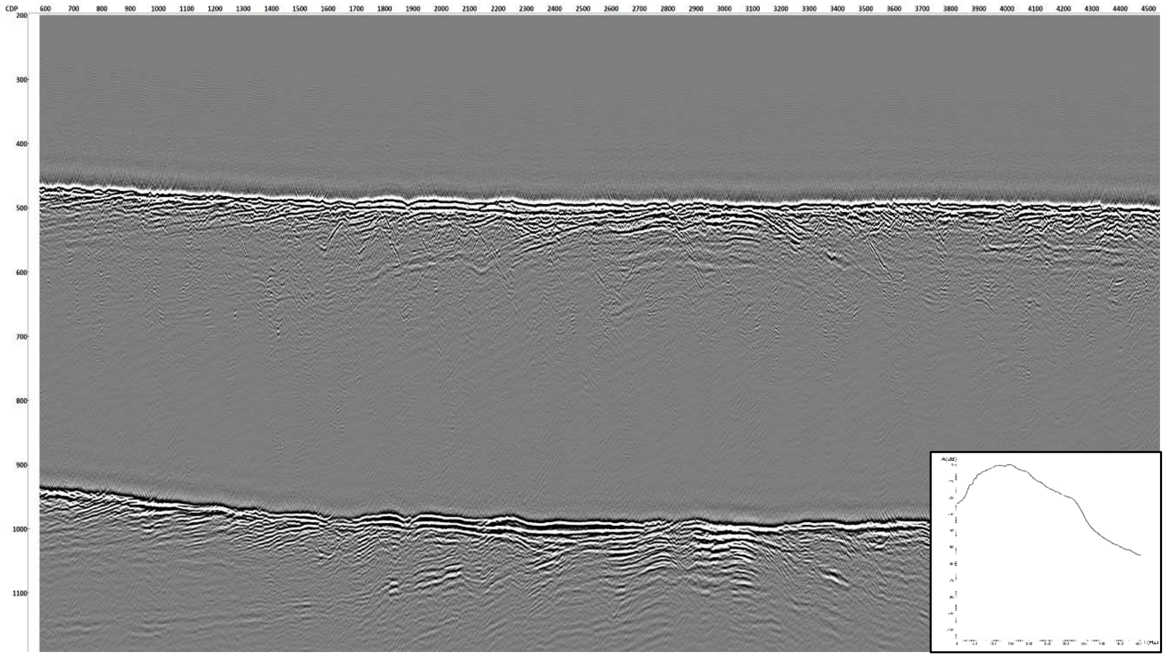

Figure 5: Debubble, F-X filtering (prior to migration), and Post-migration conditioning

3.4. CTD and water column sampling

CTD (Conductivity, Temperature, Depth) sensors measure the physical properties of seawater. In addition to measuring the conductivity, temperature and pressure (from which depth is calculated), the SBE 911plus CTD measures density, sound velocity, turbidity, fluorescence/chlorophyll and oxygen content (Figure 6). Furthermore, the CTD deck unit can trigger the closure of Niskin bottles at discrete depths. Water samples can be taken from the Niskin bottles for further analysis.

R/V Helmer Hanssen uses a SBE 911plus CTD for producing vertical profiles of seawater properties. A winch is used to lower the CTD system into the water. The SBE 911plus CTD records data at a rate of 24 samples per second. The 911plus system uses the modular SBE 3plus temperature sensor, SBE 4C conductivity sensor, SBE 5T submersible pump, and TC duct. The submersible pump pumps water along the sensor to measure the conductivity. The TC duct makes sure that temperature and conductivity are measured on the same parcel of water.

CTD data was collected during the cruise to measure variations in the sound velocity profile of the water column – a necessary calibration for multibeam echosounder surveying. Further targeted CTD data and water samples were collected at 16 sites during the cruise with the aim of tracing the passage of methane through the water column.

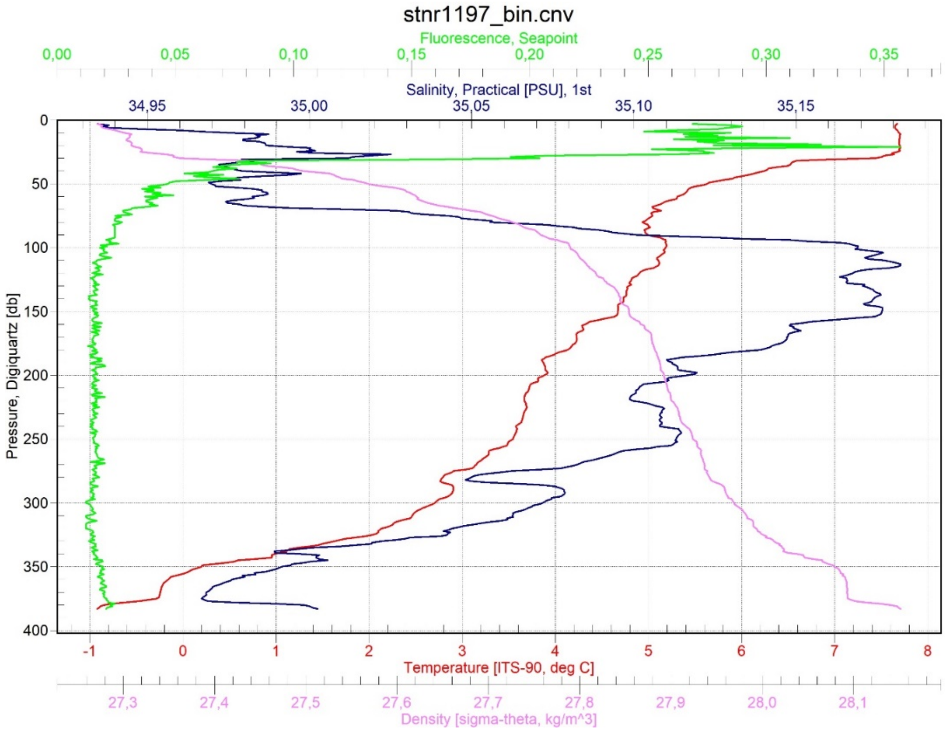

Figure 6: An example of the salinity, temperature, density and fluorescence profiles acquired with the SBE 911 plus CTD at station 1197.

3.5. ADCP – Acoustic Doppler Current Profiler

ADCP is an acoustic system used to measure current direction and speed. R/V Helmer Hanssen is equipped with a Teledyne RD "Ocean Surveyor" ADCP, operated at 75kHz. The ADCP system consists of a transducer-receiver unit installed on the ship's keel, a deck unit and a PC in a controller room. Since ADCP causes interference in water column data collected by the EM302 this instrument was therefore used only when the multibeam echosounder was switched off.

3.6. Sediment coring

Sediment samples were collected with a gravity corer and a multi corer. The main goals were to retrieve sediments from a) targeted sites where acoustic data or previous sampling indicated intense gas/oil seepage activity, b) to collect archive cores from sites sampled during previous expeditions, and c) to have reference cores from which data could be extracted to compare with anomalous seepage sites. A total of 12 gravity and 4 multi coring stations were completed.

Gravity core sampling stations were completed using a 1.3 tonne, 6 m-long gravity corer with a 119 mm-diameter barrel (Figure 7A). The device is equipped with a core catcher, top flapping mechanism and swivel on its top part. A new plastic liner was inserted at each new station. The deployment depth was controlled by the main winch and a free fall was triggered when the gravity corer was positioned ~20 m above the sea floor. Once the gravity corer was retrieved onboard, the plastic liner was extruded from the barrel and subsequently cut in 1 m long sections (0 m at seafloor). The sections were capped and labelled. Core sections needed for immediate sampling were subsequently cut lengthwise using a rotatory saw (Figure 8), with the core sediments split using a fishing line. One half was sent for core photography, core description, gas extraction, sediment subsampling, and the second half for packing and boxing in containers (D-tubes) for storage in a +4°C cool room.

Figure 7: Sediment sampling equipment. A – gravity corer; B – multi corer

Figure 8: Sediment core processing. A – core liner cut in sections; sections are labelled and sealed. B – core liner ready for splitting with a rotary saw. C – split open core section ready for subsampling and description.

The ***multi corer*** allows the collection of six 50 - 60 cm long sediment cores with minimum disturbance and good preservation of surface sediments (Figure 7B). Each core is collected in a transparent plastic liner (60 cm long and 90 mm in diameter). Upon recovery the liners were unplugged from the multicorer and the sediments were extracted from the liners section-by-section. After the subsampling, the liners were washed and reused. During CAGE 22-6-HH cruise, the multicorer was used to collect samples for benthic foraminifera analyses, interstitial gas composition (headspace), biomarker analyses, and microplastics analyses.

3.7. Sediment sampling

3.7.1. Headspace gas sampling

Once the gravity core sections were split into two parts, they were processed for headspace gas sampling. 5ml of sediment were collected using a 6 ml syringe with the luper tip removed. The sediment was then transferred in a 20 ml glass vial where 5 ml of 1M NaOH solution was added to reduce microbial degradation of the sample. The vials were immediately labelled, cleaned, sealed with a rubber septum, crimped with aluminium cap and stored at +4 °C. At most stations, samples were collected in the lowermost part of the core and, when the core was split open, at 20 cm intervals throughout the sections. 74 headspace samples were collected from 11 gravity cores and 2 multi corers.

3.7.2. Gas hydrate sampling

Gas hydrates recovered at station CAGE22-6-HH-1198-GC were immediately bagged and stored at -80°C. Additionally, the gas hydrates from the same downcore intervals were sampled in 20 ml glass vials. Pieces of hydrates were submerged in a bucket full of water, and the released gas was collected in the vials that were sealed and crimped in subaqueous conditions.

3.7.3. Hydrocarbon extraction

At seepages sites where oil seepage was inferred, portions of sediments were sampled from the lowermost part of the cores (typically the core catcher). Nine samples were collected from eight individual stations, and bags were stored at -23°C for in-house laboratory analyses on hydrocarbon content.

3.7.4. Potential methanogenic carbonates

Inferred methanogenic carbonate specimens were retrieved in the cored sediments. These were washed and bagged for further laboratory analyses.

3.7.5. Subsampling for microplastics analyses

Subsamples for microplastics analyses were collected from 3 multi corers. 1 cm-thick sediment slices were collected from the top 5 cm of the recovered sections. Additional samples were taken every 2.5 cm towards the bottom of the recovered sediments. A blank sample to identify background levels of pollution was collected at each station during deck operations. At total of 37 samples were stored at -23°C for in house laboratory analyses.

3.7.6. Subsampling for benthic foraminifera

Subsamples for micropaleontological studies were collected from 4 multi cores and 4 gravity corers. 1 cm-thick slices were collected from the top 5 cm of the recovered sections. The slices were halved, with one half was placed in a plastic bag for archiving purposes. The other half was placed in a plastic cup and later stained using Rose Bengal. Stained samples were stored at +4°C for later laboratory analysis and archived samples were frozen.

3.7.7. eDNA sampling

Undisturbed surface sediments from each of the four multi cores used for benthic foraminifera sampling were collected for future eDNA (environmental DNA) studies. With a sterilized plastic spoon, the relatively undisturbed surface sediments were scooped and placed in plastic vials pre-filled with 10ml of LifeGuard Soil Preservation Solution. The samples were then frozen for later laboratory analysis.

3.8. Oil slick observations and sampling

Oil slicks have been repeatedly observed in Hopendjupet and northern Spitsbergenbanken, on SAR satellite images and visually during CAGE 21-4 and CAGE 21-6 research cruises. During CAGE 22-6-HH research cruise we received oil detection reports by KSAT through collaboration with NPD. The reports interpreted SAR images from the RADSAT-2 satellite, and were used to guide our sampling and drifter deployment. Slicks and oil droplets reaching the sea surface were encountered during the cruise at locations consistent with previous observations.

The working boat was used to sample sea surface oil slicks (Figure 9). The sampling was done using a ETFE membrane which is optimal for sampling oil sheens from the water surface. The membrane is subjected to an extensive solvent cleaning procedure to make sure it is not contaminated and must therefore be handled with care. It is handled with plastic gloves and attached at the end of a telescopic pole for sampling the water surface. The ETFE membrane encourages the oil to be drawn from the water surface and coat the surface of the ETFE. It can be repeatedly exposed to the sheen to build up the maximum amount of oil coat onto it. When the ETFE membrane has a good visual covering of oil, it is placed into a sample bottle with the help of a wooden spatula.

Figure 9: Sampling oil slicks from the working boat using a ETFE membrane at station 1248 (Photos: H. Patton).

3.9. Air sampling

CH_4, CO_2, CO and H_2O are monitored in real-time on-board RV Helmer Hanssen using a Picarro Cavity Ring Down spectrometer (CRDS), model G2401. The sample air is dried using a nafion drier to minimise any water correction error in the instrument. A multiport valve on the instrument inlet enables simultaneous measurements in real-time and for discrete sampling (Figure 10). Working standards are calibrated against reference standards from NOAA-CMDL (CH_4 scale NOAA2004). The central inlet line for the system is connected to the top of the mast on RV Helmer Hanssen. Sample residence time in the sample line is about 10 secs.

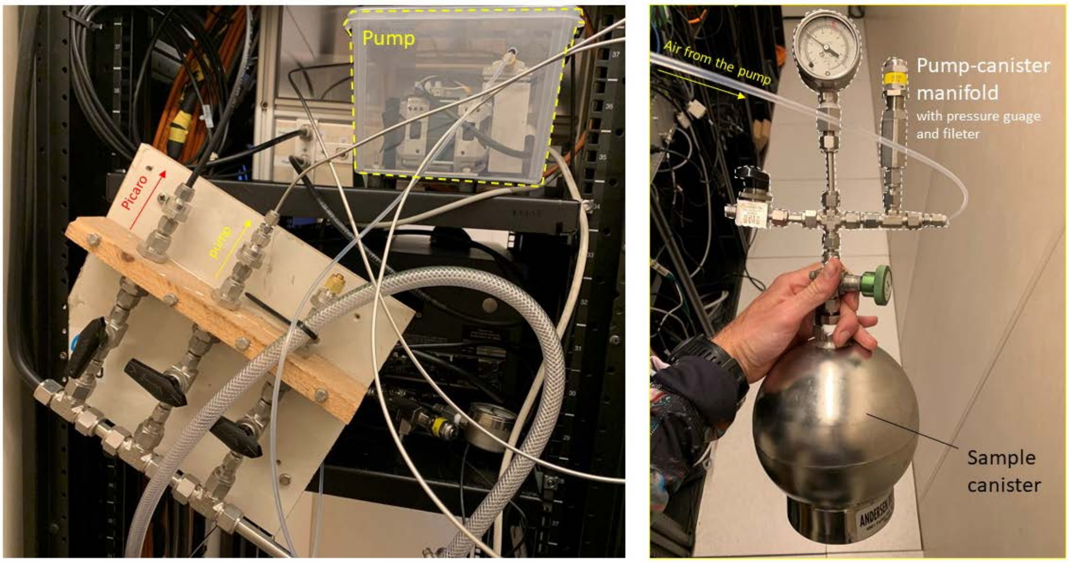

Figure 10: Equipment used for discrete air sampling via the inlet installed on the ship's mast.

Air samples were collected in evacuated canisters. Sampling began with connecting the canister with the pump-canister manifold (Figure 10). After the canister is connected, we opened the line leading to the pump (shown closed on Figure 10), started the pump and flushed the manifold 10 times. For collecting the sample, we closed the flushing valve and opened the canister needle valve. The canister needle valve was closed as soon as the pressure within the manifold reached the maximum. After the sample was taken, we turned off the pump, flushed the manifold, disconnected the canister, and put the end cap on its top. Coordinates of air sampling stations were taken immediately after the canister needle valve was open and the sample collection began. The canisters are sent to the laboratory at NILU where they are analysed on a Medusa system, like the system at the Zeppelin station on Svalbard.

The canister air sampling was guided by outputs of the Flexpart model, which used meteorological forecasts to provide qualitative estimates of the gas plume from presumed submarine source (Figure 11). Daily forecasts were provided by Ignacio Pisso at NILU via email. The air sampling is a part of NFR funded project ReGAME. The objective of the air sampling was to document the most significant gas release from the ocean to the atmosphere during the CAGE 22-6-HH research cruise. Such samples may provide composition and isotopic characteristics of the petroleum-related thermogenic gas source we documented at the seafloor level at Hopendjupet.

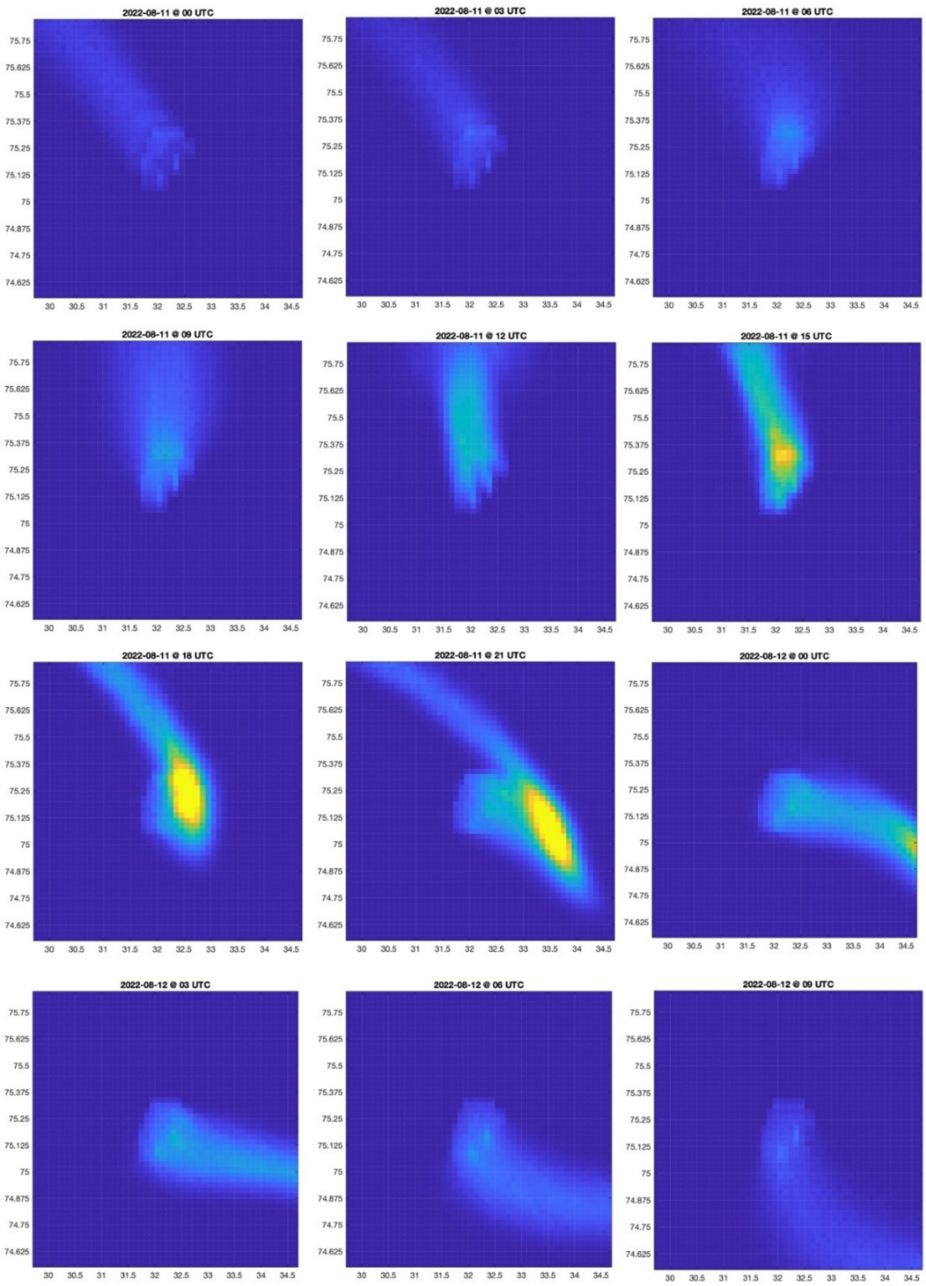

Figure 11: Example of simulation of potential gas plume from submarine seepage from 11.08.22 00 UTC to 12.08.22 09 UTC. Air sampling in Hopendjupet was done on 11.08.2022 from 09.40 UTC to 18.15 UTC. Yellow colours indicate higher potential for increased concentration of gases from the Hopendjupet submarine seep source.

3.10. Drifters

Although using satellite imagery does provide information regarding the presence and shape of oil slicks at the ocean surface, their residence time, speed and dynamics are still unknown. Drifters were deployed in Hopendjupet at the same location that oil slicks have often been observed to better understand the physical processes acting on them. The deployment occurred around the same time that a new SAR image was scheduled. Beyond improving our knowledge about the slick drift itself, this experiment also intends to use the data for further evaluation of numerical model outputs and distinct dispersion regimes faced by the drifter triplet throughout their trajectories.

Differently from commercial devices, the drifters built for this experiment are open source, low-cost and customizable (Figure 12). They were originally developed at the Norwegian Meteorological Institute – Oslo and were already used in different expeditions, both in sea ice covered areas and open waters. The drifters are composed by a 9 degrees-of-freedom sensor (9-dof, Adafruit ISM330 DHCX + LIS3MDL) which performs high-frequency (800 Hz) measurements of acceleration, angular rates and magnetic field, hence providing the wave spectrum experienced by the device.

Geographical position is obtained using a general navigation satellite system (GNSS, SparkFun Artemis Global Tracker) based on the Iridium LEO constellation. For this setup, considering sampling rates of 30 min for the GNSS and wave spectrum every 2 hrs, it is expected an operational time of around 4.5 months using two Lithium D-cells (SAFT LSH20) mounted in parallel. The sensors are assembled inside a 12 cm x 12 cm x 9 cm acrylic box and sealed with silicon sealant to prevent water infiltration. Each drifter was registered in the RockSeven server (www.rockblock.rock7.com, $180/drifter) and all the data retrieved by Iridium can be easily and quickly accessed on the ship using a bash script. The total cost for each drifter, considering the RockSeven monthly rental and credit package, is about $650, at least 10 times less than the cheapest commercial version.

Figure 12: Drifters assembled and awaiting deployment (Photo: H. Patton).

4. Study areas and data acquisition

In the CAGE 22-6-HH cruise we collected data in 4 general study areas: Storfjordrenna, Spitbergenbanken, Hopendjupet and Bjørnøyrenna (Figure 1). During the transits, multibeam water column and seafloor data and meteorological data were acquired continuously.

4.1. Storfjordrenna

The outer part of Storfjorden Trough (Storfjordrenna) accommodates a suite of gas hydrate bearing mounds (Gas Hydrate Pingos) (Hong et al., 2017; Serov et al., 2017; Waage et al., 2019). Focused free gas release from the mounds has been repeatedly observed during CAGE cruises since 2015 (see CAGE 15-2 cruise report for details). The mounds are located at 360-390 m water depth close to the termination of the gas hydrate stability zone. Video surveys (CAGE 15-2, CAGE 16-5, CAGE 18-5) document abundant microbial mats, authigenic carbonate formations and gas ebullition from the seafloor. A seafloor observatory monitoring oceanographic parameters and methane seepage activity has been deployed to gas hydrate pingo 1. One of the tasks for CAGE-22-6-HH cruise was to collect CTD data and water samples for methane concentration analyses at the location of the observatory to complement the continuous near-seafloor measurements with a water column profile (Figure 13).

Station CAGE22-6-HH-1198-GC aimed to sample a known pingo at the Storfjordrenna and to collect gas hydrates for geochemical analyses. The retrieved 180 cm long core had pogonophora worms in the top part. Drop stones and glaciocenic fine-grained fraction was present throughout the core. Irregular shaped methanogenic carbonates (?) were also observed at various depths mostly in the first section. The second section contained gas hydrates (massive, flame-shaped, lenticular, microcrystals). A very strong smell of H_2S was present throughout the core.

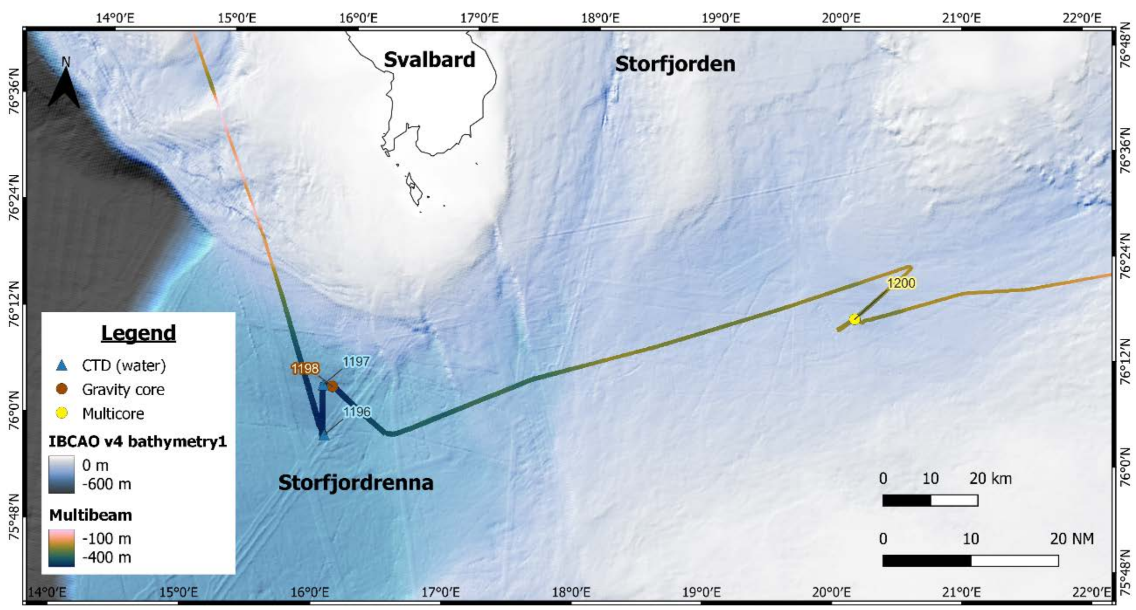

Figure 13: Stations in Storfjordrenna

4.2. Spitsbergenbanken/Nordflaket

On the transit from Storfjordrenna Gas Hydrate Pingo Site to Spitsbergenbanken site we replicated one of the stations from Boitsov et al. (2012) with a multi corer sample for biomarker analyses (CAGE22-6-HH-1200-MC). New analyses may decipher the source of previously reported high hydrocarbon content in bottom sediments could be related to natural oil seepage. Additional samples for benthic foraminifera and microplastics analyses were taken from the same multi corer cast.

A storm in Hopendjupet forced the cruise to revisit the Spitsbergenbanken area on the evening of Aug 11th. Long north-south multibeam transects were carried out south and west of Hopen Island to better constrain the extent of flaring in this region. Numerous flares were observed in proximity to Hopen (Figure 14; Figure 15). Two additional air samples were collected east of Hopen Island to document potential contribution of hydrocarbon gases from outcropping hydrocarbon-bearing formations of Hopen and Svalbard.

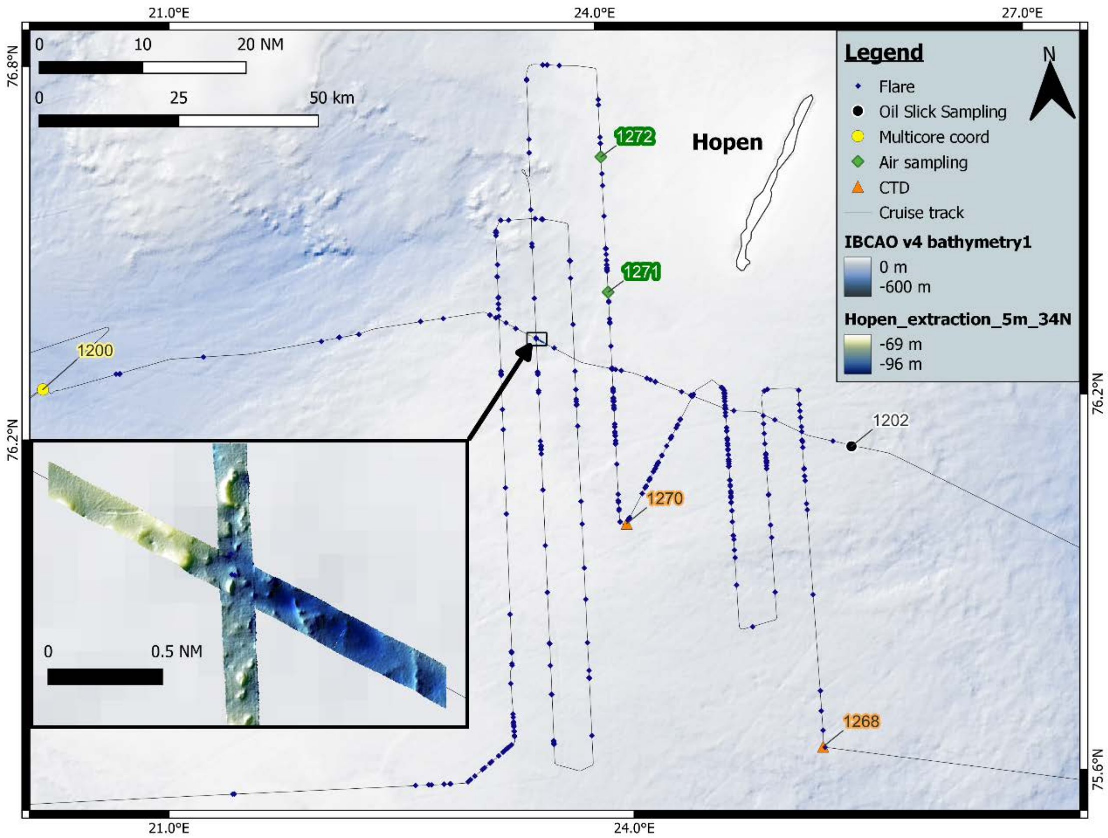

Figure 14: Stations south and west of Hopen Island. Multibeam and water column data coverage was continuous.

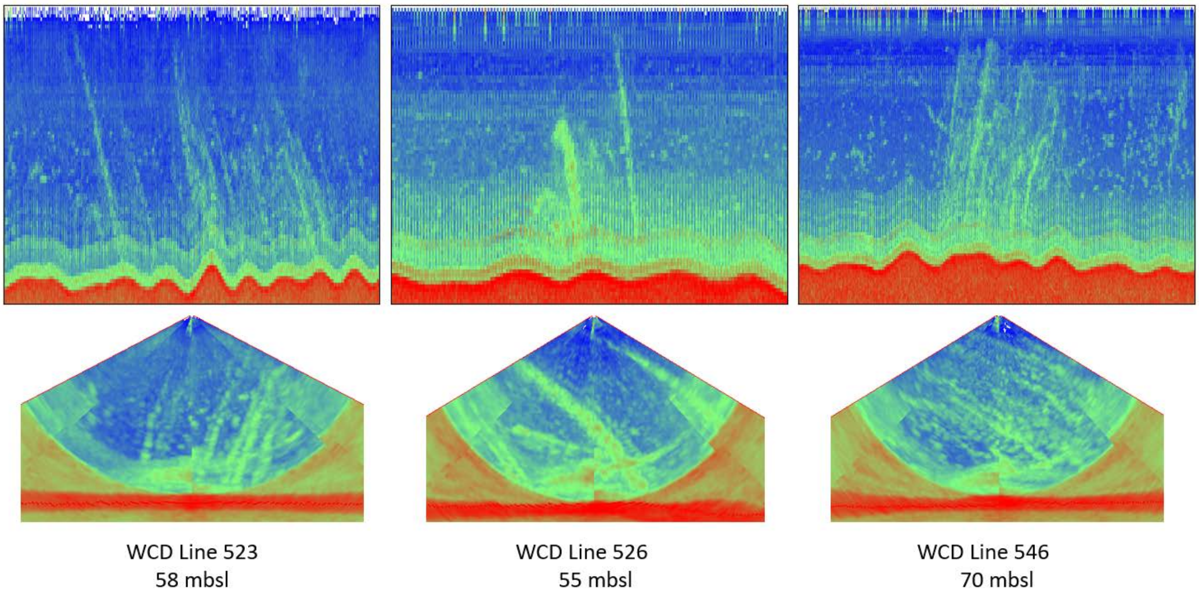

Figure 15: Flares observed in the shallow waters near Hopen Island.

Further, east-west oriented multibeam transects were acquired over Nordflaket, south of Storfjordrenna (Figure 16). Additional shorter swaths were collected in concentrated areas of discovered seepage, along with water and air samples.

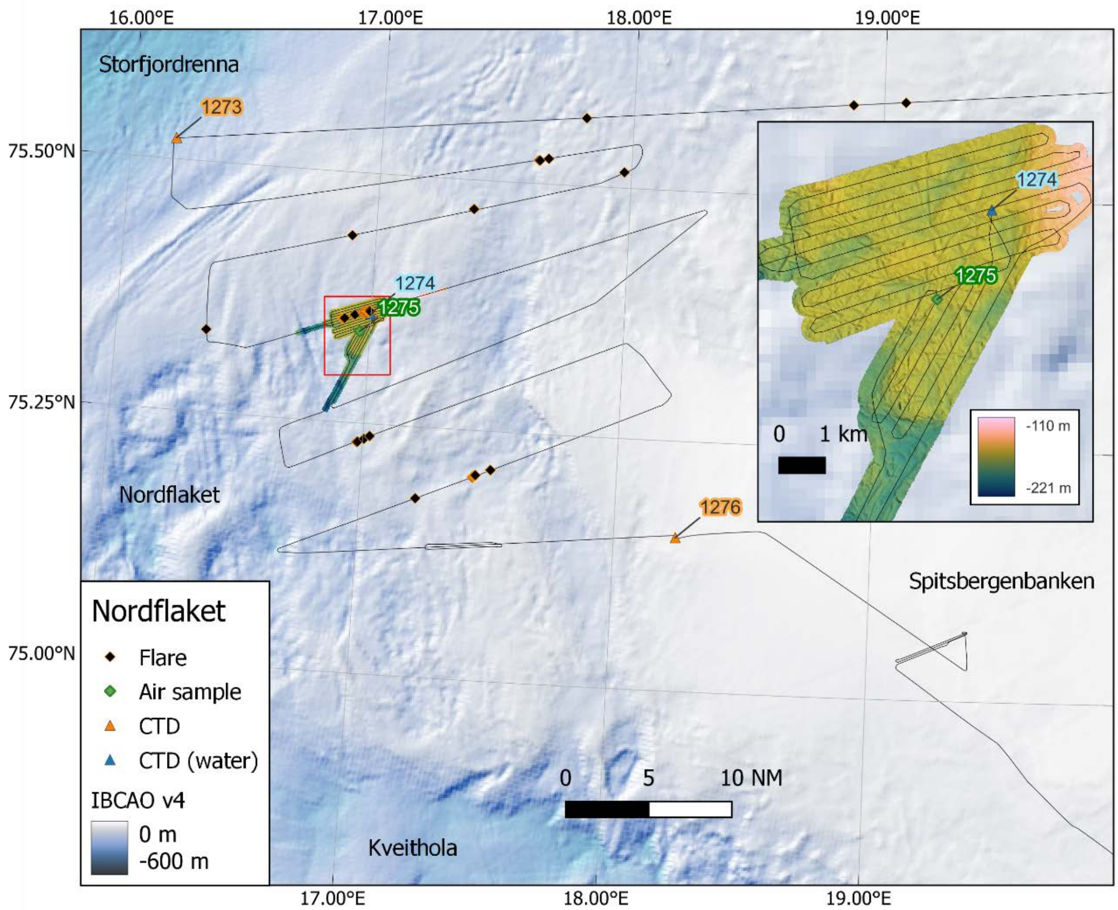

Figure 16: Stations over Nordflaket. Multibeam and water column data coverage was continuous.

4.3. Hopendjupet

The main focus of the expedition was given to Hopendjupet area which hosts one of the largest fields of gas seeps documented across the Arctic shelves. Here three key sub-areas were visited: the Hopendjupet Seepage Area, the Hopendjupet Pingo Field and western Sentralbanken (Figure 17). All three areas have been visited previously, during cruises CAGE20-2, CAGE21-4, CAGE21-6, and in all cases new further reconnaissance was undertaken to map seeps from water column data.

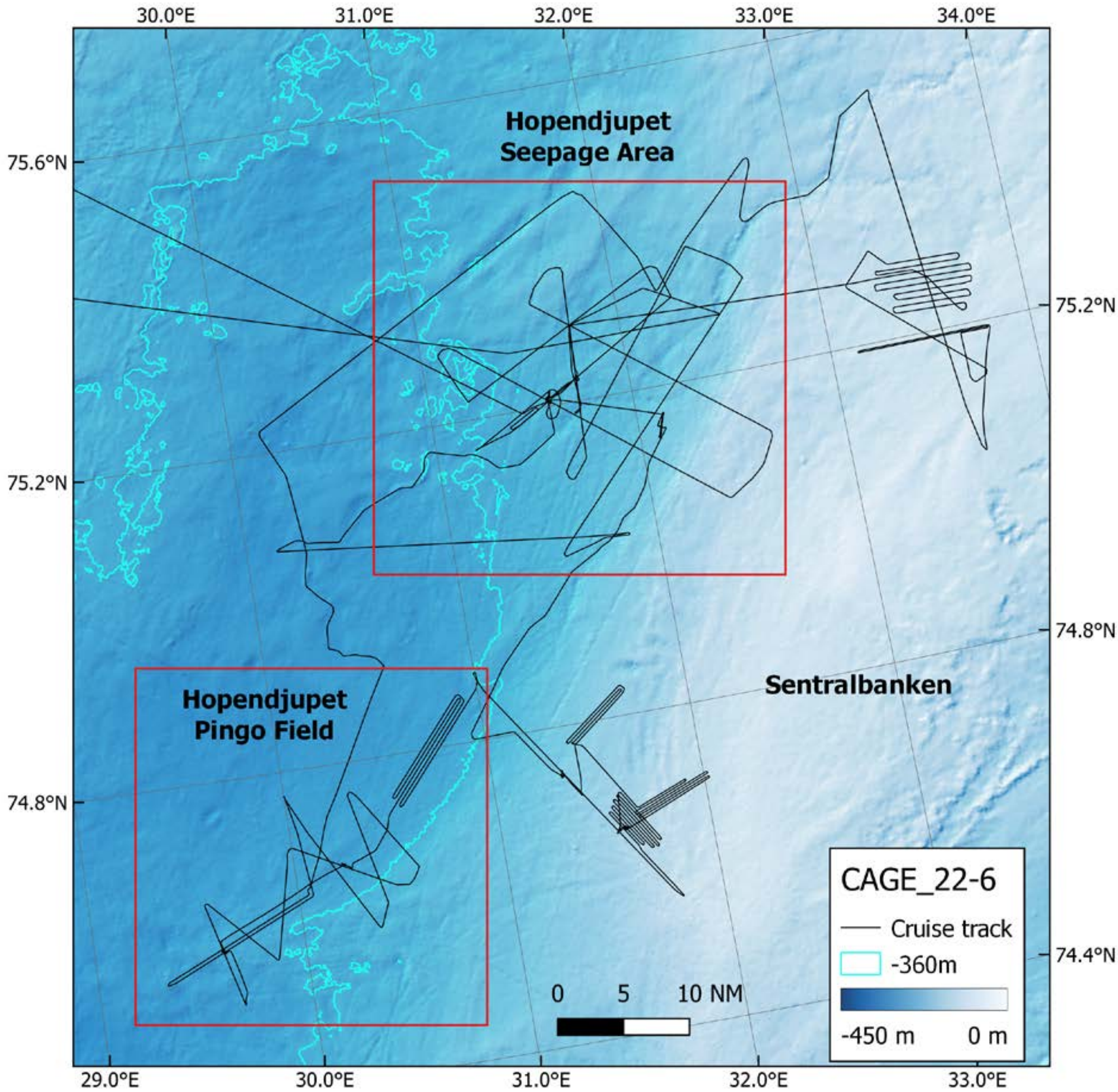

Figure 17: Overview of the Hopendjupet study area and areas visited during the cruise.

4.3.1. Hopendjupet Seepage Area

Data acquisition within this area focused on the collection of new data (2D seismic, drifters), supplementing existing datasets with new samples (e.g., sampling surface oil slicks), and repeat stations from previous cruises for identifying seasonal trends (e.g., singlebeam transects and CTD profiles). Three 'drifters' were deployed at three locations where slicks were observed on the sea surface.

One coring station (CAGE22-6-HH-1247GC) was collected at a site where potential oil seepage has been previously observed. The core was packed for archive after retrieval onboard. Ongoing seepage was confirmed by the presence of tube worms in the topmost sections and H_2S smell detected at the bottom of the core.

The ADCP was left to continuously record data in this area during the day shift of August 11th while the EM302 system was switched off.

Transects for collecting air samples were acquired based on modelled methane-plume forecasts provided by NILU. The routes and their timing were planned based on the expected maximum methane flux from the sea surface, finishing in an area upstream of the modelled emissions. The transects spanned c. 30 nm, with samples taken every c. 2 nm while sailing at a speed of 10 knots.

Seismic lines were acquired, targeting the top of the geological structure with minimum overburden where hydrocarbon seepage was observed (Figure 18).

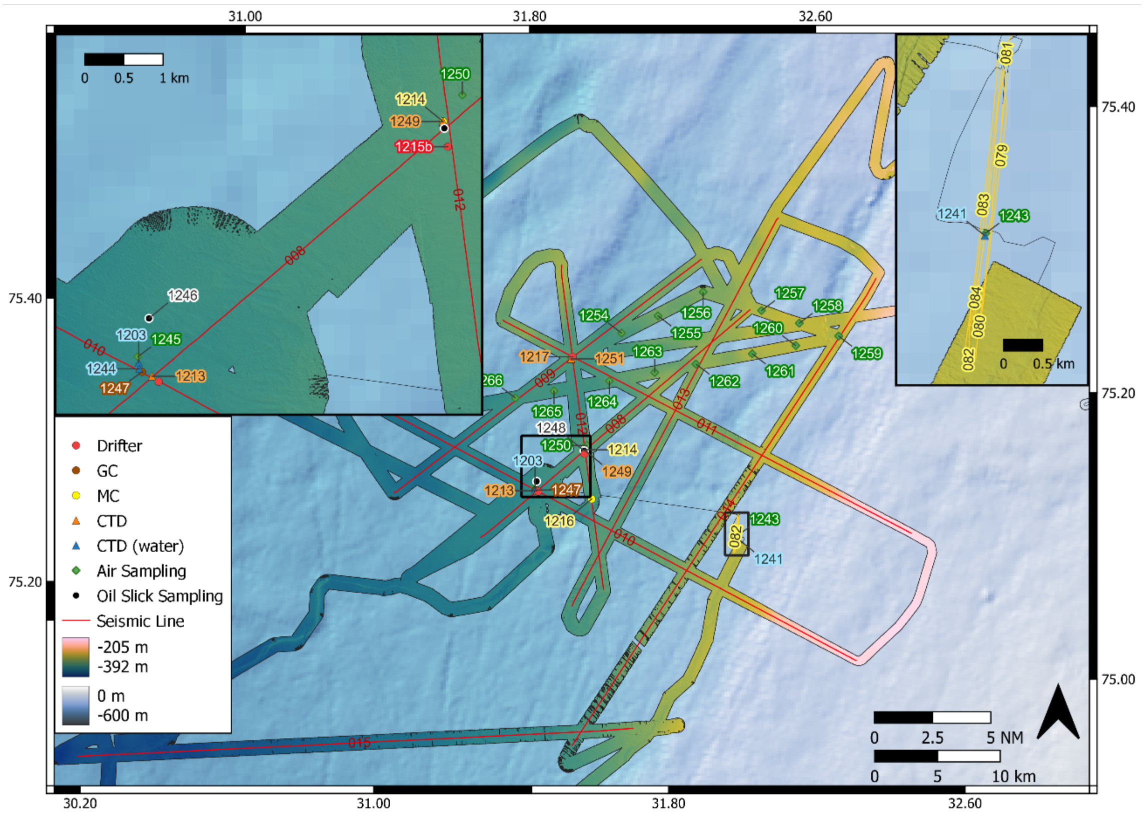

Figure 18: Sampling stations and survey lines across the Hopendjupet Seepage Area. Insets show areas of more intense sampling.

4.3.2. Hopendjupet Pingo Field

Initial reconnaissance with multibeam swaths beyond the area previously examined by CAGE were made, to identify potential new seepage locations or additional pingos. Subsequent 2D seismic lines were acquired based off this mapping, and on the predicted orientation/nature of the subsurface geological structures (Figure 19).

Seeping sites with no seafloor expression were found based on flares observed on the water column profiler, and were subsequently sampled at stations CAGE22-6-HH-1224-GC and 1225-GC. The first station contained glaciogenic sediments with some fine-grained shale and sandstone tabular rock fragments (up to 2 cm in size) suggesting the presence of possible altered subcrop at this locality. Also potential authigenic carbonates were identified. Degassing blisters were observed throughout the core indicating ongoing gas seepage. The second core was packed for archive without splitting. Further to the northeast, station CAGE22-6-HH-1227GC aimed to sample a depression (crater) in the centre of the Hopendjupet Pingo Field. The core was packed directly for archive. Stations CAGE22-6-HH-1228GC and 1229GC targeted two pingo sites identified on the bathymetry data. The first core returned completely empty. The second one recovered a 30 cm long section consisting largely of methanogenic carbonates with irregular shape within soupy sediments consisting of silty clay and sandy admixture.

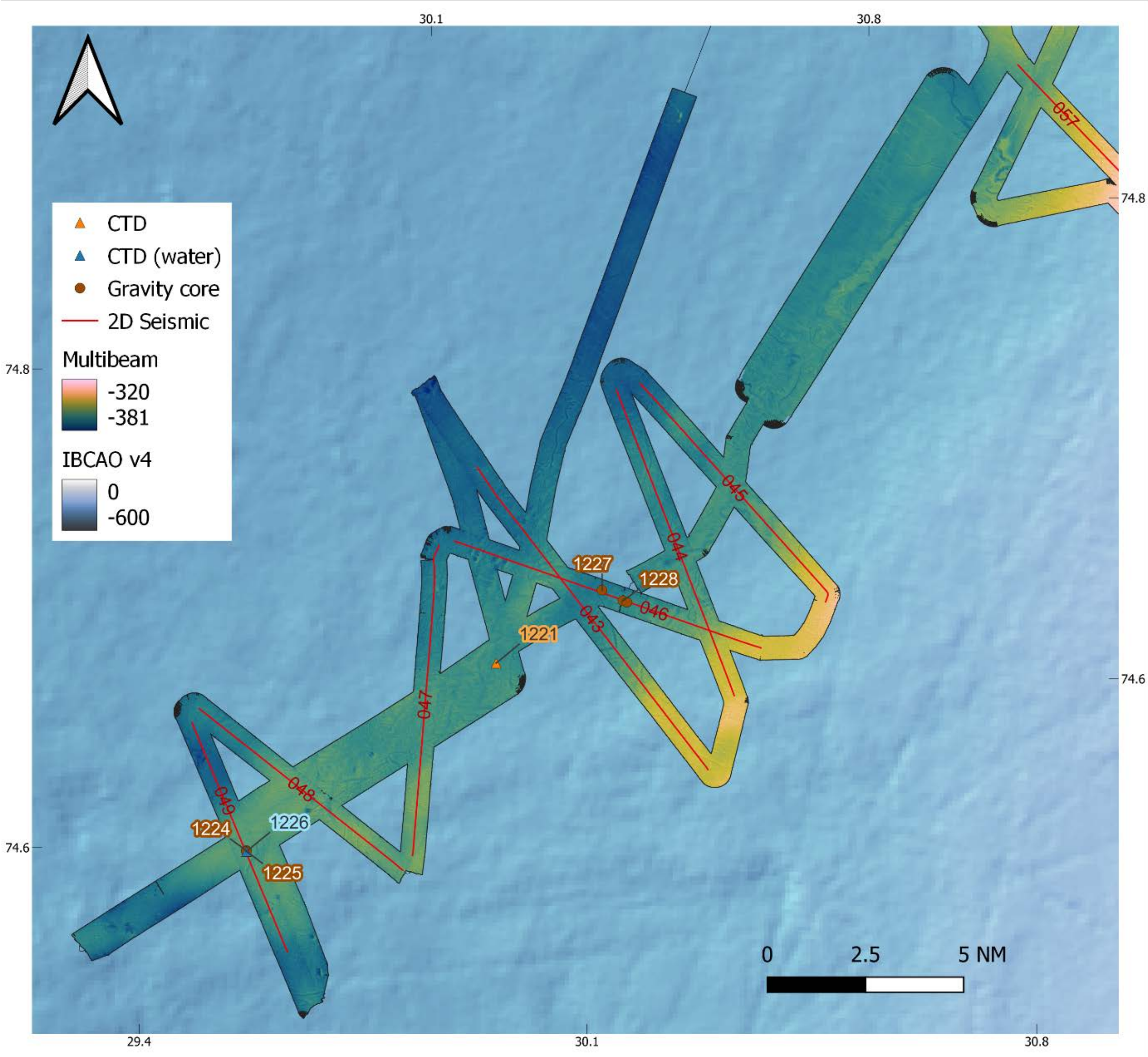

Figure 19: Sampling locations and 2D seismic lines across the Hopendjupet Pingo Field

4.3.3. Sentralbanken High

Smaller anticline structures and subcropping source rocks identified across the Sentralbanken High that have not previously been examined during CAGE cruises were targeted with multibeam transects. The distribution of flares was mapped using the water column data processed after the acquisition. These were then used to plan a 2D seismic line and to select sampling stations (Figure 21).

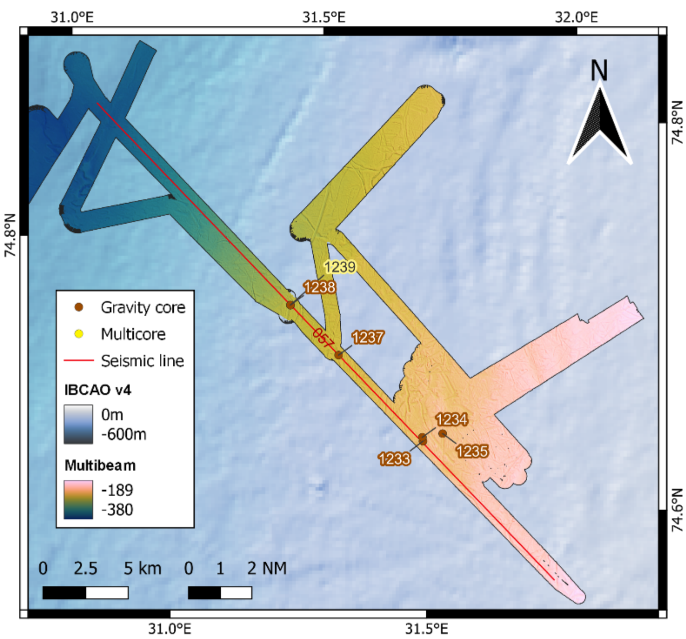

Figure 20: Sampling stations and acoustic data collection over SW Sentralbanken, adjacent to the Hopendjupet Pingo Field.

Stations CAGE22-6-HH-1233GC, 1234GC and 1235GC (Figure 20) sampled seepage sites imaged on the multibeam. All the cores retrieved similar sediments containing an upper part of hemipelagic deposits overlying glaciogenic sediments that were capping very compacted potentially subglacial sediments. All cores revealed some evidence indicative of ongoing gas seepage including pogonophora worms and likely tabular shaped authigenic carbonates. In this area a reference core CAGE22-6-HH-1237GC was also collected. Finally, a flare was targeted at station CAGE22-6-HH-1238GC that retrieved units of glaciogenic sediments and with H_2S smell detected in the lowermost 20 cm of the core.

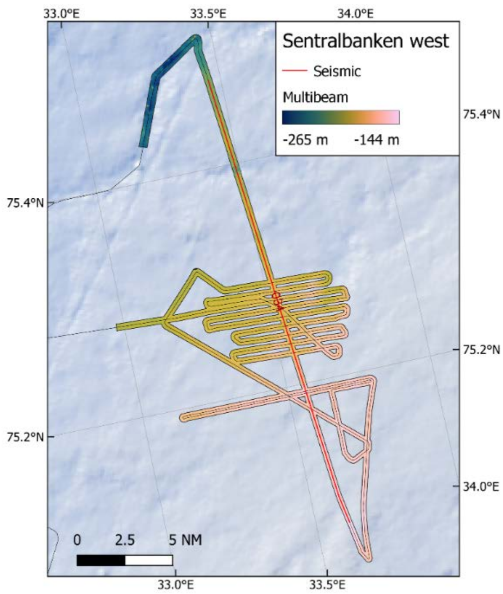

Figure 21: Seismic and multibeam surveying over the western Sentralbanken region, east of and adjacent to the Hopendjupet Seepage Area.

4.4. Bjørnøyrenna

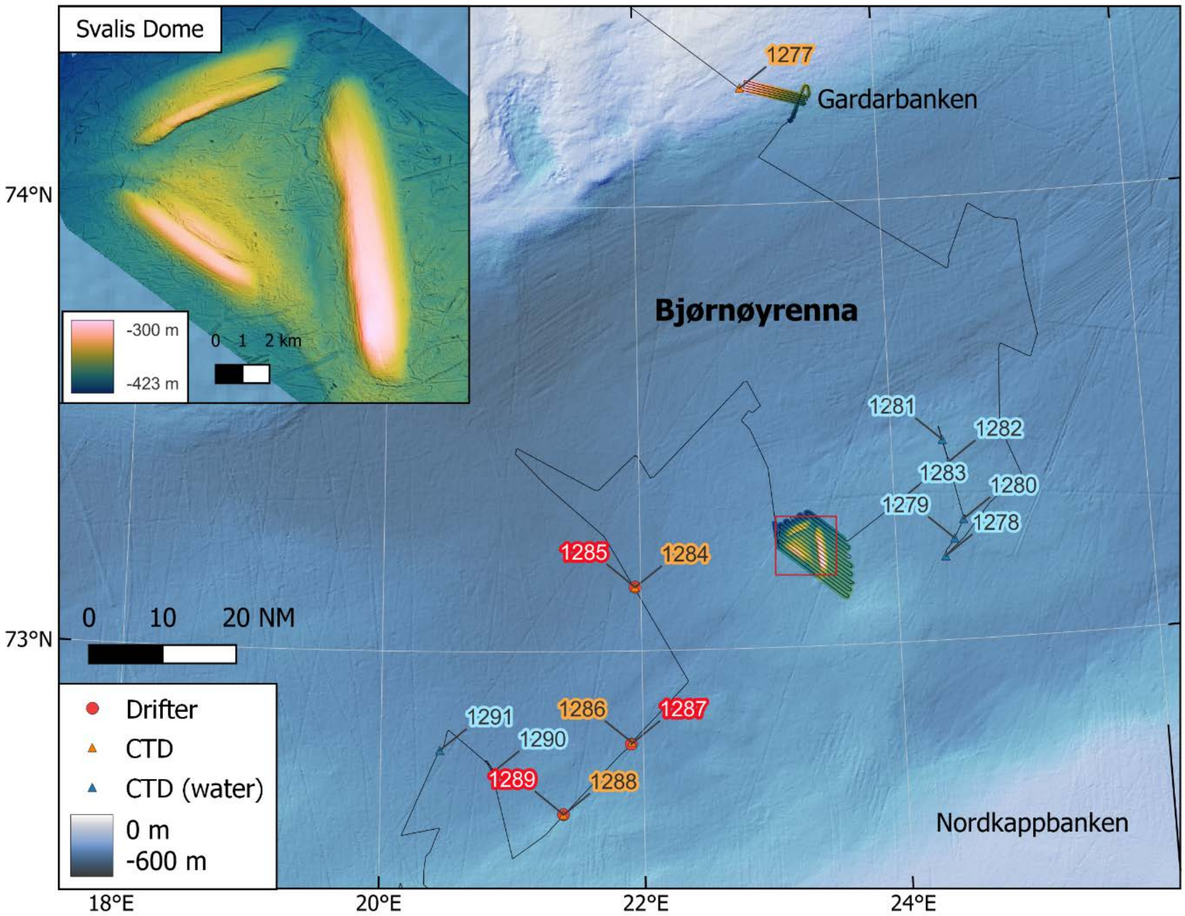

Figure 22: Sampling stations and multibeam surveys in Bjørnøyrenna.

4.4.1. Gardarbanken

A small multibeam survey was carried out over Gardarbanken, on the northern flank of Bjørnøyrenna, with several flares identified on water column data (Figure 22).

4.4.2. Svalis Dome

The summit of the Svalis salt dome is expressed on the present seafloor within Bjørnøyrenna as three distinctive topographic rises, up to 70 m high, lying just below the present-day hydrate stability zone. The dome has experienced glacial erosion by streaming ice, producing its unique structure visible today (Figure 22). A comprehensive multibeam survey was collected over Svalis Dome and the surrounding area to examine the potential seafloor leakage of hydrocarbons resulting from the subsurface deformation imposed by this salt extrusion. No flaring activity was found.

4.4.3. Transit over exploration wells

Following observations during the CAGE20-2 cruise where c. 50% of the exploration wells surveyed in the southern Barents Sea were seeping gas, a survey was planned during the transit towards Tromsø to pass over 78 wells (Figure 23). 25 were found to be leaking. In addition, 8 CTDs with water samples were collected during this transit (Figure 22).

Three drifters were deployed at regular contour intervals leading out of Bjørnøyrenna to track variations in drift patterns at varying water depths. CTD stations without water sampling accompanied the drifter deployments.

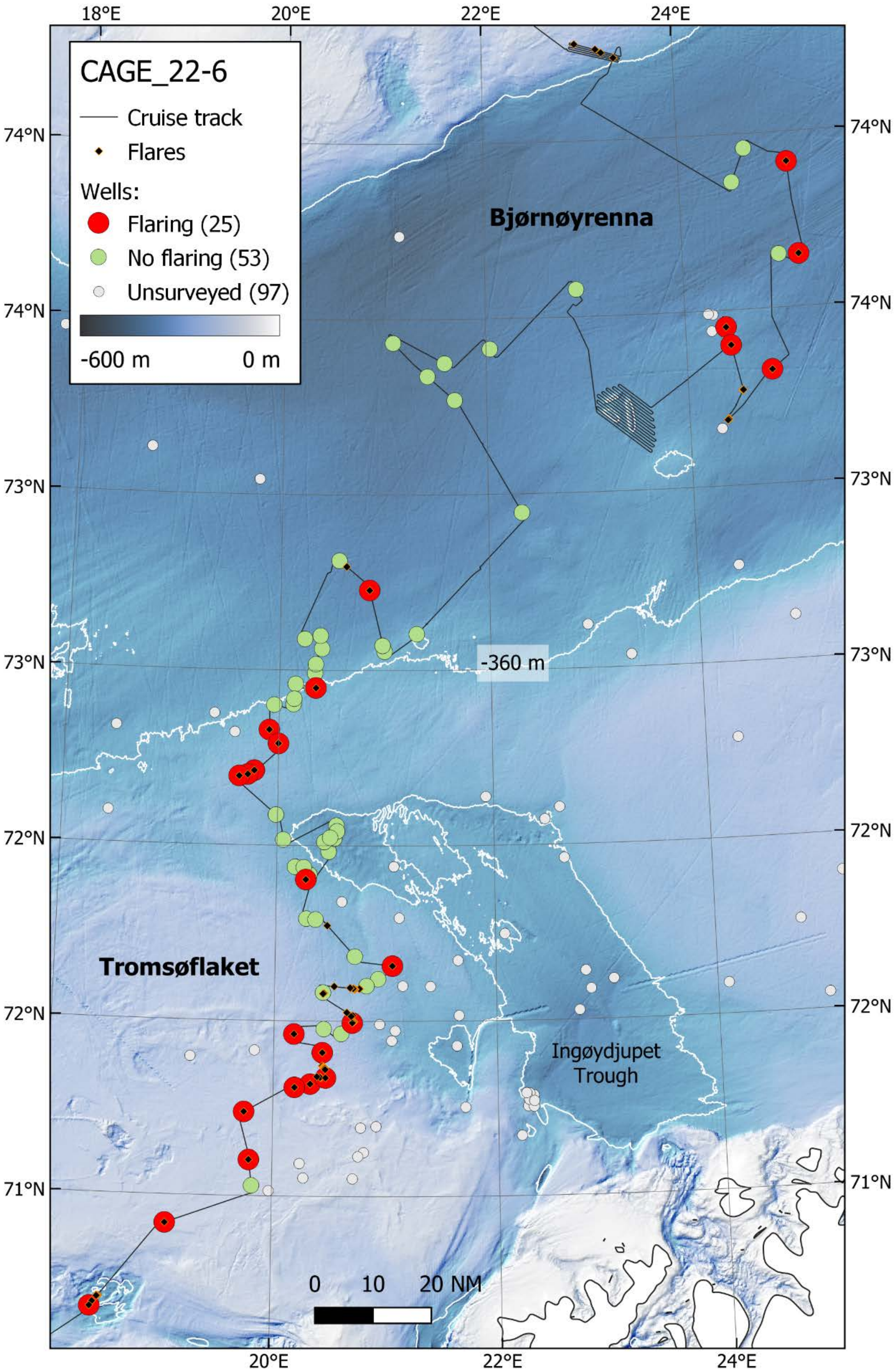

Figure 23: Flaring activity associated with natural seeps and exploration wells in Bjørnøyrenna and Tromsøflaket. Well locations are from NPD.no.

4.4.4. Fugløybanken

A final reconnaissance for flaring activity was taken over the western edge of Fugløybanken bank (south of Haåkjerringdjupet Trough) (Figure 24). No flaring activity was observed here.

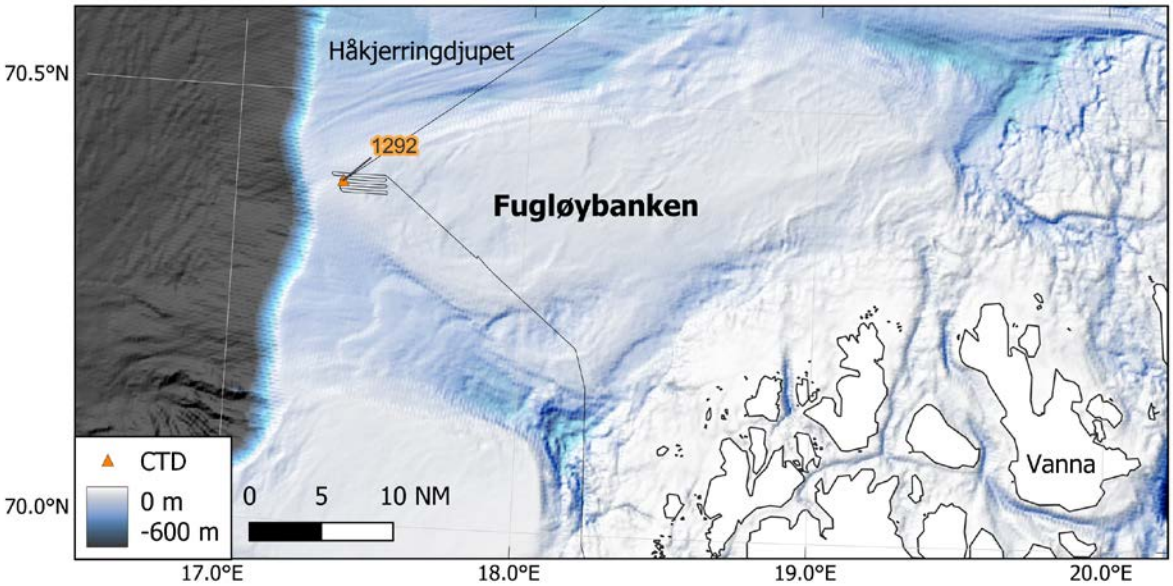

Figure 24: Short multibeam/water column survey on western Fugløybanken en route to Tromsø.

5. Teaching and outreach activities

The GEO-3144 and GEO-8144 “Arctic marine geology and geophysics cruise” course for master and PhD students comprised a central component of the CAGE 22-6-HH cruise. During the cruise, the students were taught methods, and were involved, in geophysical data acquisition (MBES, CTD, 2D seismic), water sampling with CTD, and sediment sampling with the gravity corer and multicorer. They were also acquainted with data processing and visualization techniques, getting hands-on experience with software including Fledermaus, OLEX, and QPS FMMidwater and QGIS. During the evenings, the science party attended 16 talks (Table 3), which included topics from the senior staff and from each of the students on their research topics. Following the talks, a short period for questions and discussion was included.

During the cruise students worked on their written course assignment – a student cruise report – which includes scientific objectives and rationale of the cruise, geological settings of the study areas, brief description of methods, and tentative interpretations of the data. Students were encouraged to discuss with the senior scientific staff and with other students throughout the cruise. The student reports were largely completed by the end of the cruise. Each student also contributed to this cruise report with a station map for an assigned area.

Table 3: Talks during the CAGE 22-6-HH cruise

02.08.22	Pavel Serov “*Objectives and study areas of CAGE 22-6-HH cruise*”
05.08.22	Rune Mattingsdal “*Geological insights driving fluid flow in Hopendjupet and the wider Barents Sea”*
05.08.22	Adriano Mazzini “*Overview of the main discoveries during the TTR programme*”
06.08.22	Henry Patton “*Ice sheet glaciation in the Barents Sea and Hopendjupet*”
07.08.22	Grace Shephard “*Ending rainbows but keeping the pots of gold*”
08.08.22	Pavel Serov and Rune Mattingsdal “*Best moments of CAGE 21-6 ROV video*”
10.08.22	Rune Mattingsdal “*Geological settings of Hopendjupet Pingo Site*”
10.08.22	Student presentation. Victor “*Ocean Dynamics and Uncertainties*”
11.08.22	Student presentation. Giulia Alessandrini “*Potential instability of gas hydrates along the Chilean Margin due to Ocean warming*”
12.08.22	Student presentation. Juan Camilo Meza Cala “*Continental extension and breakup evolution in the NE Atlantic and Arctic margins*”
13.08.22	Student presentation. Villads Dyrved Holm “*Tales from the deep*”
14.08.22	Student presentation. Paula Luerssen *“Anchor marks in Strande Bay”*
15.08.22	Grace Shephard. “*Introduction to GPlates – tectonics and quick maps”*
15.08.22	Rune Mattingsdal *“Multibeam survey towards Tromsø”*
17.08.22	Adriano Mazzini *“The Lusi eruption and the ERC-LUSILAB project”*
18.08.22	Frances Cooke “*Seismic processing*”

2 blog reports were written during the cruise including for the CAGE and CEED websites:

- https://cage.uit.no/2022/09/02/whats-lurking-on-top-of-the-below/
- https://www.mn.uio.no/ceed/english/about/blog/2022/bathymetry-and-bubbles-in-the-barents.html

6. Cruise narrative

Date	Time (UTC)	
02.08.22	18.00	Departure from Longyearbyen
03.08.22	10.00	Arrive Storfjordrenna Gas Hydrate Pingo Site. Collect CTD at the K-lander location and gas hydrate samples with a gravity core
03.08.22		Begin transit line to the inner Storfjordrenna
04.08.22	00.30	Collect multicorer for biomarker analyses, Villads' master thesis project and microplastics analyses
04.08.22		Begin transit to Hopendjupet. Transit line deviates to cover possible fluid flow sites based on seismic data
04.08.22	04.20	Observed possible oil slick. Sample the slick from the small boat. Continue the transit to Hopendjupet.
04.08.22	17.30	Collect CTD at the oil slick location from SAR images and search for visible slicks. Poor visibility.
04.08.22	06:30	Deployed 2D seismic. Start the survey consisting of 7 lines. Estimated duration: 40 hours
05.08.22	09:30	Observed oil droplets & slicks above southern seep site
05.08.22	18.30	Observed oil droplets above the northern oil seep site. Continuous slick is not observed.
05.08.22	21.20	Oil droplets repeatedly observed at the northern oil seep site. Continuous slick is not observed. Wind speed 6.6 m/s, waves ca. 1m
06.08.22	22.13	Oil slick and oil droplets observed at the location of the central emission point. The slick is patchy, the patches have brownish and rainbow colors.
06.08.22	12:30	Air guns were brought on deck for inspection after line 14 – the metal frame needed rewelding. Guns back in the water at 14:10.
07.08.22	22:00-06:00	Collected 2 multicorers, 3 CTD stations (1 with water), deployed 3 drifters at the main slicks in Hopendjupet.
07.08.22	08:00	Begin multibeam survey at Sentralbanken High east of Hopendjupet
07.08.22	22:48	2D seismic line at Sentralbanken High crossing newly mapped gas flares
08.08.22	05:50	Multibeam line to map beaded esker, fault zone north of the main Hopendjupet survey area, and the tunnel valley heading SW. The line finishes at Hopendupet Pingo Site.
08.08.22	17:30	Multibeam survey to search for new gas hydrate pingos. At least one new potential pingo found.
08.02.22	22:05	2D seismic survey across the fault zone and Hopendjupet gas hydrate pingo site. Test different acquisition settings: 2 guns; 5 sec shot interval and 1 gun, 4 sec shot interval
09.08.22	12:30	Stopped the 2d survey over the Hopendjupet pingo field and began gravity coring/water sampling
09.08.22	19:44	Began multibeam survey to map the extend of the Hopendjupet gas hydrate pingo field
10.08.22	02:00	2D seismic survey east of the Hopendjupet pingo field.
10.08.22	07:15	2D equipment brought in to investigate leakage. Found on tow cable. Continuation of 2D seismic acquisition seems unlikely during the remainder of the cruise. Switched to multibeam mapping of flare distributions and gravity coring around structures near the Hopendjupet pingo field.
10.08.22	23:30	Began gravity coring along seismic line 17.

11.08.22	02:15	Multibeam survey along possible meltwater channel on the way to Hopendjupet oil and gas seepage area
11.08.22		Returned to Hopendjupet main gas and oil leaking area for air sampling, CTD and water sampling and single-beam echosounder lines acquisition
11.08.22	17:50	Began transit toward Hopen Island
12.08.22	04:15	Started acquiring multibeam data in S-N orientation crossing transit lines of CAGE 18-1 and CAGE 19-2 cruises
13.08.22	17:00	Began transit to Nordflaket and a series of east-west multibeam lines
14.08.22	15:25	Identified prominent seepage area at Nordflaket. Began dense grid survey to outline the seep cluster. Collected a CTD and air sample in the middle of the seep cluster.
14.08.22	20:10	Continue with widely spaced east-west multibeam lines on Nordflaket
15.08.22	19.45	Began multibeam survey at Gardbanken
16.08.22	05.54	Began transiting over exploration wells in a general south/westerly direction.
16.08.22	15:47	Began a CTD/water sampling survey around the Maud Basin
16.08.22	23:45	Began a multibeam survey over the Svalis Dome
17.08.22	17:00	Continue transiting over exploration wells in a general SW direction
18.08.22	03:20	Conducted three CTD stations and deployed three drifter
18.08.22	08:00	Continue transiting over exploration wells in a general SW direction
19.08.22	22:35	Finish surveying over Fugløybanken and begin transit to Tromsø
20.08.22	07:00	Arrive in Tromsø

7. References

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8. Line log

Location	Line ID	Date	Time (UTC) START	Lat. [N] Long. [E] START	Time (UTC) STOP	Lat. [N] Long. [E] STOP	Pulse mode	Shot Rate (HZ)	Ship Speed (kn)	Comments
Storfjordrenna	CAGE22-6-HH-001-MB	02/08	20:17	78°06.456' 13°45.999'	10:00 +1 day	16°00.305' 16°08.366'			10	
Storfjordrenna	CAGE22-6-HH-002-MB	03/08	13:37	76°05.262' 16°08.366'	14:36	76°01.495' 16°28.903'			10	
Storfjordrenna	CAGE22-6-HH-003-MB	03/08	14:37	76°01.495' 16°28.903'	20:42	76°22.929' 20°34.047'			10	
Storfjordrenna	CAGE22-6-HH-004-MB	03/08	20:46	76°22.603' 20°35.149'	21:48	76°15.721' 20°02.087'			10	
Storfjordrenna	CAGE22-6-HH-005-MB	03/08	22:44	76°16.775' 20°13.753'	03:04 +1 day	76°23.489' 23°12.301'			10	
Storfjordrenna	CAGE22-6-HH-006-MB	04/08	03:04	76°23.489' 23°12.301'	06:38	76°08.950' 25°34.363'			10	
Storfjordrenna	CAGE22-6-HH-007-MB	04/08	07:20	76°08.965' 25°35.623'	17:14	75°11.855' 31°26.564'			10	
Hopendjupet	CAGE22-6-HH-008-2D	04/08	21:55	75°10.880' 31°24.900'	01:34	75°18.360' 32°16.280'		4000	4	Seisimic line 001, wind speed 4, wind direction 290, 2 guns 30/30 and 15/15 170bar, 5 sec shot rate, 3 sec length, change birds from 3m depth to 2.5m shot 1013, dead channels: 13,16,35,47,75, noisy channel: 92. Multibeam on as well
Hopendjupet	CAGE22-6-HH-009-2D	05/08	02:25	75°20.850' 32°09.500'	06:22	75°13.420' 31°11.540'		4000	4	Line 002 Channels 49, 69 spiky
Hopendjupet	CAGE22-6-HH-010-2D	05/08	07:38	75°17.479' 31°09.809'	13:09	75°02.736' 32°22.331'		4000	4	Line 003 - recorded transit
Hopendjupet	CAGE22-6-HH-011-2D	05/08	14:43	75°07.626' 32°35.336'	19:21	75°19.860' 31°34.760'		4000	4	Line 004
Hopendjupet	CAGE22-6-HH-012-2D	05/08	19:24	75°21.690' 31°46.160'	23:49	75°07.730' 31°43.270'		4000	4	Line005
Hopendjupet	CAGE22-6-HH-013-2D	06/08	00:33	75°07.340' 31°37.780'	04:48	75°21.969' 32°23.730'		4000	4	Line 006
Hopendjupet	CAGE22-6-HH-014-2D	06/08	06:02	75°18.580' 32°37.720'	12:16	75°01.399' 31°33.515'		4000	4	Line007 change gun set up from 2 guns to 1 - just the 30/30 and shooting rate to 4s and 140 bar shot 22320. bird height changed to 2.5 m, wind 13. bird height changed to 3m 08:19.
Hopendjupet	CAGE22-6-HH-015-2D	06/08	14:13	75°01.661' 31°43.680'	20:03	75°04.441' 30°12.572'		4000	4	Just the 30/30 and shooting rate to 4s and 140 bar. wind 10. Lost GPS'signal on COM-port at 19:10 tromsø time, reinstalled at 21:45 Tromsø time.
Hopendjupet	CAGE22-6-HH-016-MB	06/08	20:51	75°04.837' 30°17.953'	23:23	75°12.688' 31°34.755'				line follows beaded esker and a channel
Sentralbanken	CAGE22-6-HH-017-MB	07/08	05:17	75°17.733' 31°46.517'	08:49	75°16.413' 33°45.030'				end MB223

Sentralbanken	CAGE22-6-HH-018-MB	07/08	08:55	75°15.930' 33°45.267'	09:45	75°16.269' 33°17.240'				MB 225-226
Sentralbanken	CAGE22-6-HH-019-MB	07/08	09:50	75°15.799' 33°17.508'	10:36	75°15.471' 33°45.140'				MB 228-229
Sentralbanken	CAGE22-6-HH-020-MB	07/08	10:40	75°15.048' 33°44.560'	11:21	75°15.250' 33°21.880'				MB 231-232
Sentralbanken	CAGE22-6-HH-021-MB	07/08	11:26	75°14.792' 33°23.331'	11:59	75°14.490' 33°43.540'			10	
Sentralbanken	CAGE22-6-HH-022-MB	07/08	12:04	75°14.020' 33°43.290'	12:43	75°14.325' 33°20.919'			10	
Sentralbanken	CAGE22-6-HH-023-MB	07/08	12:47	75°13.853' 33°21.705'	13:22	75°13.498' 33°42.001'			10	
Sentralbanken	CAGE22-6-HH-024-MB	07/08	13:28	75°13.133' 33°40.292'	14:19	75°16.954' 33°18.020'			10	
Sentralbanken	CAGE22-6-HH-025-MB	07/08	14:24	75°17.202' 33°18.817'	15:05	75°16.914' 33°42.531'			10	
Sentralbanken	CAGE22-6-HH-026-MB	07/08	15:11	75°17.380' 33°41.888'	15:43	75°17.618' 33°21.643'			10	
Sentralbanken	CAGE22-6-HH-027-MB	07/08	15:43	75°17.618' 33°21.643'	15:55	75°18.872' 33°16.669'			10	
Sentralbanken	CAGE22-6-HH-028-MB	07/08	15:56	75°18.800' 33°16.420'	16:14	75°16.661' 33°08.325'			10	
Sentralbanken	CAGE22-6-HH-029-MB	07/08	16:16	75°16.417' 33°16.780'	17:41	75°08.006' 33°43.669'			10	
Sentralbanken	CAGE22-6-HH-030-MB	07/08	17:50	75°07.829' 33°39.078'	18:16	75°11.385' 33°39.500'			10	
Sentralbanken	CAGE22-6-HH-031-MB	07/08	18:16	75°11.385' 33°39.500'	18:30	75°11.348' 33°46.969'			10	
Sentralbanken	CAGE22-6-HH-032-MB	07/08	18:33	75°11.459' 33°46.345'	19:33	75°11.517' 33°08.681'			10	
Sentralbanken	CAGE22-6-HH-033-MB	07/08	19:37	75°11.616' 33°08.279'	22:00	75°02.876' 33°37.756'			10	
Sentralbanken	CAGE22-6-HH-034-2D	07/08	22:48	75°04.434' 33°36.696'	05:05 +1 day	75°28.520' 33°27.440'			4	Line009 wind 10, wind dir 15, back to using 2 guns, 5 secs shot interval
Hopendjupet	CAGE22-6-HH-035-MB	08/08	05:43	75°30.726' 33°26.981'	07:27	75°23.077' 32°41.803'			10	
Hopendjupet	CAGE22-6-HH-036-MB	08/08	07:30	75°23.470' 32°41.539'	07:57	75°27.183' 32°47.248'				
Hopendjupet	CAGE22-6-HH-037-MB	08/08	08:02	75°27.536' 32°45.467'	09:16	75°19.128' 32°12.885'			10	
Hopendjupet	CAGE22-6-HH-038-MB	08/08	09:18	75°19.294' 32°12.207'	10:18	75°27.654' 31°53.311'			10	
Hopendjupet	CAGE22-6-HH-039-MB	08/08	10:18	75°27.654' 31°53.311'	13:24	75°13.812' 30°09.841'				

Hopendjupet	CAGE22-6-HH-040-MB	08/08	13:28	75°13.247' 30°09.220'	17:30	74°38.961' 30°03.000'				
Hopendjupet	CAGE22-6-HH-041-MB	08/08	17:54	74°38.492' 30°02.709'	19:09	74°33.391' 29°19.700'			10	
Hopendjupet	CAGE22-6-HH-042-MB	08/08	19:12	74°33.247' 29°20.100'	20:26	75°38.344' 30°04.146'			10	
Hopendjupet	CAGE22-6-HH-043-2D	08/08	22:05	74°43.838' 30°03.982'	00:27 +1 day	74°35.300' 30°21.410'			4	Line 10, 2 guns, 5 second shot interval
Hopendjupet	CAGE22-6-HH-044-2D	09/08	01:00	74°37.060' 30°24.870'	02:51	74°45.320' 30°18.220'			4.5	Line 11, 1 gun, 4 second shot interval, birds at 2.5m, wind speed 8
Hopendjupet	CAGE22-6-HH-045-2D	09/08	03:06	74°45.250' 30°20.850'	04:42	74°39.344' 30°35.211'			4.5	Line12,1 gun, 4 second shot interval, birds at 2.5m, wind speed 8
Hopendjupet	CAGE22-6-HH-046-2D	09/08	00:00	74°38.332' 30°27.380'	07:05	74°42.152' 30°00.400'			4.5	Line 13, 2 guns, 5 second shot interval
Hopendjupet	CAGE22-6-HH-047-2D	09/08	07:12	74°41.712' 29°58.384'	09:01	74°34.370' 29°52.110'			4.5	Line 14, 2 guns, 5 second shot interval, restarted multibeam at end of line
Hopendjupet	CAGE22-6-HH-048-2D	09/08	09:10	74°34.264' 29°50.431'	10:44	74°38.935' 29°33.870'			4.5	Line 15, 1 gun, 4 second interval, 170 pressure, birds at 2.5m, wind 8.3
Hopendjupet	CAGE22-6-HH-049-2D	09/08	10:54	74°38.469' 29°33.285'	12:24	74°32.392' 29°39.137'			4.5	Line 16, 5s interval, 2 guns, 170 pressure, birds at 2.5m, wind 5.7
Hopendjupet	CAGE22-6-HH-050-MB	09/08	12:53	74°31.146' 29°40.629'	13:22	74°35.159' 29°38.490'				
Hopendjupet	CAGE22-6-HH-051-MB	09/08	16:00	74°36.088' 29°36.680'	17:15	74°40.313' 30°13.859'				
Hopendjupet	CAGE22-6-HH-052-MB	09/08	19:43	74°40.419' 30°17.182'	21:12	74°51.292' 30°54.835'				end MB 374
Hopendjupet	CAGE22-6-HH-053-MB	09/08	21:14	74°51.381' 30°54.341'	22:08	74°44.790' 30°31.810'				end MB 377
Hopendjupet	CAGE22-6-HH-054-MB	09/08	22:13	74°45.110' 30°31.790'	23:04	74°51.620' 30°53.650'				
Hopendjupet	CAGE22-6-HH-055-MB	09/08	23:11	74°50.970' 30°55.210'	00:06 +1 day	74°44.360' 30°33.080'				
Hopendjupet	CAGE22-6-HH-056-MB	10/08	00:11	74°44.150' 30°33.670'	01:02	74°50.630' 30°55.470'				
Hopendjupet	CAGE22-6-HH-057-2D	10/08	02:16	74°51.710' 31°01.197'	06:55	74°34.407' 31°45.634'				Line 17, 5s interval, 2 guns, 170 pressure, birds at 2.5m, wind 5.7. Streamer leakage.
Hopendjupet	CAGE22-6-HH-058-MB	10/08	07:28	74°34.066' 31°47.444'	08:16	74°40.960' 31°31.570'			10	
Hopendjupet	CAGE22-6-HH-059-MB	10/08	08:19	74°40.840' 31°32.390'	08:40	74°38.079' 31°39.534'			10	
Hopendjupet	CAGE22-6-HH-060-MB	10/08	08:43	74°38.315' 31°39.420'	09:04	74°41.238' 31°32.463'			10	
Hopendjupet	CAGE22-6-HH-061-MB	10/08	09:07	74°41.272' 31°33.270'	09:34	74°37.739' 31°41.922'				

Hopendjupet	CAGE22-6-HH-062-MB	10/08	09:37	74°37.980' 31°41.927'	10:05	74°41.769' 31°33.168'				
Hopendjupet	CAGE22-6-HH-063-MB	10/08	10:09	74°41.630' 31°34.424'	10:38	74°37.860' 31°43.790'				
Hopendjupet	CAGE22-6-HH-064-MB	10/08	10:41	74°38.120' 31°43.340'	11:10	74°42.089' 31°34.389'				
Hopendjupet	CAGE22-6-HH-065-MB	10/08	11:14	74°41.980' 31°35.296'	11:42	74°38.240' 31°44.200'				
Hopendjupet	CAGE22-6-HH-066-MB	10/08	11:45	74°38.380' 31°44.450'	12:14	74°42.311' 31°35.322'				
Hopendjupet	CAGE22-6-HH-067-MB	10/08	15:33	74°39.487' 31°35.837'	16:27	74°42.220' 32°01.490'				
Hopendjupet	CAGE22-6-HH-068-MB	10/08	16:29	74°42.290' 32°00.860'	17:06	74°40.140' 31°39.870'				
Hopendjupet	CAGE22-6-HH-069-MB	10/08	17:09	74°40.340' 31°39.920'	17:48	74°42.520' 32°01.070'				
Hopendjupet	CAGE22-6-HH-070-MB	10/08	17:52	74°42.630' 32°00.170'	18:31	74°40.455' 31°39.149'			9	
Hopendjupet	CAGE22-6-HH-071-MB	10/08	18:35	74°40.715' 31°39.250'	19:05	74°42.295' 31°54.668'			9	
Hopendjupet	CAGE22-6-HH-072-MB	10/08	19:07	74°42.362' 31°54.057'	19:32	74°40.921' 31°39.672'			9	
Hopendjupet	CAGE22-6-HH-073-MB	10/08	19:34	74°41.156' 31°39.057'	20:10	74°46.334' 31°26.600'			10	
Hopendjupet	CAGE22-6-HH-074-MB	10/08	20:20	74°46.632' 31°24.672'	20:57	74°49.300' 31°41.103'			9.5	
Hopendjupet	CAGE22-6-HH-075-MB	10/08	21:00	74°49.820' 31°39.590'	21:35	74°46.615' 31°23.117'			9.5	
Hopendjupet	CAGE22-6-HH-076-MB	10/08	21:41	74°47.254' 31°25.255'	22:12	74°50.001' 31°39.347'			9.5	
Hopendjupet	CAGE22-6-HH-077-MB	10/08	22:20	74°49.540' 31°40.684'	22:55	74°46.449' 31°25.246'				
Hopendjupet	CAGE22-6-HH-078-MB	11/08	02:14	74°44.749' 31°17.830'	06:23	75°08.764' 32°07.924'			10	
Hopendjupet	CAGE22-6-HH-079-SB	11/08	07:11	75°09.687' 32°07.512'	07:27	75°08.426' 32°06.121'		38	5	ADCP on; MB off
Hopendjupet	CAGE22-6-HH-080-SB	11/08	07:37	75°08.354' 32°06.009'	07:55	75°09.778' 32°07.732'		38	5	
Hopendjupet	CAGE22-6-HH-081-SB	11/08	07:59	75°09.859' 32°07.714'	08:19	75°08.369' 32°05.904'		38	5	
Hopendjupet	CAGE22-6-HH-082-SB	11/08	08:27	75°08.274' 32°05.782'	08:46	75°09.823' 32°07.650'		38	5	
Hopendjupet	CAGE22-6-HH-083-SB	11/08	08:54	75°09.777' 32°07.472'	09:14	75°08.274' 32°05.363'		38	5	

Hopendjupet	CAGE22-6-HH-084-SB	11/08	09:24	75°08.493' 32°06.018'	10:04	75°09.590' 32°07.483'		38	1.5	1.5 knots over the central portion
Hopendjupet	CAGE22-6-HH-085-MB	11/08	15:30	75°18.135' 31°50.529'	16:36	75°16.453' 32°29.857'			10	
Hopendjupet	CAGE22-6-HH-086-MB	11/08	16:36	75°16.453' 32°29.857'	18:15	75°16.928' 31°19.795'			10	
Hopendjupet	CAGE22-6-HH-087-MB	11/08	18:15	75°16.928' 31°19.795'	03:59 +1 day	75°40.273' 25°14.869'			10	MB498 and on is tried with acquiring MB-data at 1 Hz.
Hopen	CAGE22-6-HH-088-MB	12/08	04:12	75°40.361' 25°14.296'	08:09	76°14.860' 25°14.548'			10	
Hopen	CAGE22-6-HH-089-MB	12/08	08:09	76°14.860' 25°14.548'	08:26	76°14.957' 25°01.494'			10	
Hopen	CAGE22-6-HH-090-MB	12/08	08:30	76°14.240' 24°59.881'	10:46	75°52.824' 24°59.238'				Swtich back to mb trigger midway on line 502
Hopen	CAGE22-6-HH-091-MB	12/08	10:46	75°52.824' 24°59.238'	11:05	75°52.135' 24°46.424'				
Hopen	CAGE22-6-HH-092-MB	12/08	11:08	75°52.415' 24°45.059'	13:27	76°15.026' 24°45.074'				
Hopen	CAGE22-6-HH-093-MB	12/08	13:52	76°15.352' 24°33.475'	15:23	76°03.130' 24°03.220'			10	
Hopen	CAGE22-6-HH-094-MB	12/08	15:46	76°03.366' 24°00.100'	20:24	76°46.722' 23°59.910'			10	
Hopen	CAGE22-6-HH-095-MB	12/08	21:00	76°47.270' 23°31.268'	04:13 +1 day	75°40.190' 23°30.140'			10	took a detour in the middle of the line
Hopen	CAGE22-6-HH-096-MB	13/08	04:37	75°40.070' 23°45.010'	10:13	76°31.998' 23°44.800'			10	
Hopen	CAGE22-6-HH-097-MB	13/08	10:13	76°31.998' 23°44.800'	10:51	76°31.763' 23°15.055'				
Hopen	CAGE22-6-HH-098-MB	13/08	10:55	76°31.763' 23°15.055'	15:28	75°49.855' 23°14.982'				
Hopen	CAGE22-6-HH-099-MB	13/08	16:53	75°38.607' 22°54.501'	02:34 +1 day	75°31.266' 16°11.544'				
Nordflaket	CAGE22-6-HH-100-MB	14/08	03:26	75°27.077' 16°15.780'	06:01	75°32.655' 18°01.560'			10	
Nordflaket	CAGE22-6-HH-101-MB	14/08	06:12	75°31.085' 17°59.500'	08:40	75°23.912' 16°21.552'			10	
Nordflaket	CAGE22-6-HH-102-MB	14/08	08:42	75°23.492' 16°21.095'	09:08	75°19.230' 16°22.004'			10	
Nordflaket	CAGE22-6-HH-103-MB	14/08	09:13	75°19.195' 16°25.089'	12:24	75°28.909' 18°18.060'			10	
Nordflaket	CAGE22-6-HH-104-MB	14/08	12:27	75°28.607' 18°17.900'	13:24	75°22.988' 17°52.501'				
Nordflaket	CAGE22-6-HH-105-MB	14/08	13:24	75°22.988' 17°52.501'	15:21	75°15.802' 16°52.386'				

Nordflaket	CAGE22-6-HH-106-MB	14/08	15:24	75°16.086' 16°52.313'	15:56	75°21.226' 17°01.999'				
Nordflaket	CAGE22-6-HH-107-MB	14/08	16:08	75°21.850' 17°02.490'	16:34	75°20.690' 16°50.050'				
Nordflaket	CAGE22-6-HH-108-MB	14/08	16:39	75°21.000' 16°50.200'	17:03	75°22.250' 17°03.690'				
Nordflaket	CAGE22-6-HH-109-MB	14/08	17:09	75°22.260' 17°02.160'	17:32	75°21.220' 16°50.580'				
Nordflaket	CAGE22-6-HH-110-MB	14/08	17:36	75°21.440' 16°51.600'	17:54	75°22.390' 17°02.170'				
Nordflaket	CAGE22-6-HH-111-MB	14/08	17:57	75°22.500' 17°01.470'	18:20	75°21.329' 16°50.500'				
Nordflaket	CAGE22-6-HH-112-MB	14/08	18:25	75°20.640' 16°52.014'	18:44	75°21.748' 17°03.200'				
Nordflaket	CAGE22-6-HH-113-MB	14/08	18:46	75°21.625' 17°03.427'	19:09	75°20.476' 16°51.440'				
Nordflaket	CAGE22-6-HH-114-MB	14/08	19:01	75°20.318' 16°51.979'	19:29	75°21.312' 17°01.667'				
Nordflaket	CAGE22-6-HH-115-MB	14/08	19:33	75°21.242' 17°02.921'	19:53	75°20.218' 16°52.289'				
Nordflaket	CAGE22-6-HH-116-MB	14/08	19:56	75°20.006' 16°52.129'	20:12	75°20.980' 17°00.890'				
Nordflaket	CAGE22-6-HH-117-MB	14/08	20:37	75°20.750' 16°59.795'	20:48	75°18.839' 16°56.403'				
Nordflaket	CAGE22-6-HH-118-MB	14/08	22:35	75°12.065' 16°43.020'	00:47 +1 day	75°20.615' 17°59.741'				
Nordflaket	CAGE22-6-HH-119-MB	15/08	01:24	75°17.074' 18°09.454'	04:12	75°07.303' 16°43.202'				
Nordflaket	CAGE22-6-HH-120-MB	15/08	04:17	75°06.980' 16°43.790'	05:26	75°08.277' 17°32.892'				
Nordflaket	CAGE22-6-HH-121-MB	15/08	05:31	75°08.109' 17°33.400'	06:00	75°07.714' 17°16.461'				
Nordflaket	CAGE22-6-HH-122-MB	15/08	06:04	75°08.026' 17°17.363'	07:32	75°09.350' 18°14.376'				
Spitsbergen-banken	CAGE22-6-HH-123-MB	15/08	07:46	75°09.153' 18°14.399'	08:19	75°09.798' 18°33.997'			10	New EM302 survey CAGE_22-6-HH_2
Spitsbergen-banken	CAGE22-6-HH-124-MB	15/08	08:23	75°09.677' 18°35.829'	10:04	75°01.889' 19°22.981'			10	
Spitsbergen-banken	CAGE22-6-HH-125-MB	15/08	10:08	75°02.435' 19°23.384'	10:17	75°04.037' 19°22.833'			10	
Spitsbergen-banken	CAGE22-6-HH-126-MB	15/08	10:26	75°04.045' 19°22.751'	10:50	75°02.270' 19°07.110'				
Spitsbergen-banken	CAGE22-6-HH-127-MB	15/08	10:55	75°02.490' 19°08.280'	11:23	75°04.170' 19°23.160'				

Spitsbergen-banken	CAGE22-6-HH-128-MB	15/08	11:26	75°03.970' 19°22.330'	11:52	75°02.130' 19°07.170'				
Spitsbergen-banken	CAGE22-6-HH-129-MB	15/08	12:00	75°01.430' 19°09.520'	19:51	75°15.501' 22°54.548'			11	Stopped to do a CTD near end
Gardarbanken	CAGE22-6-HH-130-MB	15/08	19:51	75°15.501' 22°54.548'	20:42	74°13.248' 23°25.671'			10	
Gardarbanken	CAGE22-6-HH-131-MB	15/08	20:46	74°13.524' 23°25.620'	21:38	74°15.825' 22°55.307'			10	
Gardarbanken	CAGE22-6-HH-132-MB	15/08	21:42	74°16.111' 22°55.783'	22:35	74°13.775' 23°26.051'			10	
Gardarbanken	CAGE22-6-HH-133-MB	15/08	22:42	74°14.058' 23°25.792'	23:30	74°16.457' 22°56.068'			10	
Gardarbanken	CAGE22-6-HH-134-MB	15/08	23:35	74°16.792' 22°56.399'	00:32	74°14.244' 23°27.117'			10	
Gardarbanken	CAGE22-6-HH-135-MB	16/08	00:47	74°15.409' 23°25.088'	01:55	74°06.400' 23°01.742'			10	
Gardarbanken	CAGE22-6-HH-136-MB	16/08	01:55	74°06.273' 23°02.168'	05:47	73°50.509' 24°29.630'			7	slowed down due to storm
Bjørnøyrenna	CAGE22-6-HH-137-MB	16/08	05:54	73°50.247' 24°31.280'	06:59	73°58.718' 24°42.952'			8	
Bjørnøyrenna	CAGE22-6-HH-138-MB	16/08	07:02	73°58.766' 24°43.783'	08:11	73°56.203' 25°06.229'			6	
Bjørnøyrenna	CAGE22-6-HH-139-MB	16/08	08:15	73°55.873' 25°06.717'	10:54	73°37.643' 25°08.622'			6	
Bjørnøyrenna	CAGE22-6-HH-140-MB	16/08	10:56	73°37.674' 25°07.895'	11:20	73°39.597' 24°55.143'			10	
Bjørnøyrenna	CAGE22-6-HH-141-MB	16/08	11:23	73°39.450' 24°54.388'	13:45	73°21.840' 25°00.670'				
Bjørnøyrenna	CAGE22-6-HH-142-MB	16/08	13:47	73°21.670' 25°00.110'	15:33	73°11.074' 24°21.624'				
Bjørnøyrenna	CAGE22-6-HH-143-MB	16/08	16:24	73°12.480' 24°24.492'	16:39	73°13.655' 24°27.389'			7	
Bjørnøyrenna	CAGE22-6-HH-144-MB	16/08	17:07	73°14.136' 24°28.309'	17:28	73°16.642' 24°32.935'			8	
Bjørnøyrenna	CAGE22-6-HH-145-MB	16/08	18:10	73°16.525' 24°32.358'	19:32	73°28.892' 24°22.831'			10	
Bjørnøyrenna	CAGE22-6-HH-146-MB	16/08	21:25	73°23.931' 24°25.402'	22:35	73°18.447' 23°59.039'			8	
Bjørnøyrenna	CAGE22-6-HH-147-MB	16/08	22:57	73°18.222' 23°58.063'	23:42	73°14.033' 23°37.161'			10	
Svalis Dome	CAGE22-6-HH-148-MB	16/08	23:45	73°14.158' 23°36.225'	00:21 +1 day	73°17.977' 23°20.076'				
Svalis Dome	CAGE22-6-HH-149-MB	17/08	00:27	73°17.799' 23°18.667'	01:10	73°13.529' 23°36.819'				

Svalis Dome	CAGE22-6-HH-150-MB	17/08	01:18	73°12.998' 23°36.313'	02:03	73°17.660' 23°16.550'			10	
Svalis Dome	CAGE22-6-HH-151-MB	17/08	02:09	73°17.420' 23°15.280'	02:59	73°12.380' 23°36.730'			10	
Svalis Dome	CAGE22-6-HH-152-MB	17/08	03:07	73°11.760' 23°36.860'	04:03	73°17.360' 23°12.960'			10	
Svalis Dome	CAGE22-6-HH-153-MB	17/08	04:10	73°17.140' 23°11.677'	05:09	73°11.050' 23°37.630'			10	
Svalis Dome	CAGE22-6-HH-154-MB	17/08	05:19	73°10.850' 23°35.820'	06:20	73°17.052' 23°09.371'			10	
Svalis Dome	CAGE22-6-HH-155-MB	17/08	06:25	73°16.749' 23°08.462'	07:35	73°09.576' 23°38.641'			10	
Svalis Dome	CAGE22-6-HH-156-MB	17/08	07:41	73°09.464' 23°36.950'	08:47	73°16.544' 23°06.691'			10	
Svalis Dome	CAGE22-6-HH-157-MB	17/08	08:54	73°16.062' 23°06.179'	10:10	73°08.678' 23°37.971'			10	Ran BIST on EM203 after end of line
Svalis Dome	CAGE22-6-HH-158-MB	17/08	10:30	73°08.266' 23°37.436'	11:42	73°15.620' 23°05.755'			10	
Svalis Dome	CAGE22-6-HH-159-MB	17/08	11:48	73°15.059' 23°05.824'	13:07	73°07.580' 23°37.783'			10	
Svalis Dome	CAGE22-6-HH-160-MB	17/08	13:13	73°07.371' 23°36.212'	14:34	73°14.562' 25°03.337'			10	
Svalis Dome	CAGE22-6-HH-161-MB	17/08	14:39	73°14.044' 23°05.564'	15:47	73°06.720' 23°36.640'			10	
Svalis Dome	CAGE22-6-HH-162-MB	17/08	15:52	73°06.484' 23°35.143'	17:11	73°13.524' 23°05.090'			10	
Bjørnøyrenna	CAGE22-6-HH-163-MB	17/08	17:14	73°13.829' 23°04.732'	22:19	73°26.385' 21°58.739'				
Bjørnøyrenna	CAGE22-6-HH-164-MB	17/08	22:23	73°26.277' 21°57.444'	23:05	73°21.801' 21°40.710'				
Bjørnøyrenna	CAGE22-6-HH-165-MB	17/08	23:09	73°21.884' 21°38.545'	00:23 +1 day	73°27.478' 21°02.355'				
Bjørnøyrenna	CAGE22-6-HH-166-MB	18/08	00:30	73°26.655' 21°01.957'	02:55	73°08.758' 21°56.733'				
Bjørnøyrenna	CAGE22-6-HH-167-MB	18/08	03:23	73°08.454' 21°57.141'	04:54	72°55.740' 22°21.058'				
Bjørnøyrenna	CAGE22-6-HH-168-MB	18/08	04:55	72°55.740' 22°21.058'	10:08	72°32.041' 21°00.185'				
Bjørnøyrenna	CAGE22-6-HH-169-MB	18/08	10:09	72°32.130' 21°00.064'	11:30	72°44.570' 20°49.930'			8	
Bjørnøyrenna	CAGE22-6-HH-170-MB	18/08	12:27	72°43.855' 20°50.420'	13:24	72°49.347' 20°30.960'				
Bjørnøyrenna	CAGE22-6-HH-171-MB	18/08	13:26	72°49.224' 20°30.369'	13:43	72°46.816' 20°28.199'				

Bjørnøyrenna	CAGE22-6-HH-172-MB	18/08	14:17	72°46.783' 20°26.350'	15:43	72°35.070' 20°09.890'				
Bjørnøyrenna	CAGE22-6-HH-173-MB	18/08	15:45	72°35.090' 20°10.760'	16:14	72°36.110' 20°27.100'				
Bjørnøyrenna	CAGE22-6-HH-174-MB	18/08	16:17	72°35.830' 20°26.890'	17:21	72°27.051' 20°24.712'				
Bjørnøyrenna	CAGE22-6-HH-175-MB	18/08	17:23	72°26.955' 20°24.352'	17:51	72°26.956' 20°12.084'				
Bjørnøyrenna	CAGE22-6-HH-176-MB	18/08	17:52	72°27.080' 20°11.807'	18:02	72°28.576' 20°09.804'				
Bjørnøyrenna	CAGE22-6-HH-177-MB	18/08	18:04	72°28.547' 20°09.531'	18:38	72°23.240' 20°07.595'				
Bjørnøyrenna	CAGE22-6-HH-178-MB	18/08	18:38	72°23.235' 20°07.481'	19:06	72°24.195' 19°54.685'				
Bjørnøyrenna	CAGE22-6-HH-179-MB	18/08	19:07	72°24.151' 19°54.619'	19:40	72°18.879' 19°54.833'				
Bjørnøyrenna	CAGE22-6-HH-180-MB	18/08	19:40	72°18.879' 19°54.833'	19:50	72°18.309' 19°59.550'				
Bjørnøyrenna	CAGE22-6-HH-181-MB	18/08	19:50	72°18.309' 19°59.550'	20:03	72°16.293' 20°00.108'			9	
Bjørnøyrenna	CAGE22-6-HH-182-MB	18/08	20:03	72°16.293' 20°00.108'	00:00	72°11.829' 19°35.052'			9	
Bjørnøyrenna	CAGE22-6-HH-183-MB	18/08	21:05	72°11.595' 19°34.970'	22:12	72°04.602' 20°01.263'			9	
Bjørnøyrenna	CAGE22-6-HH-184-MB	18/08	22:13	72°04.473' 20°01.373'	22:41	72°00.000' 20°04.150'			10	
Bjørnøyrenna	CAGE22-6-HH-185-MB	18/08	22:41	72°00.000' 20°04.150'	23:38	72°04.630' 20°32.068'			10	
Bjørnøyrenna	CAGE22-6-HH-186-MB	18/08	23:42	72°04.396' 20°32.519'	23:58	72°01.638' 20°33.536'			10	
Bjørnøyrenna	CAGE22-6-HH-187-MB	19/08	00:02	72°01.133' 20°33.899'	00:21	72°01.513' 20°24.991'			10	
Bjørnøyrenna	CAGE22-6-HH-188-MB	19/08	00:24	72°01.205' 20°25.385'	00:43	71°58.275' 20°29.567'			10	
Bjørnøyrenna	CAGE22-6-HH-189-MB	19/08	00:44	71°58.095' 20°29.282'	01:13	71°54.149' 20°20.404'			10	
Bjørnøyrenna	CAGE22-6-HH-190-MB	19/08	01:14	71°54.255' 20°19.950'	01:42	71°57.677' 20°10.665'			10	
Bjørnøyrenna	CAGE22-6-HH-191-MB	19/08	01:49	71°56.868' 20°08.486'	02:16	71°53.500' 20°18.160'			10	
Bjørnøyrenna	CAGE22-6-HH-192-MB	19/08	02:18	71°53.160' 20°18.290'	02:52	71°47.546' 20°13.848'			10	
Bjørnøyrenna	CAGE22-6-HH-193-MB	19/08	02:56	71°47.490' 20°15.542'	03:14	71°47.216' 20°25.685'			10	

Bjørnøyrenna	CAGE22-6-HH-194-MB	19/08	03:15	71°47.216' 20°25.685'	04:09	71°40.172' 20°45.831'			10	
Bjørnøyrenna	CAGE22-6-HH-195-MB	19/08	04:10	71°40.112' 20°46.364'	04:49	71°39.294' 21°07.417'			10	
Bjørnøyrenna	CAGE22-6-HH-196-MB	19/08	04:51	71°39.121' 21°06.887'	05:37	71°35.479' 20°46.336'			10	
Bjørnøyrenna	CAGE22-6-HH-197-MB	19/08	05:37	71°35.479' 20°46.336'	06:20	71°36.135' 20°24.155'			10	
Bjørnøyrenna	CAGE22-6-HH-198-MB	19/08	06:22	71°36.019' 20°24.292'	07:13	71°30.437' 20°44.525'			10	
Bjørnøyrenna	CAGE22-6-HH-199-MB	19/08	07:14	71°30.391' 20°44.474'	07:43	71°27.073' 20°33.776'			10	
Bjørnøyrenna	CAGE22-6-HH-200-MB	19/08	07:44	71°27.105' 20°33.508'	08:34	71°28.923' 20°09.730'			10	
Bjørnøyrenna	CAGE22-6-HH-201-MB	19/08	08:35	71°28.873' 20°09.734'	08:51	71°26.360' 20°11.957'			10	
Bjørnøyrenna	CAGE22-6-HH-202-MB	19/08	08:52	71°26.347' 20°12.201'	09:24	71°25.523' 20°28.466'			10	
Bjørnøyrenna	CAGE22-6-HH-203-MB	19/08	09:26	71°25.394' 20°28.322'	09:42	71°23.437' 20°23.221'			10	
Bjørnøyrenna	CAGE22-6-HH-204-MB	19/08	09:43	71°23.380' 20°23.347'	10:05	71°20.465' 20°30.931'			10	
Bjørnøyrenna	CAGE22-6-HH-205-MB	19/08	10:08	71°20.152' 20°30.591'	10:26	71°20.501' 20°21.897'			10	
Bjørnøyrenna	CAGE22-6-HH-206-MB	19/08	10:26	71°20.449' 20°21.740'	10:41	71°18.351' 20°18.333'			10	
Bjørnøyrenna	CAGE22-6-HH-207-MB	19/08	10:42	71°18.342' 20°19.916'	11:56	71°13.830' 19°47.971'			10	
Bjørnøyrenna	CAGE22-6-HH-208-MB	19/08	11:57	71°13.603' 19°41.870'	13:16	71°00.535' 19°49.643'			10	
Bjørnøyrenna	CAGE22-6-HH-209-MB	19/08	13:18	71°00.393' 19°49.195'	14:58	70°54.560' 19°00.342'			10	
Bjørnøyrenna	CAGE22-6-HH-210-MB	19/08	14:59	70°54.477' 19°00.110'	16:56	70°39.040' 18°23.340'			10	
Bjørnøyrenna	CAGE22-6-HH-211-MB	19/08	16:57	70°38.960' 18°23.040'	19:34	70°23.847' 17°22.221'			10	
Bjørnøyrenna	CAGE22-6-HH-212-MB	19/08	19:56	70°23.707' 17°22.175'	20:18	70°23.654' 17°30.923'			10	
Bjørnøyrenna	CAGE22-6-HH-213-MB	19/08	20:17	70°23.654' 17°30.923'	20:34	70°23.415' 17°21.542'			10	
Bjørnøyrenna	CAGE22-6-HH-214-MB	19/08	20:38	70°23.252' 17°21.840'	20:59	70°23.221' 17°31.050'			10	
Bjørnøyrenna	CAGE22-6-HH-215-MB	19/08	21:04	70°23.000' 17°30.570'	21:23	70°23.060' 17°21.700'			10	

Bjørnøyrenna	CAGE22-6-HH-216-MB	19/08	21:28	70°23.912' 17°21.690'	21:46	70°23.918' 17°30.849'			10	
Bjørnøyrenna	CAGE22-6-HH-217-MB	19/08	21:49	70°24.097' 17°29.647'	22:08	70°24.117' 17°20.111'			10	
Bjørnøyrenna	CAGE22-6-HH-218-MB	19/08	22:12	70°24.360' 17°20.180'	22:35	70°24.088' 17°31.688'			10	

9. Sample log

Location	Station Id	Date	Time (UTC)	Lat. [N] Long. [E]	Water Depth [m]	Notes
Storfjordrenna	CAGE22-6-HH-1196-CTD	03/08	10:04	76°00.788' 16°00.143'	379	6nm south of pingos
Storfjordrenna	CAGE22-6-HH-1197-CTD	03/08	11:33	76°06.480' 15°57.740'	385	
Storfjordrenna	CAGE22-6-HH-1198-GC	03/08	13:04	76°06.348' 16°02.078'	380	Over SE pingo, hydrates in base of core. Hydrate sample to freezer.
Storfjordrenna	CAGE22-6-HH-1200-MC	03/08	22:15	76°16.899' 20°08.815'	346	
Storfjordrenna	CAGE22-6-HH-1202-OilS	04/08	06:56	76°08.968' 25°34.662'	110	
Hopendjupet	CAGE22-6-HH-1203-CTD	04/08	17:32	75°12.507' 31°35.013'	341	
Hopendjupet	CAGE22-6-HH-1213-CTD	06/08	23:31	75°12.404' 31°35.305'	338	CTD at the Southern Slick prior drifter deployement
Hopendjupet	CAGE22-6-HH-1213b-Drift	07/08	00:14	75°12.357' 31°35.455'	338	
Hopendjupet	CAGE22-6-HH-1214-MC	07/08	01:33	75°13.771' 31°44.256'	329	Samples for benthic fauna, headspace gas, 1 core in cooling room
Hopendjupet	CAGE22-6-HH-1215-CTD	07/08	01:50	75°13.762' 31°44.232'	328	
Hopendjupet	CAGE22-6-HH-1215b-Drift	07/08	02:11	75°13.593' 31°44.258'	328	
Hopendjupet	CAGE22-6-HH-1216-MC	07/08	03:47	75°11.634' 31°44.024'	333	Samples for benthic fauna, headspace gas, mi-croplastics, frozen core for MAREANO, frozen samples for biomarkers
Hopendjupet	CAGE22-6-HH-1217-CTD	07/08	04:47	75°17.774' 31°45.183'	329	
Hopendjupet	CAGE22-6-HH-1217b-Drift	07/08	05:05	75°17.774' 31°45.183'	329	
Hopendjupet	CAGE22-6-HH-1221-CTD	08/08	17:32	74°38.909' 30°02.815'	361	
Hopendjupet	CAGE22-6-HH-1224-GC	09/08	13:55	74°35.153' 29°36.576'	359	
Hopendjupet	CAGE22-6-HH-1225-GC	09/08	14:52	74°35.137' 29°36.565'	359	no hydrate in either cores
Hopendjupet	CAGE22-6-HH-1226-CTD	09/08	15:17	74°35.129' 29°36.566'	359	
Hopendjupet	CAGE22-6-HH-1227-GC	09/08	17:32	74°40.327' 30°13.895'	369	
Hopendjupet	CAGE22-6-HH-1229-GC	09/08	18:01	74°39.924' 30°16.081'	363	
Hopendjupet	CAGE22-6-HH-1228-GC	09/08	18:27	74°39.977' 30°15.713'	362	
Hopendjupet	CAGE22-6-HH-1233-GC	10/08	13:08	74°39.479' 31°33.114'		
Hopendjupet	CAGE22-6-HH-1234-GC	10/08	13:54	74°39.605' 31°33.126'		
Hopendjupet	CAGE22-6-HH-1235-GC	10/08	14:54	74°39.605' 31°35.588'		

Hopendjupet	CAGE22-6-HH-1237-GC	10/08	23:37	74°42.616' 31°24.999'		
Hopendjupet	CAGE22-6-HH-1238-GC	11/08	00:49	74°44.437' 31°20.376'		
Hopendjupet	CAGE22-6-HH-1239-MC	11/08	01:42	74°44.438' 31°20.367'		
Hopendjupet	CAGE22-6-HH-1241-CTD	11/08	06:37	75°08.895' 32°06.569'	297	
Hopendjupet	CAGE22-6-HH-1243-Air	11/08	09:39	75°08.908' 32°06.601'	296	Ship station slightly delayed from sample location marked precisely here
Hopendjupet	CAGE22-6-HH-1244-CTD	11/08	11:05	75°12.469' 31°35.004'	341	
Hopendjupet	CAGE22-6-HH-1246-OilS	11/08	11:40	75°12.795' 31°35.503'	340	
Hopendjupet	CAGE22-6-HH-1247-GC	11/08	12:38	75°12.442' 31°35.060'	340	
Hopendjupet	CAGE22-6-HH-1248-OilS	11/08	13:11	75°12.549' 31°35.318'		Position not in stasjonslapper, but few 100 m north of CTD station/seep
Hopendjupet	CAGE22-6-HH-1245-Air	11/08	13:17	75°12.549' 31°35.022'	340	
Hopendjupet	CAGE22-6-HH-1249-CTD	11/08	14:00	75°13.772' 31°44.253'	328	
Hopendjupet	CAGE22-6-HH-1250-Air	11/08	14:16	75°13.927' 31°44.896'	330	
Hopendjupet	CAGE22-6-HH-1252-Air	11/08	15:13	75°17.715' 31°45.011'	329	
Hopendjupet	CAGE22-6-HH-1251-CTD	11/08	15:16	75°17.691' 31°44.916'	329	
Hopendjupet	CAGE22-6-HH-1254-Air	11/08	15:36	75°18.391' 31°54.055'		
Hopendjupet	CAGE22-6-HH-1255-Air	11/08	15:49	75°18.986' 32°02.117'		
Hopendjupet	CAGE22-6-HH-1256-Air	11/08	16:02	75°19.470' 32°08.843'		
Hopendjupet	CAGE22-6-HH-1257-Air	11/08	16:14	75°18.220' 32°17.940'		
Hopendjupet	CAGE22-6-HH-1258-Air	11/08	16:24	75°17.380' 32°23.770'		
Hopendjupet	CAGE22-6-HH-1259-Air	11/08	16:34	75°16.520' 32°29.860'		
Hopendjupet	CAGE22-6-HH-1260-Air	11/08	16:48	75°16.470' 32°22.470'		
Hopendjupet	CAGE22-6-HH-1261-Air	11/08	17:00	75°16.475' 32°15.025'		
Hopendjupet	CAGE22-6-HH-1262-Air	11/08	17:14	75°16.496' 32°05.394'		
Hopendjupet	CAGE22-6-HH-1263-Air	11/08	17:25	75°16.472' 31°58.313'		
Hopendjupet	CAGE22-6-HH-1264-Air	11/08	17:37	75°16.461' 31°50.557'		
Hopendjupet	CAGE22-6-HH-1265-Air	11/08	17:50	75°16.477' 31°41.084'		
Hopendjupet	CAGE22-6-HH-1266-Air	11/08	18:01	75°16.475' 31°34.475'		
Hopendjupet	CAGE22-6-HH-1267-Air	11/08	18:12	75°16.463' 31°27.448'		
Hopen	CAGE22-6-HH-1268-CTD	12/08	04:01	75°40.316' 25°14.665'	120	

Hopen	CAGE22-6-HH-1270-CTD	12/08	15:29	76°02.933' 24°02.832'	65	
Hopen	CAGE22-6-HH-1271-Air	12/08	18:11	76°25.288' 24°00.082'		
Hopen	CAGE22-6-HH-1272-Air	12/08	19:31	76°38.333' 23°59.937'		
Storfjordrenna	CAGE22-6-HH-1273-CTD	14/08	02:50	75°31.262' 16°10.703'	286	
Nordflaket	CAGE22-6-HH-1276-CTD	15/08	07:37	75°09.229' 18°14.469'	48	
Bjørnøyrenna	CAGE22-6-HH-1277-CTD	15/08	19:32	74°15.775' 22°53.259'		
Bjørnøyrenna	CAGE22-6-HH-1278-CTD	16/08	15:47	73°11.370' 24°22.897'		Over pingo
Bjørnøyrenna	CAGE22-6-HH-1279-CTD	16/08	16:40	73°13.709' 24°27.521'		Between pingo
Bjørnøyrenna	CAGE22-6-HH-1280-CTD	16/08	17:43	73°16.244' 24°32.153'		Over flaring pingo
Bjørnøyrenna	CAGE22-6-HH-1281-CTD	16/08	19:34	73°27.118' 24°24.278'		Over well
Bjørnøyrenna	CAGE22-6-HH-1282-CTD	16/08	20:56	73°24.028' 24°26.684'		Over well
Bjørnøyrenna	CAGE22-6-HH-1283-CTD	16/08	22:28	73°18.437' 23°59.188'		Reference
Bjørnøyrenna	CAGE22-6-HH-1284-CTD	18/08	03:20	73°08.606' 21°57.265'	445	
Bjørnøyrenna	CAGE22-6-HH-1285-Drift	18/08	03:26	73°08.606' 21°57.265'		Drifter1
Bjørnøyrenna	CAGE22-6-HH-1286-CTD	18/08	06:11	72°47.681' 21°54.683'	420	
Bjørnøyrenna	CAGE22-6-HH-1287-Drift	18/08	06:39	73°47.420' 21°54.442'		Drifter2
Bjørnøyrenna	CAGE22-6-HH-1288-CTD	18/08	08:29	72°37.938' 21°23.233'	388	
Bjørnøyrenna	CAGE22-6-HH-1289-Drift	18/08	08:50	72°37.983' 21°23.245'	390	Drifter3
Bjørnøyrenna	CAGE22-6-HH-1290-CTD	18/08	11:58	72°43.690' 20°51.083'	422	
Bjørnøyrenna	CAGE22-6-HH-1291-CTD	18/08	13:49	72°46.653' 20°26.903'	418	
Bjørnøyrenna	CAGE22-6-HH-1292-CTD	19/08	19:37	70°23.830' 17°22.004'	172	