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R/V Helmer Hanssen

08-July (start) - 21 July (end) 2020

Tromsø – Tromsø

20-2.CAGE Cruise report

Hunting gas flares in Hopendjupet and glacial sediments in Sentralbankrenna

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Key words: gas flares, multibeam, pingo, gravity core, hydrate
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Contents

1. Scientific objectives

The cruise was part of the Centre of Excellence (SFF) Centre for Arctic Gas Hydrate. Environment and Climate (CAGE) at UiT - The Arctic University of Norway. It was partly supported by The Norwegian Petroleum Directorate (NPD).

The cruise had the following scientific objectives:

- Identification of gas seepage associated with known and assumed sandstone reservoirs sub-cropping at the sea floor due to erosion of overlying cap rocks.
- Identification of gas seepage related to leakage along faults and geological structures breaching the seafloor in Hopendjupet.
- Collection of gravity cores, multibeam and sub-bottom profiling from the Sentralbankrenna glacial system to establish how grounding zone processes impact marine-based ice sheet behaviour and trigger ice-stream retreat during deglaciation (GlaciVar project, PI: Dr. M. Esteves).

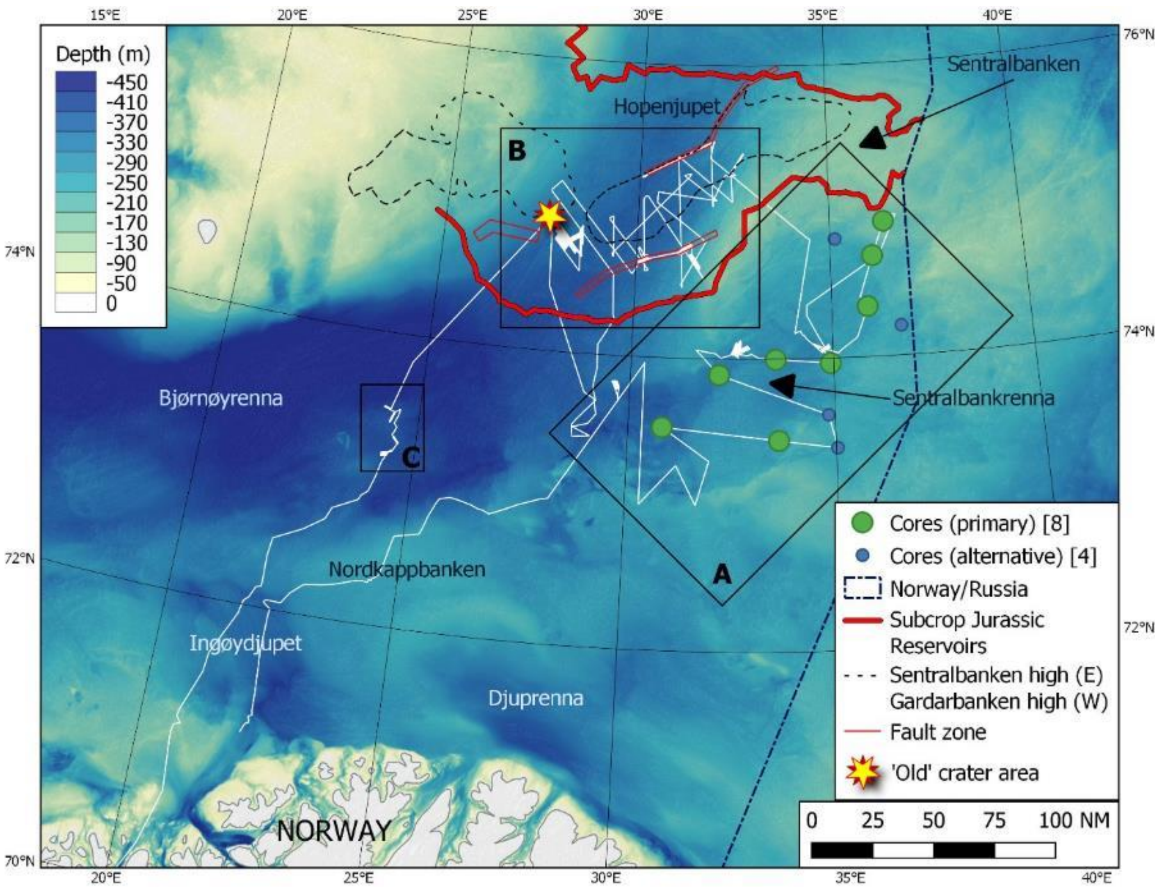


Figure 1: Working areas for cruise CAGE_20-2, with planned coring locations and the ship route taken. Box A – Sentralbankrenna; Box B – Hopendjupet; Box C – Maud Basin.

1.1. Geological setting

Geologically, Hopendjupet (the Hopen Deep) represents a viable setting for significant gas flaring linked to thermogenic source rocks. The area is bounded by outcropping Jurassic-age reservoir rocks (Realgrunnen Sub-Group - Figure 1), indicating where Cretaceous age rocks have since been eroded by the Cenozoic ice sheets. On and around the structural highs, Triassic-age rocks (Upper Triassic Snadd Fm and Middle Triassic

Kobbe Fm) subcrop at the seafloor. The major regional geological structures include the Sentralbanken (east) and the Gardarbanken (west) highs, which route and act as focus points for the migration of free gas from the subsurface. Fault zones associated with these structural elements provide additional pathways to the seafloor. North of Hopendjupet lies Storbanken, previously visited by CAGE during the CAGE_19-2 cruise, where structurally controlled flaring was also observed. Hopendjupet is also host to a large crater field, where km-scale depressions record the blowout of methane gas accumulations after the last deglaciation and when the gas hydrate stability zone (GHSZ) severely diminished (Andreassen et al., 2017). Today the GHSZ lies at around 360 meters of water depth in this region.

1.2. Glacial setting

Sentralbankrenna (Central Bank Trough) hosted a large ice stream during the Last Glacial Maximum, which acted as a tributary to the larger Bjørnøyrenna ice stream further west. The Barents Sea ice sheet retreated to these central bank areas c. 15 ka BP, with the marine based ice sheet continuing to collapse very rapidly during the Bølling Interstadial. These areas likely hosted some of the last remnants of the last Barents Sea ice sheet. Today, Sentralbankrenna is characterised by numerous meltwater features, indicating significant subglacial water drainage at the glacier bed prior to deglaciation. The retreat of this marine-terminating ice stream provides an excellent analogue for present-day ice-stream systems in West Antarctica.

2. Cruise participants

Name	**Position**	**Shift**	**Cabin**
Henry Patton (cruise leader)	Researcher (CAGE)	open	505
Rune Mattingsdal	Geologist (NPD)	1	210
Nikolitsa Alexandropoulou	PhD (CAGE)	1	209
Pavel Serov	Postdoc (CAGE)	2	213
Frances Cooke	PhD (CAGE)	2	211
Truls Holm	Engineer (UiT)	1	404
Stormer Alexander Jensen	Engineer (UiT)	2	411

Shift 1: 08:00-14:00; 20:00-02:00. Shift 2: 14:00:08:00; 02:00-08:00 (TOS time)

Departed from Tromsø 08.07 at 09:30, transit to Sentralbankrenna via Ingøydjupet: ca 30 hrs.

Cruise shifts started Wednesday 09.07 at 20:00, and stopped Monday 20.07 at 14:00.

Arrived in Tromsø 21.07 at 1200.

3. Corona-based risk assessment

Only 7 people were on the cruise, including 2 engineers. This already reduces the risk that people cross each other in corridors. Each of the participants will have their own cabin as stipulated in the new cruise rules from UiT. All participants respected the selfquarantine time of 10 days within Norway prior to the cruise and completed a health check self-assessment immediately prior to coming on-board. All participants are also resident of Norway. The restriction of keeping expedition activity within a 24-hour sailing distance of the Norwegian mainland was lifted by UiT a week prior to the cruise start.

Furthermore, observation of the computer screens in the instrument room is to be done with more than 1 m between each other. While on deck all precautions will be taken to prevent infection, including keeping a minimum of 1 m distance whenever possible.

The information below will be communicated and repeated to all participants to reduce the risk for covid-19 infection:

1. Sick people are not allowed to go on a cruise – if anyone gets sick during the cruise they immediately have to be isolated
2. At all times we all need to keep good hand hygiene and cough etiquette
3. Follow measures that limit contact frequency.

Further restrictions were in place during the cruise to prevent infection, including: social distancing within the mess and in the common area, hand sanitizers to be used before entering the mess and the common area, and closure of the gym to scientific crew.

4. Equipment used

4.1. Subbottom Profiler (CHIRP)

A X-STAR Full Spectrum Sonar is a versatile wideband FM sub-bottom profiler that generates cross-sectional images of the seabed and collects digital normal incidence reflection data over many frequency ranges. X-STAR transmits an FM pulse that is linearly swept over a full spectrum frequency range (also called “chirp pulse”). The chirp system comprises of a hull-mounted 4 x 4 transducer array operated at an energy level of 4 kW and at a shot rate of 1 s. The signal lasts 40 ms, starts at 1.5 kHz and end at 9 kHz. The system can operate in up to 8000 m of water. The penetration depth depends on the sediment type/thickness, it can be up to 80 m in soft clay.

The CHIRP was started Wednesday 08.07 at time 18:51 on transit to Sentralbankrenna. A 2-6kHz pulse was used with a ping rate of 0.3 Hz, with live data used for identifying suitable sites for gravity coring.

The CHIRP was deactivated on 14.07 at 00:15 during surveying in Hopendjupet in order to reduce interference and allow increased sailing speed from 8 to 10 knots during collection of water column data for identifying flares. One additional CHIRP line was taken over the Hopendjupet Pingo Field (line 96).

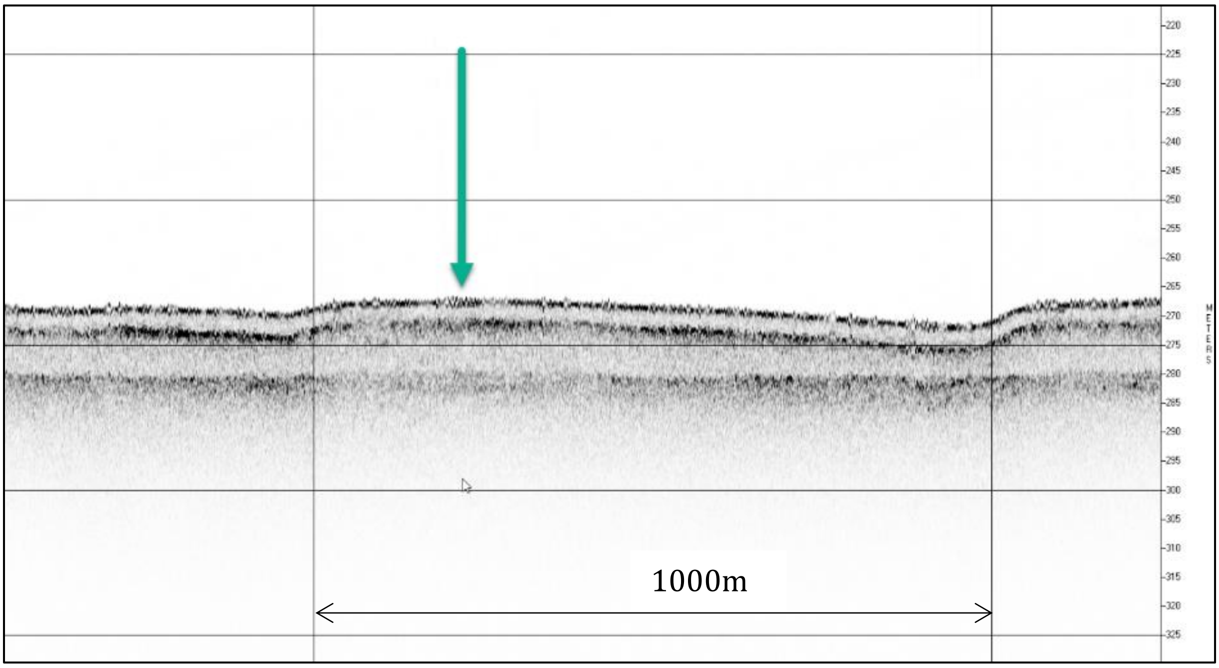


Figure 2 Chirp profile line 075 displaying position of gravity core station 334. The total core length was 439 cm.

4.2. Multibeam echosounder

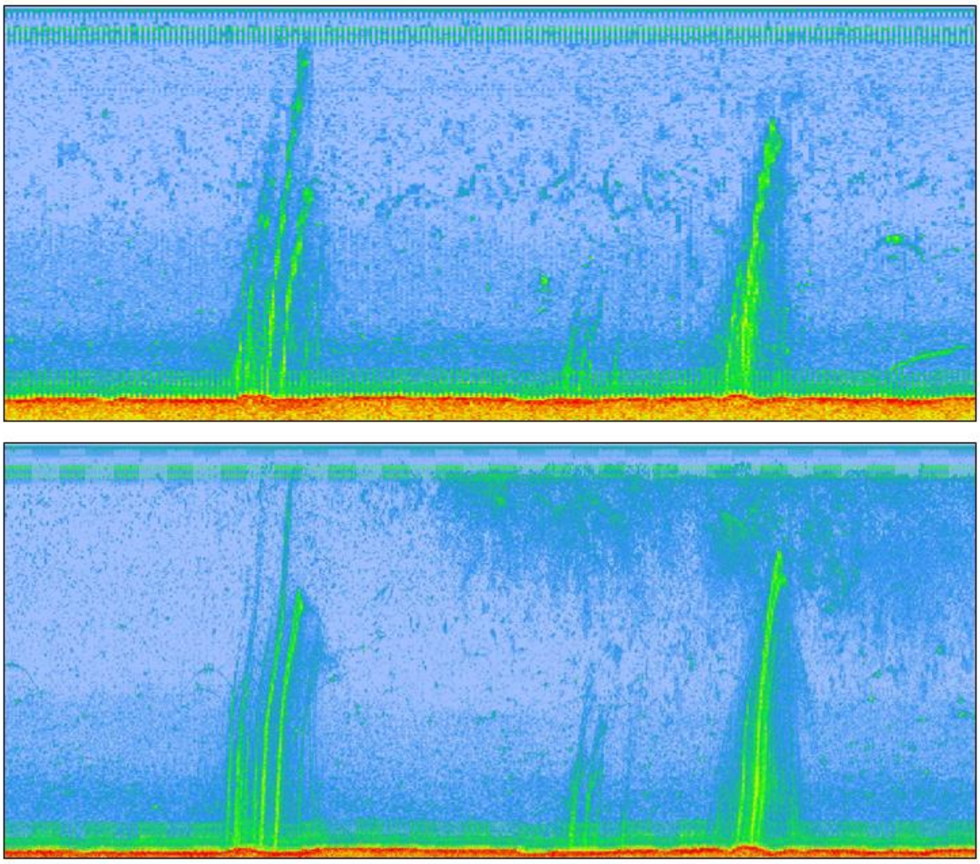
Multi-beam echosounders use a swath of beams giving off-track depth. Basic components of a multi-beam system are two linear transducer arrays in a Mills cross configuration with separate units for transmitting and receiving. Echosounders measure the two-way travel time that a sound wave initiated by the transmitter needs to reach the seafloor and be reflected back to the receiver. The time-depth conversion can be done using the sound velocity through seawater calculated from the closest CTD measurements.

R/V Helmer Hanssen is equipped with the hull-mounted Kongsberg Simrad EM302 multi-beam echosounder system. Its 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 system was mainly used with a 60°/60° opening angle. The ping rate depends on the water depth and switched frequently between 0.5 and 2 Hz. The EM302 provides high-resolution bathymetric data up to a water depth of 7000 m. The achievable swath width on the seafloor depends on the bathymetry and the selected opening angle.
During the entire cruise, the EM302 provided continuous bathymetric data to give an overview of seafloor morphology in the study area. The QPS Qimera software was used to create preliminary high-resolution bathymetric maps.

Another application of the EM302 is to monitor the water column. The acquired data were analysed using the QPS FMMidwater software. Before any analysis could be done, the provided sonar source files (*.all, *.wcd) had to be converted to the generic water column file format (*.gwc).

The objective of analysing water column data was the detection of acoustic flares indicating gas seepage from the seafloor to the water column and their spatial mapping on top of the bathymetry and along the seismic lines acquired during the cruise. To improve the quality of this water column data while hunting for gas flares, the CHIRP and EK60 (singlebeam echosounder) signals were switched off, allowing the EM320 ping rate to increase from 0.33 to c. 0.7 Hz. The effect of switching off the external trigger mode for the EM302 results in much better quality water-column data (Figure 3).

Comparison EM302 WCD R Stack, with and without external trigger



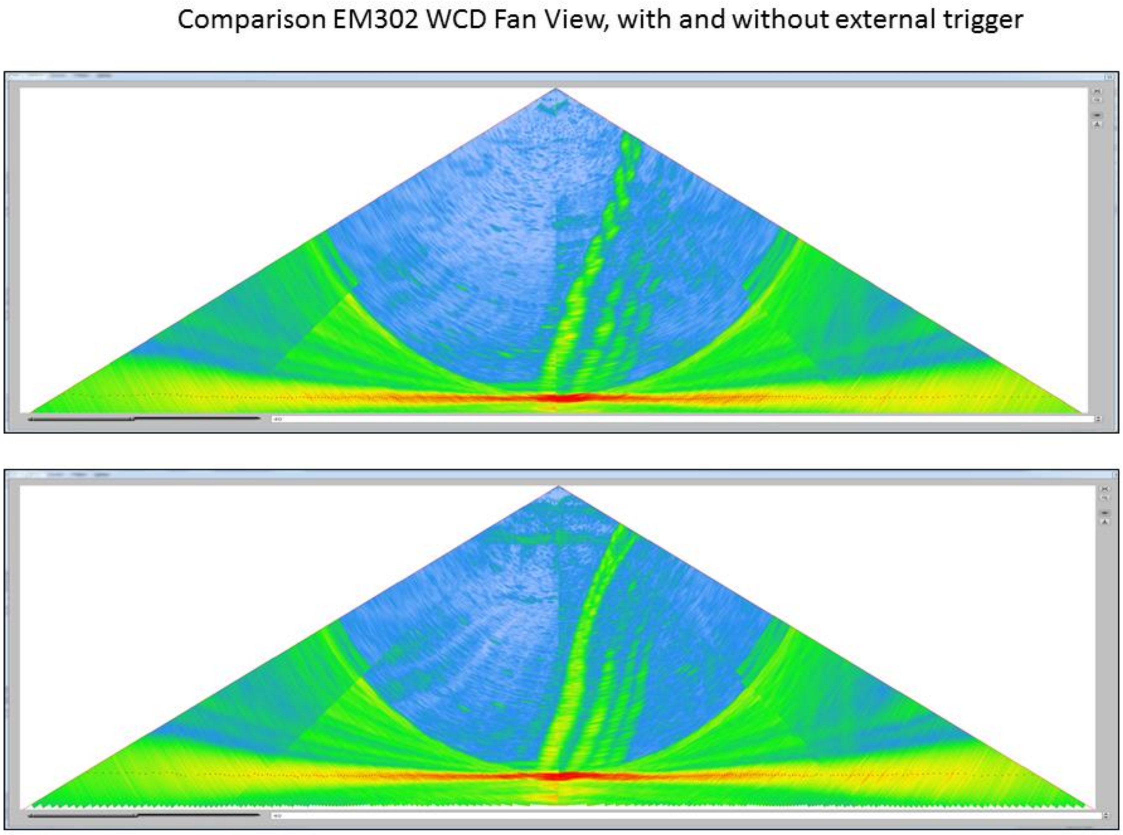


Figure 3: Differences in the quality of EM302 water column data collected over the same line with external trigger on/off.

The following steps were carried out to count gas flares and extract flare data in QPS FMMidwater:

a) Identification and counting of acoustic flares using a playback of the data in fan view. Typically, a stack of 3 pings was used in a playback mode.
b) Selection of the flare.
    i. Selection of a reasonable beam range in the fan view (Figure 4a).
    ii. Selection of the flare area in the R-stack view, narrowing down the amplitude range (Figure 4b).
    iii. Export of the selection as an ASCII file.
c) Importing the flare to a QPS Fledermaus project (Figure 4c).

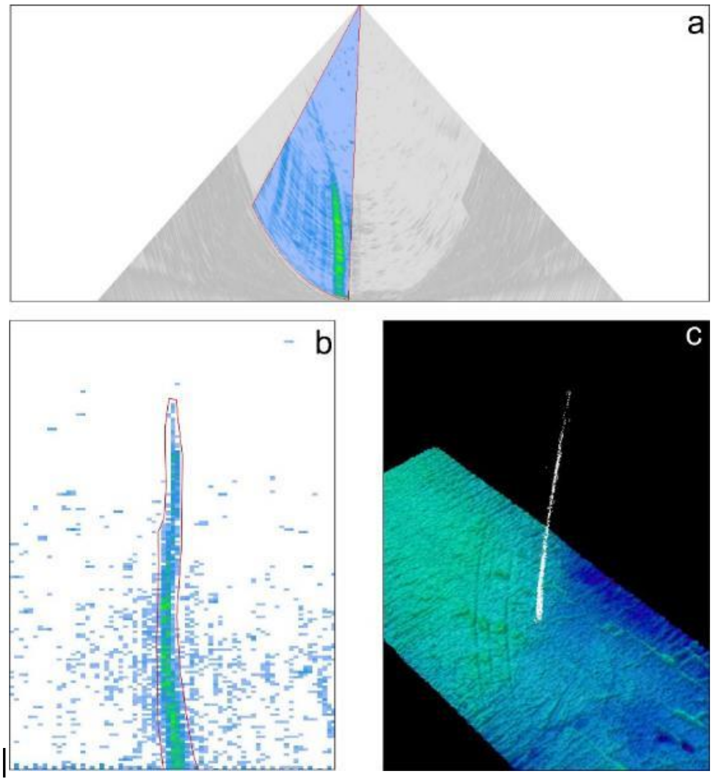


Figure 4: Stages of flare selection and preparation.

4.3. CTD

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 CTD sensors measure or calculate salinity of seawater, density, sound velocity, turbidity, fluorescence/chlorophyll, and oxygen content. Furthermore, the CTD deck unit can trigger closing of Niskin bottles at discrete depths. Water samples may 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 can measure physical properties of the seawater from up to eight auxiliary sensors, in marine or fresh-water environments at depths up to 6000 meters. However, the winch wire length limits CTD measurements to approximately 3200 meters. The CTD sensors record 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 at intervals during the cruise to measure variations in the sound velocity profile of the water column – a necessary calibration for multibeam echosounder when surveying over large distances (Figure 5).

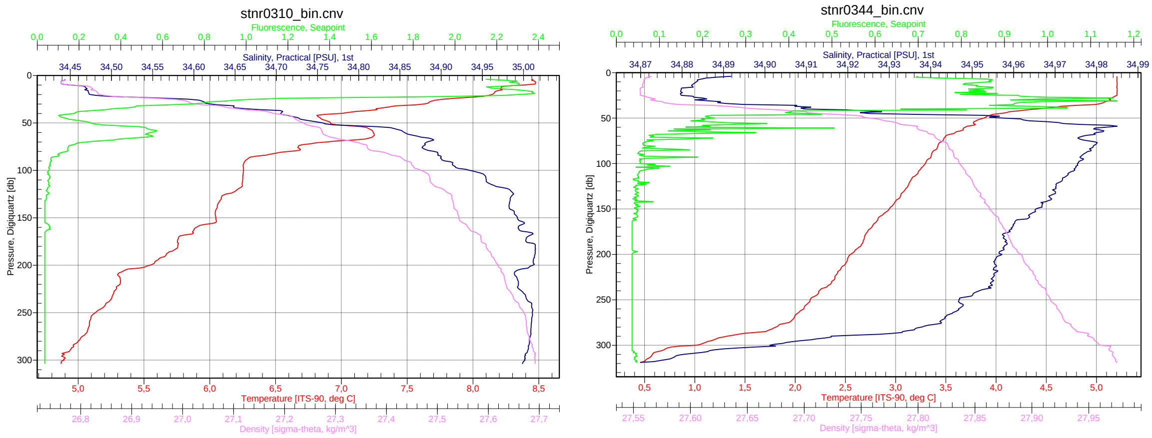


Figure 5: CTD profiles at station 310 (left) and 344 (right) illustrating the changing water column properties at different locations.

4.4. Singlebeam echosounder

Single beam echo sounders are common among all types of ships. Their primary purpose is to estimate the depth of the seafloor. In a single beam echo sounder, 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 echo sounder 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 500m respectively.
The EK60 was switched off during the collection of water column data in order to help reduce interference and increase resolution in the EM302 data.

4.5. 2D reflection seismic

Seismic equipment was deployed at the Hopendjupet Pingo Field though numerous issues occurred before data acquisition was eventually abandoned:

1) IP address of the controller PC was incorrect, this was corrected and the software was then able to start
2) Error message “Eels not responding 1-4” this problem was resolved with several power cycles of the Deck Unit and restarts of Geoeel software
3) All channels were overdriven once system was up and running.

Streamers were deployed on transit back to Tromsø to test the power supply units. One PSU, which previously had an unstable trigger in May (on KPH, Serial #: PS01064), was faulty. Although the current problem is not thought to be related to the trigger. The spare PSU on-board (serial #: PS01116) was found to work OK.

4.6. Gravity coring

Sediments were sampled with a gravity corer (max core length 6 m, outer diameter 119 mm). The main objective of the coring was to acquire glacigenic and glaciofluvial sediments to characterize and constrain the timing of glacial retreat through Sentralbankrenna.

Of the 12 sites planned for coring in Sentralbankrenna, sediments were acquired from 10. Two cores were acquired at each 'primary' site and one core at 'additional' sites. An extra, third core was acquired at site 4 in upper Sentralbankrenna.

Chirp profiles were used to check for sediments at the core locations. After retrieval of the gravity cores, the plastic liners were cut into sections of up to 100 cm length. They were covered with plastic caps, taped, labelled and stored in the cooling room at 4˚C for analyses once back onshore. Material in the core-catcher was saved into a plastic bag and also put into cold storage.

A 6 m-long barrel was bent when penetrating stiff muds at station 326. The spare 6 m-long barrel was used for subsequent sites.

Additional coring was carried out to recover hydrate/gas samples from seeping pingos. The first site was Pingo 1 in the Hopendjupet Pingo Field, with gas hydrate recovered within 1.2 m of sediment (station 347; Figure 20). These sediments were sampled for gas on board (see section 4.7). A second pingo was cored in the Maud Basin Pingo Field. Hydrate flakes were recovered from the corecatcher of a 1.9 m core (station 352).

Figure 6: A) Gravity core being raised onto deck; B) Successful recovery of sediments by the corer; C) Removing the core liner prior to preparation for cold storage. (Photos: H. Patton).

4.7. Gas in sediments

A total of 9 sediment samples for headspace gas analysis were collected from GC347 – taken from Pingo 1 in the Hopendjupet Pingo Field. We split the plastic liner in half on deck, then sampled for headspace gas samples at 20 cm intervals. Core GC351 (Maud Basin pingo field) was sampled with 50 cm interval. Additional samples for stable isotope analyses were taken from the core catcher and the bottom of the core. Core GC352 (not opened) was sampled from the bottom and core catcher bearing hydrates. For all sampling we used a 5 mL syringe without the luer tip to collect 5 mL of sediments. The sediment sample was transferred to a 20 mL serum vial containing a glass bead and was added 10 mL of 1M NaOH solution to stop microbial degradation of the sample. The vial was immediately closed with a septum and an aluminium crimp seal. Headspace gas samples were then stored under 4˚C for onshore analyses. Subsamples for other potential analysis were kept frozen at -20˚C.

5. Study areas and ship tracks

5.1. Transit north to Sentralbankrenna

Small detours were made during the transit north to Sentralbankrenna in order to see if gas flaring above sites of known hydrocarbon reservoirs can be observed (lines 1-7). These include the Goliat field, Caurus discovery, Samson Dome shallow-gas anomaly, Arenaria discovery, Norvag discovery, Ververis discovery. The central dome of the Mjølnir impact crater was surveyed as a small detour from the planned routes in Sentralbankrenna (lines 8-13). At all sites natural gas flaring was observed (Figure 7), as well as at some well heads (Figure 8).

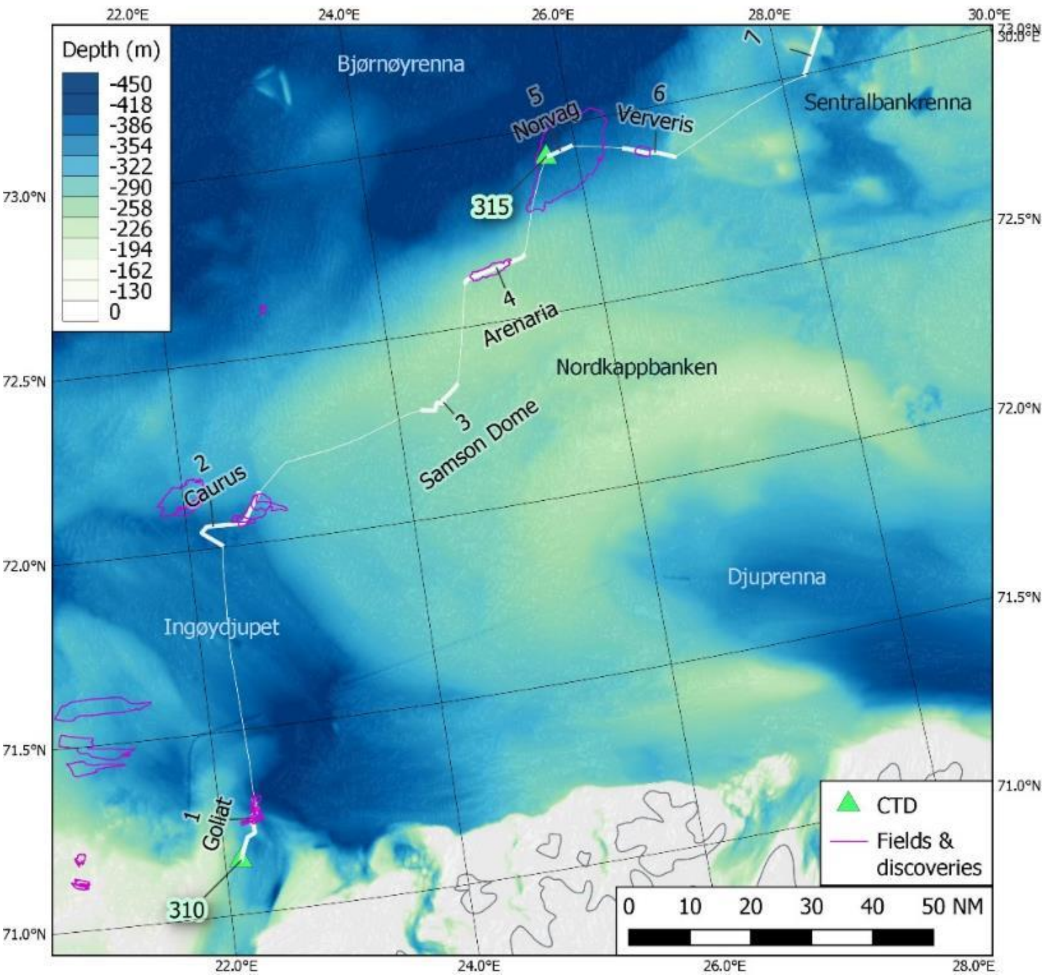


Figure 7: Transit line north over known hydrocarbon reservoirs (purple). Labelled line numbers refer to the line log.

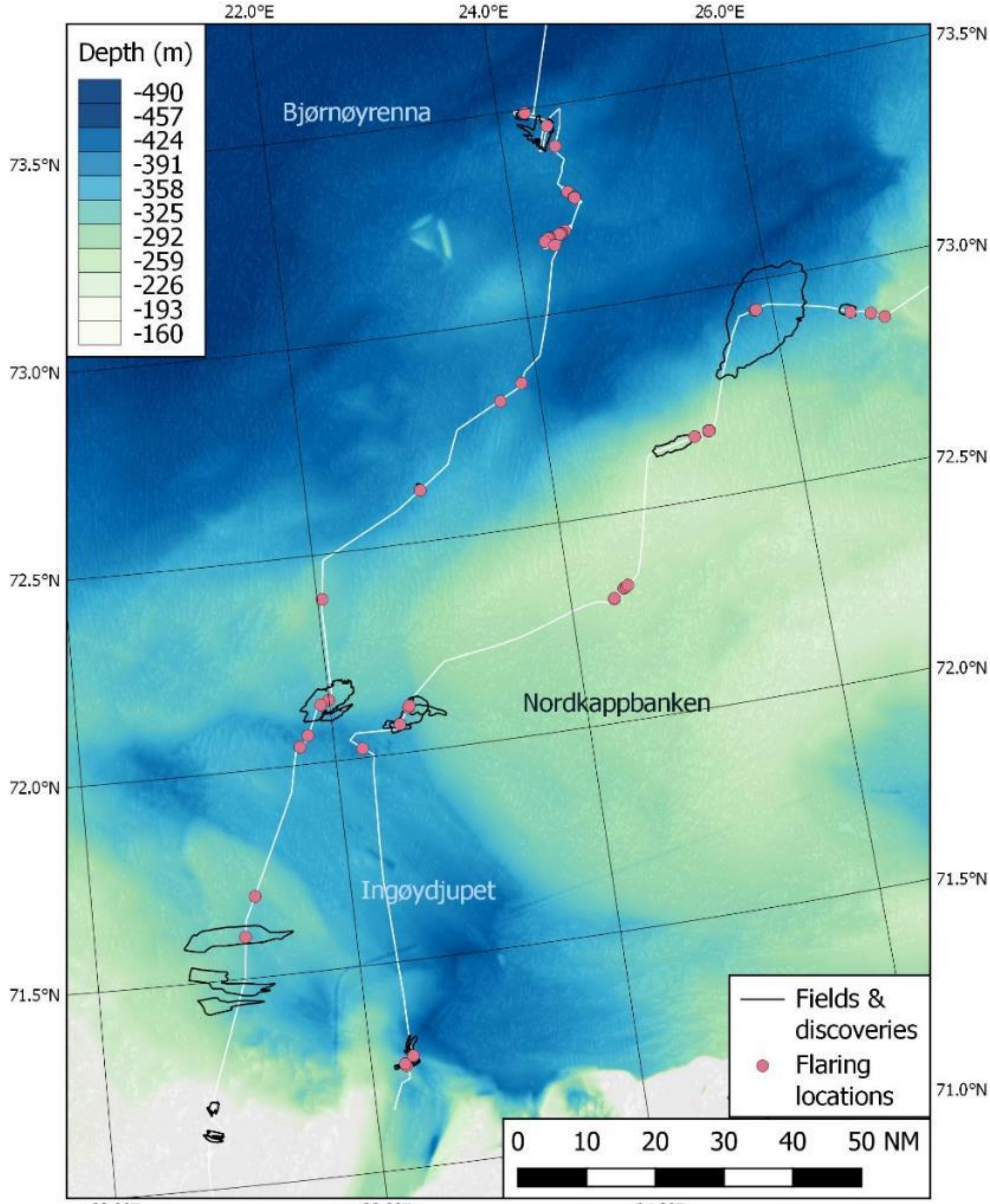


Figure 8: Flaring locations, mostly over known gas/oil discoveries and well heads, around the Ingøydupet and Nordkappbanken region. Specific examples are given in Figure 9 and Figure 10.

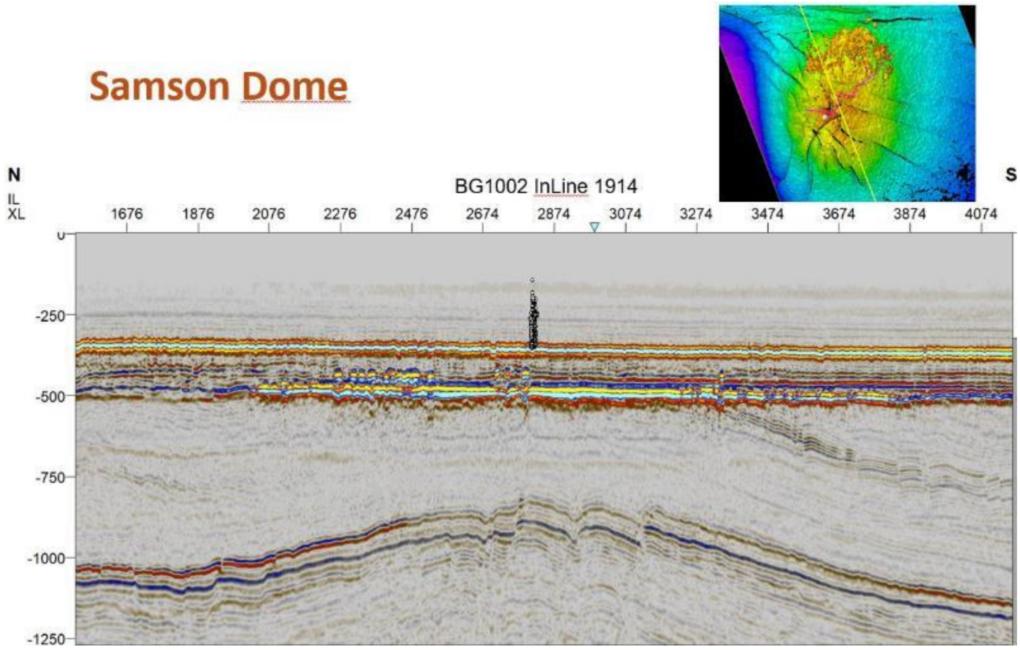


Figure 9: Seismic line overlain with gas flaring observed over the Samson Dome (line 3). Shallow acoustic anomalies indicate the presence of free gas.

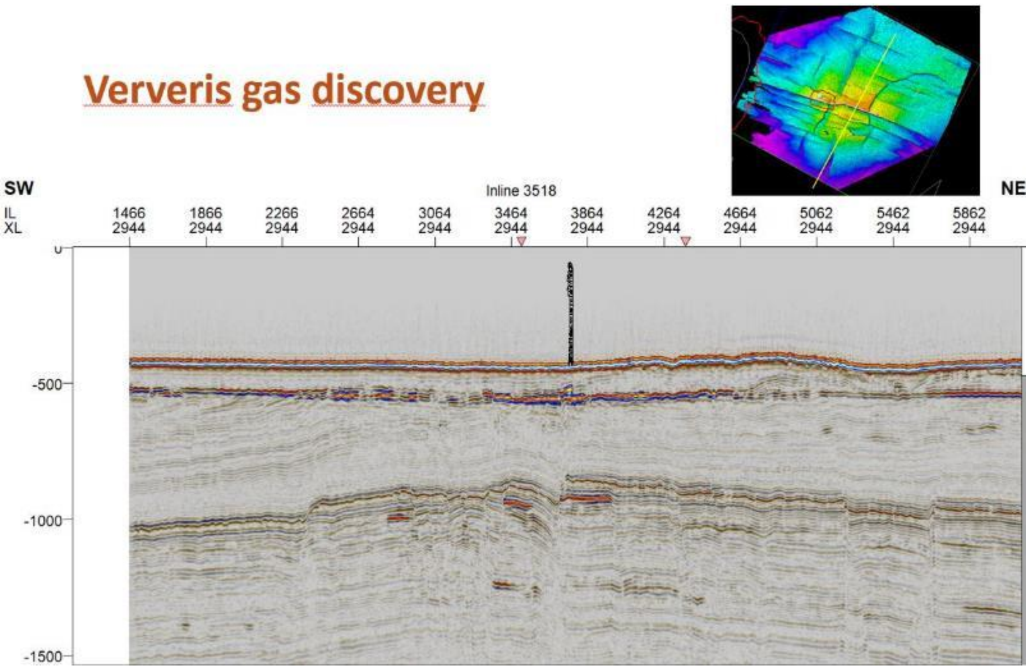


Figure 10: Seismic line overlain with gas flaring observed over the Ververis gas discovery (line 6). Shallow acoustic anomalies indicate the presence of free gas.

5.2. Sentralbankrenna

An overview of multibeam/CHIRP, coring locations and CTD stations that were acquired in Sentralbankrenna is given in Figure 11. More detailed bathymetry collected is shown in subsequent figures. Deviations were made to the pre-planned route in order to survey glacigenic landforms of interest.

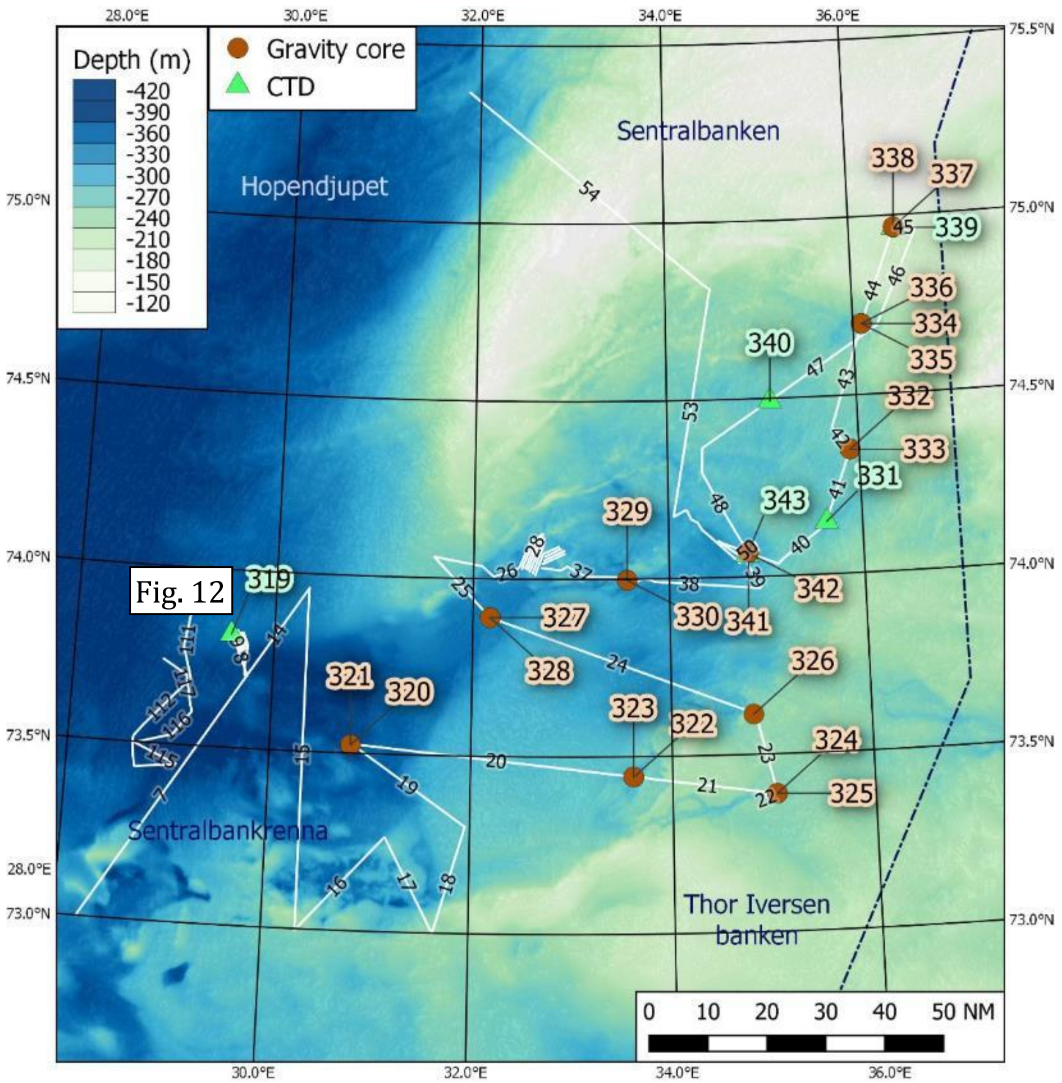


Figure 11: Overview of data collection and ship tracks across Sentralbankrenna. Labelled numbers are logged ship stations and multibeam/CHIRP line numbers.

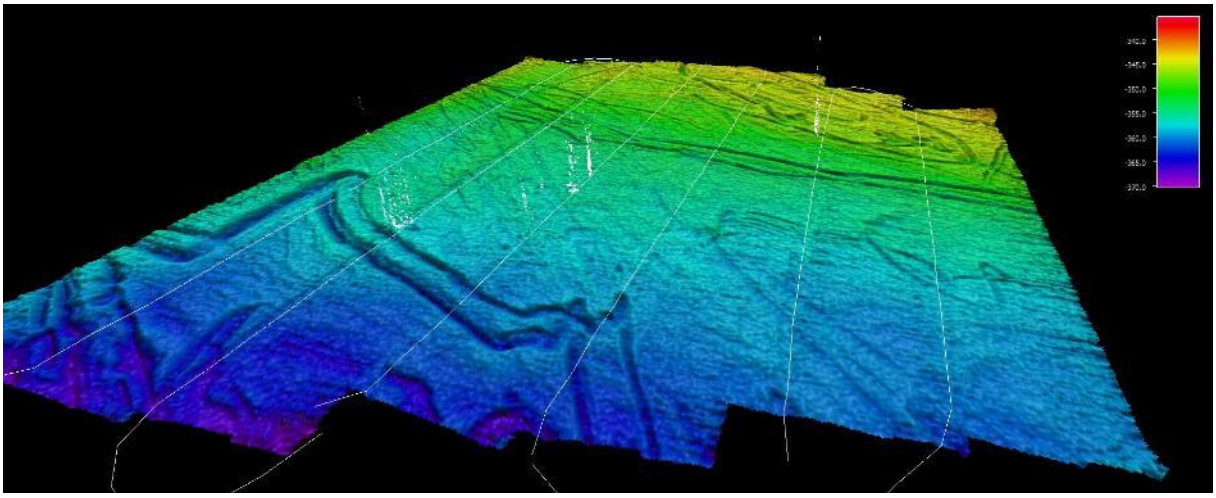


Figure 12: Flaring observed over the central peak of the Mjølnir impact crater, the expression of which is only visible in the subsurface (lines 8-13).

A reconnaissance of the source for the mega iceberg ploughmarks discovered in line 7 was made from the eastern side of Hopendjupet. Further MSGLs and ploughmarks were discovered trending south across the mouth of Sentralbankrenna.

5.3. Hopendjupet Seep Area

Acquisition of data within this area focused on constraining the extent of flaring in relation to subsurface structures, including the outcropping Storbanken High. EM302 water column data provided improved resolution and coverage for mapping flares compared to the singlebeam EK60 echosounder. Across the Hopendjupet Seep Area a total of **4,329** individual flares were identified (e.g., Figure 14-Figure 15).

Opportunistic and smaller, detailed surveys were carried out according to observed subsurface structures and shallow acoustic anomalies, which can indicate the presence of gas leaking at the seafloor. An overview of the geophysical data acquisition is given in Figure 13 and subsequent sub-sections.

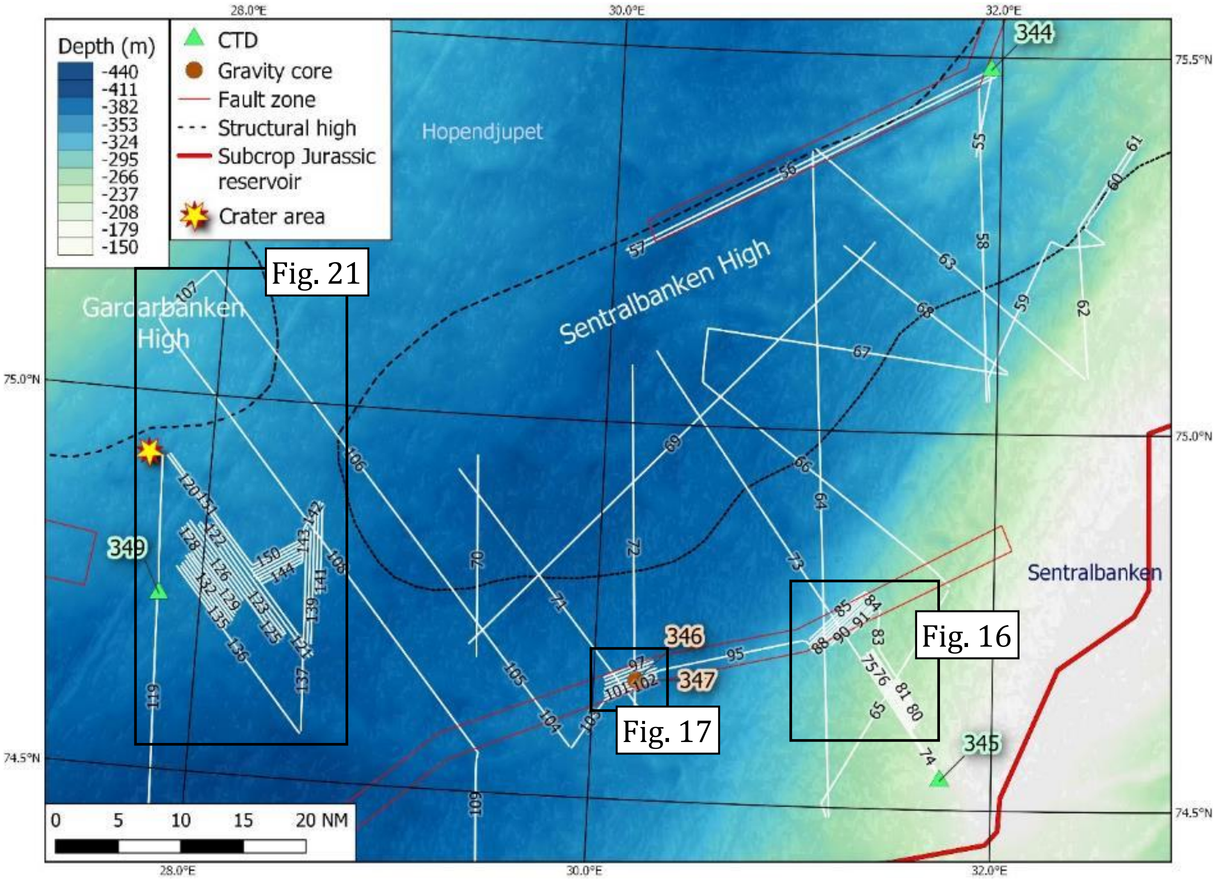


Figure 13: Overview of data acquisition and ship tracks within Hopendjupet. Labelled numbers are logged ship stations and multibeam line numbers.

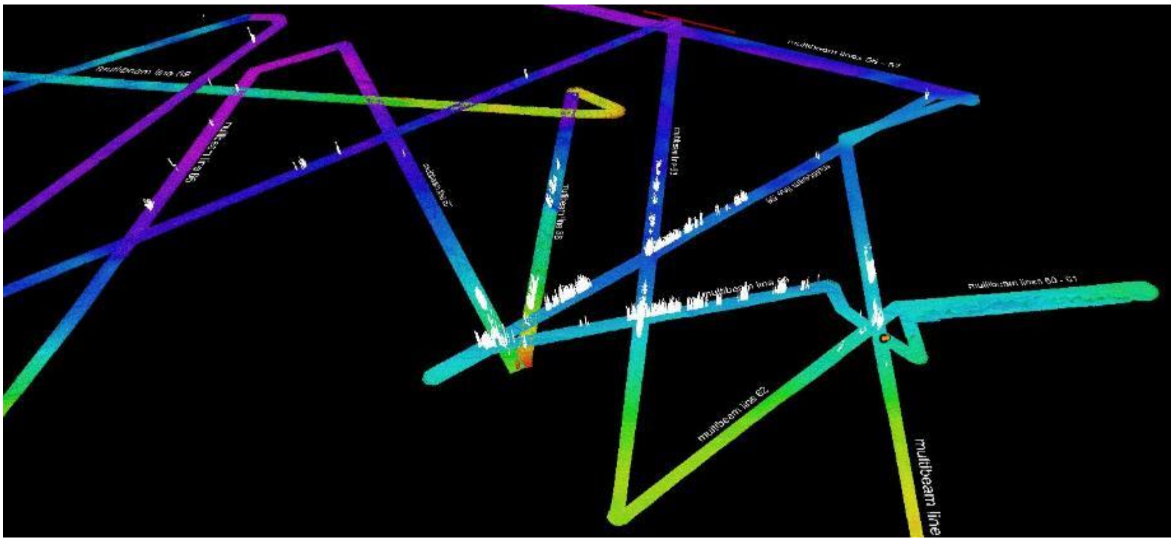


Figure 14: Intense flare activity (white) across eastern Hopendjupet within the area of sub-cropping Triassic reservoir rocks.

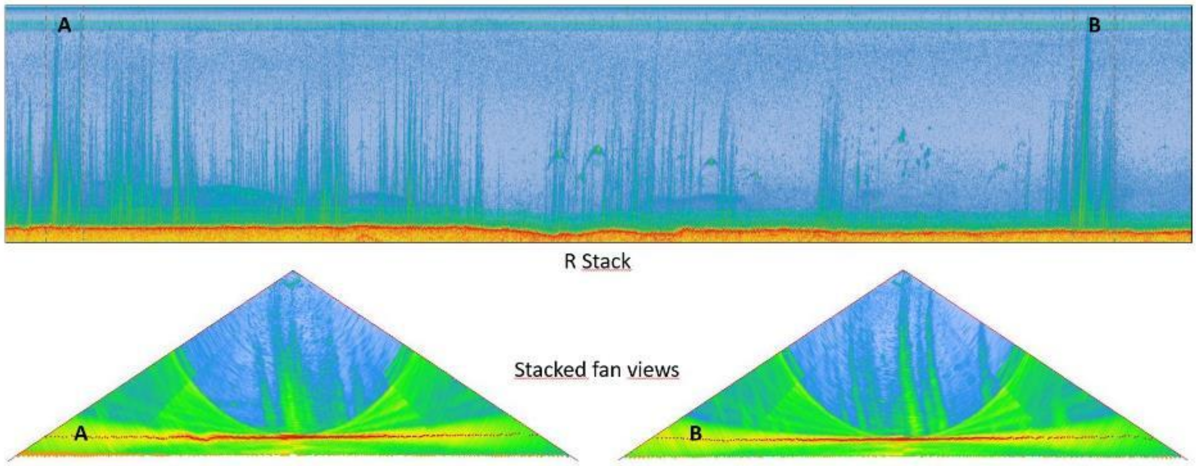


Figure 15: Intense flare activity along line 59, often to the sea-surface.

5.3.1. Eastern Hopendjupet: detailed survey 1

Mounds, which were speculated to be gas-hydrate pingos from Olex data, were revealed to be a 12-km section of a beaded esker within a tunnel valley feeding from Sentralbanken.

5.3.2. Eastern Hopendjupet: detailed surveys 2 & 3

Seismic observations of shallow acoustic anomalies were found related to subsurface structures. Flaring was observed at both sites (Figure 16). Survey 3 relates to a fault zone while survey 2 is adjacent to the sub-cropping Jurassic reservoir rocks.

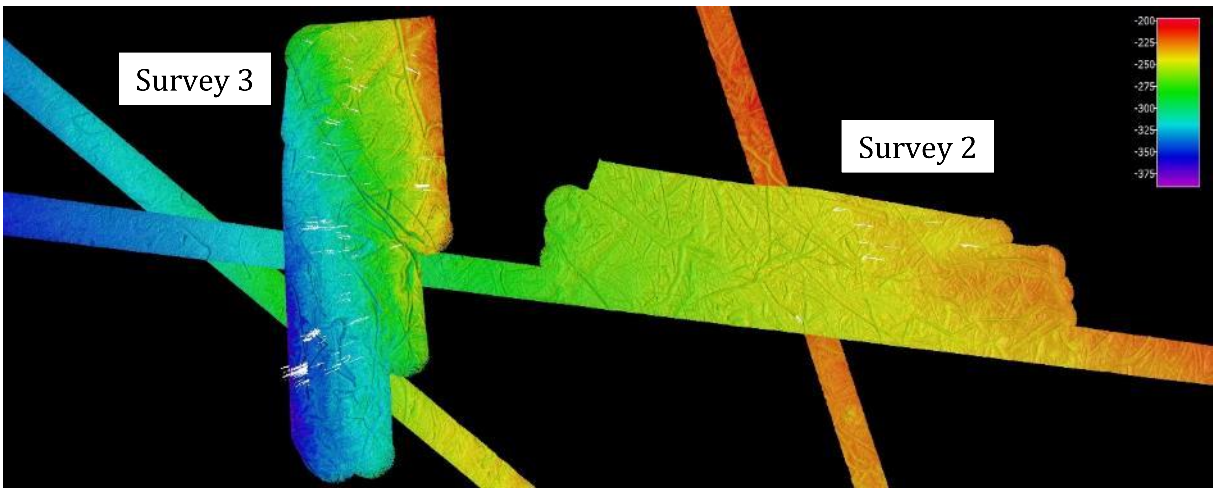


Figure 16: Flaring activity within local survey areas in eastern Hopendjupet

5.3.3. Eastern Hopendjupet: Hopendjupet Pingo Field

Similar observations of shallow acoustic anomalies, which provide impetus for initial exploratory multibeam lines, led to the discovery of a potential gas-hydrate pingo on the eastern flank of Hopendjupet. This area was revisited later to more closely examine this feature and to survey the local area for other potential pingos. A total of c. 10 potential pingos were identified: 7 intensely flaring (often to the sea surface), 2 smaller, flaring pingos, and 1 large pingo structure that was not flaring. Given their prevalence at this location, we refer to this area as the Hopendjupet Pingo Field (Figure 17).

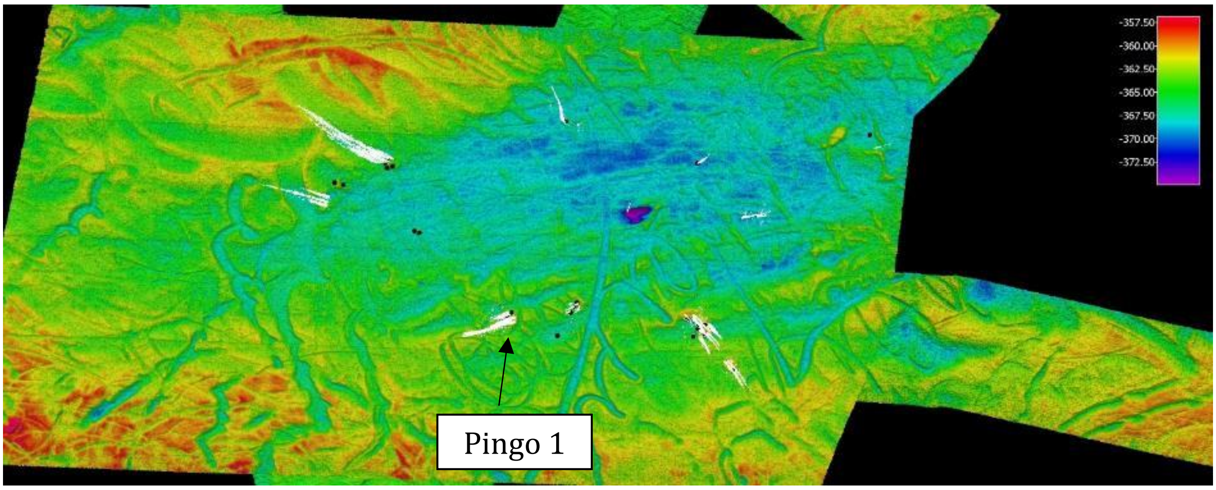


Figure 17: Hopendjupet Pingo Field. Flares (white) were picked from EM302 water column data, with additional flaring activity indicated from outside the fan view by black dots. A gravity core (347) was taken from the summit of Pingo 1.

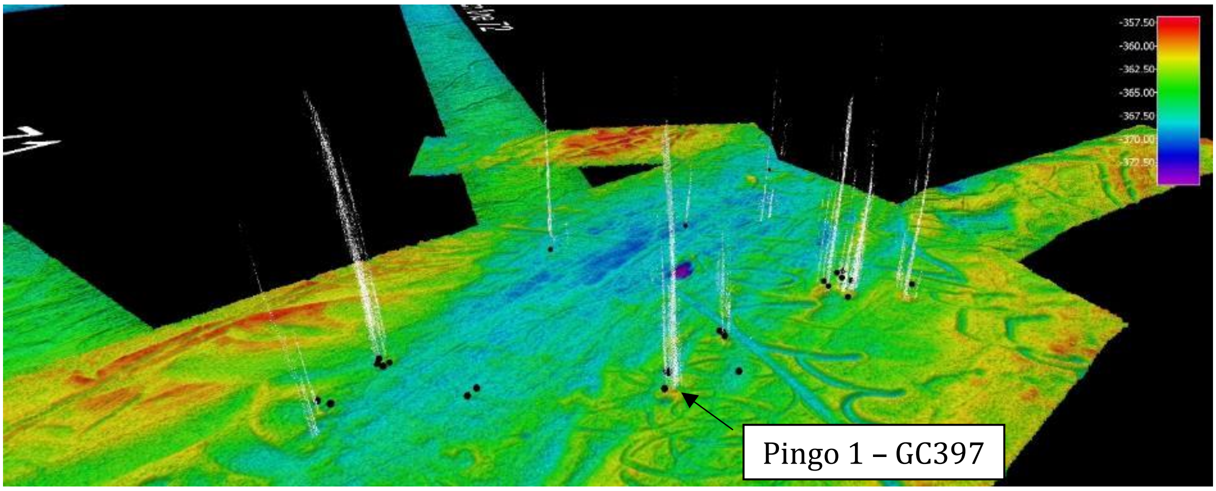
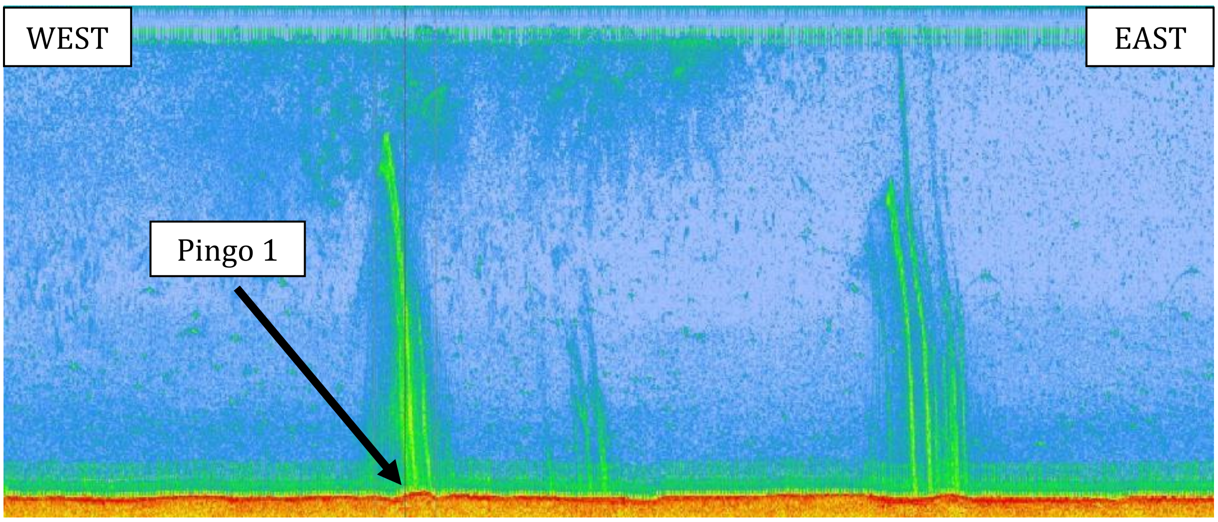


Figure 18: Pingo 1 gravity core location.



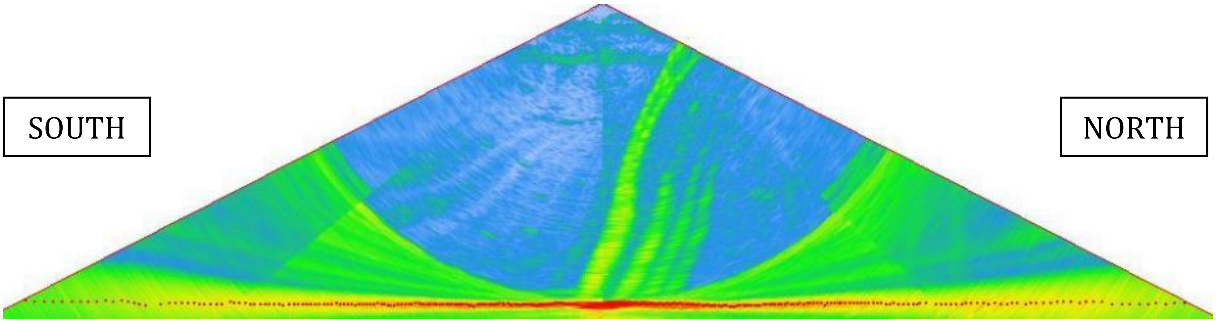


Figure 19: Water column data from a section of line 096 (flipped) over Pingos 1 & 2, at 360 m water depth. A) D stack, and B) Fan view over Pingo 1, showing currents from the south.

A gravity core from the flare on the summit of 'Pingo 1' (Figure 19) revealed an abundance of gas hydrate (Figure 20). Gas samples from the sediment were taken and the base of the core section frozen for further analysis at UiT. A seismic line was attempted, but technical problems in GeoEel, time constraints, and no readily identifiable solution meant we abandoned this data acquisition.

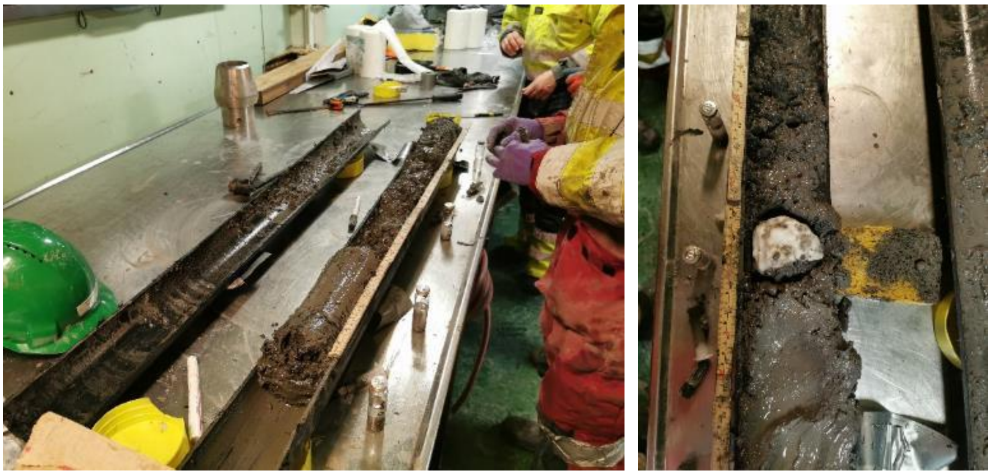


Figure 20: Gravity core 347 with hydrate recovered from Pingo 1 in Hopendjupet Pingo Field. Hydrate was also found at the base of the core. (Photos: H. Patton).

5.3.4. Western Hopendjupet

Western Hopendjupet hosts an area of previously studied methane blowout craters that lie on the western flank of a large anticline (Andreassen et al., 2017). Gas leakage here is associated with fractures and faults which penetrate to the Triassic hydrocarbon source and reservoir rocks directly into the observed craters and mounds. Broad survey lines were carried out here to determine the regional extent of gas flaring in order to identify the potential pinch-out of the gas hydrate stability zone at the seafloor. A subsequent, focussed survey was carried out, with flaring found to be associated with a suspected subsurface sandstone channel (Figure 21).

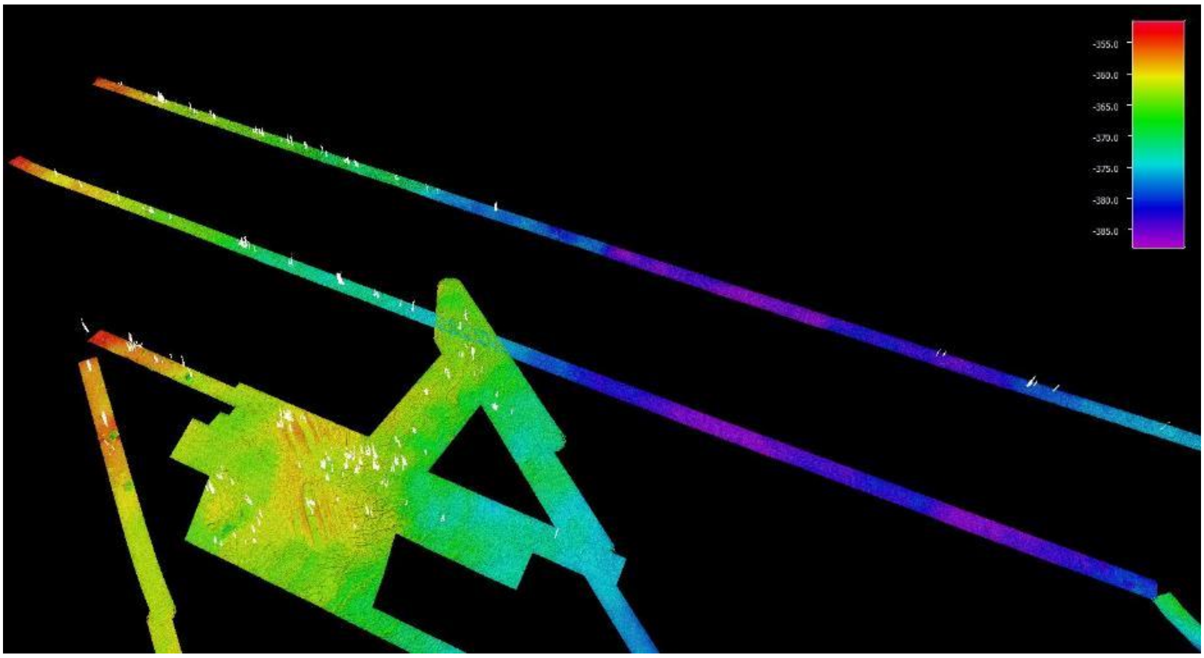


Figure 21: Flaring activity across western Hopendjupet, southeast of the 'old' crater area.

5.4. Transit south through Bjørnøyrenna

As with the transit north, small deviations were made to the route in order to observe potential gas flaring above known hydrocarbon reservoirs (lines 153-178) and seismic observations. These include: the Wisting field (three well heads), Alfa structure, Obesum discovery, Svanefjell discovery, Snøhvit field and Alke discoveries (Figure 8).

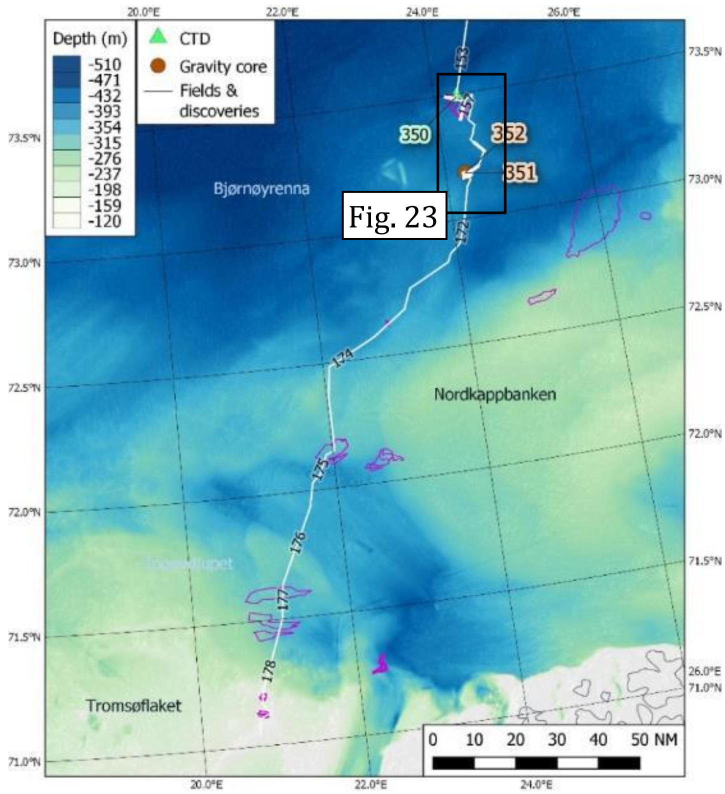


Figure 22: Transit line south via the Maud Basin and known hydrocarbon reservoirs (purple). Labelled line numbers refer to the line log.

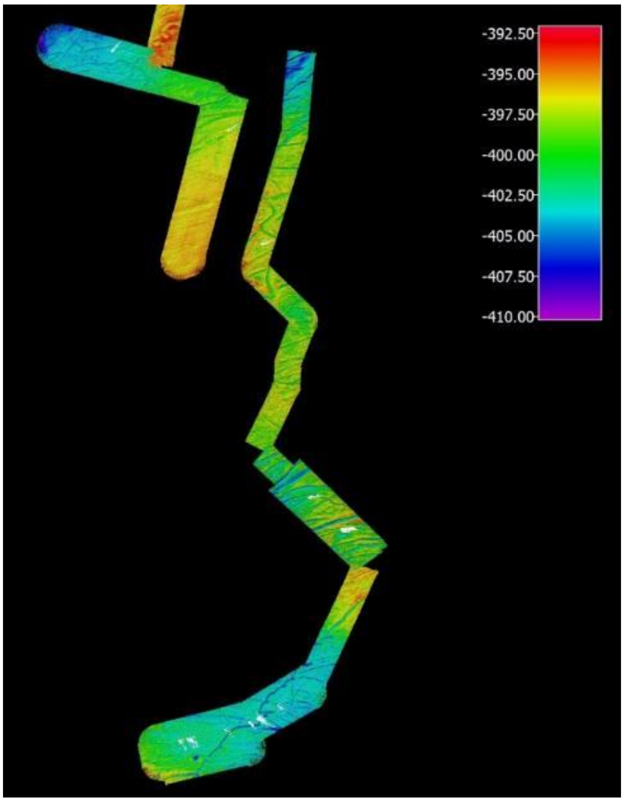


Figure 23: Multibeam coverage from the Wisting area and Maud Basin Pingo area, with areas of flaring (white).

5.4.1. Maud Basin

Pingos discovered in the Maud Basin during the CAGE_16-2 cruise were revisited. Multibeam/water column data was collected over the area prior to gravity coring a pingo at a depth of 403 m (Figure 24). Flaring intensity here was relatively modest compared to previous sites. The first core (station 351) was split on deck. No hydrates were observed, but possible gas conduits were visible. The sediments also contained bivalve shells. This core was frozen on board. A second core (station 352) was recovered at the same position, with flakes of hydrate found in the core-catcher (Figure 25). This core was not split, and stored into the fridge.

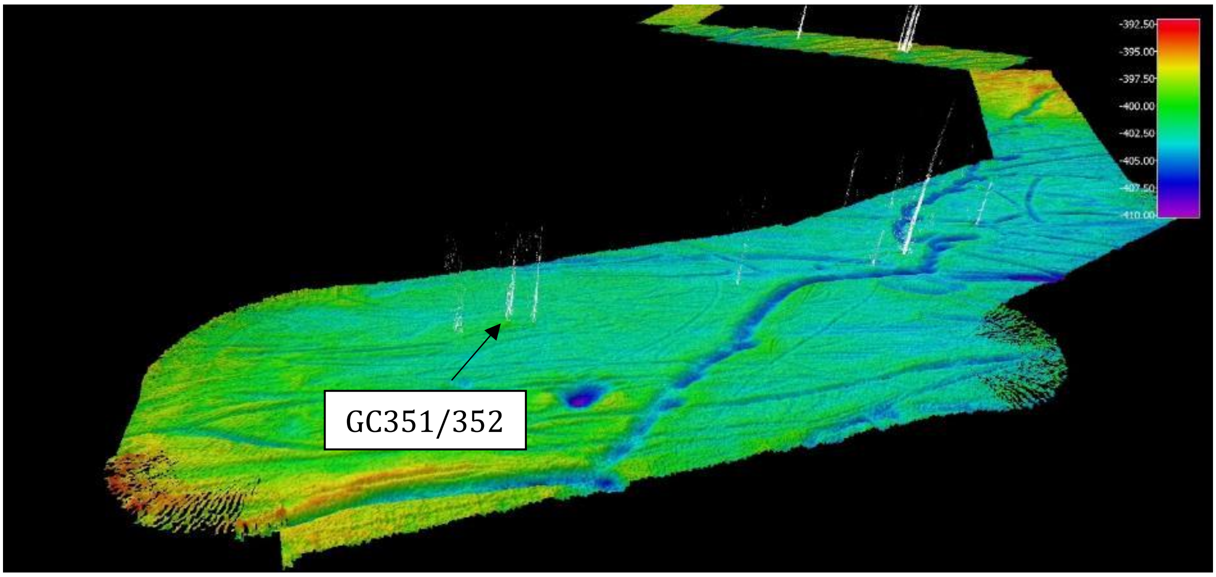


Figure 24: Gravity coring location over the Maud Basin Pingo area.

Figure 25: Hydrate flakes recovered from the core-catcher of GC352 and set alight. (Photo: N. Alexandropoulou).

6. References

Andreassen, K., Hubbard, A., Winsborrow, M., Patton, H., Vadakkepuliyambatta, S., Plaza-Faverola, A., Gudlaugsson, E., Serov, P., Deryabin, A., Mattingsdal, R., Mienert, J., Bünz, S., 2017. Massive blow-out craters formed by hydrate-controlled methane expulsion from the Arctic seafloor. Science 356, 948–953. https://doi.org/10.1126/science.aal4500

7. Logs

7.1. Event log

Date	Time (UTC)	Event
08-07-20	09.30	Departed Tromsø, heading to Goliat field in Ingøydjupet.
08-07-20	20.00	Begin multibeam survey line at Goliat field, station 311, MB-line 0021-0024
08-07-20	23:20	Begin multibeam survey line at Caurus discovery, station 312 MB-line 0033-0038
09-07-20	04:05	Begin multibeam survey line at Samson Dome, station 313 MB-line 0045-0047
09-07-20	06:40	Begin multibeam survey line at Arenaria discovery, station 314 MB-line 0052-0054
09-07-20	10:04	Begin multibeam survey line at Norvag discovery, station 316 MB-line
09-07-20	11:34	Begin multibeam survey line at Ververis discovery, station 317 MB-line 0065-71
09-07-20	14:44	Arrived at Sentralbankrenna, beginning CHIRP/multibeam survey
09-07-20	18:00	Started shifts
09-07-20	21:12	Diverted off line to survey flares over Mjølnir impact crater
10-07-20	21:10	Gravity cores taken from outside GZW of Sentralbankrenna. Good recovery of sediments, each 3.5 m+
11-07-20	05:20	Gravity cores taken from lake basin site 6. Good recovery, 1.6 m and 4.6 m
11-07-20	09:08	3 extra CHIRP lines over lake basin site 10 at 8 knots.
11-07-20	10:45	Coring on Sentralbanken. 2m recovery at station 325, long barrel bent at station 326 in stiff mud. Now using the long backup barrel.
11-07-20	18:54	Coring adjacent to GZW in Sentralbankrenna at site 1. Good recovery: 3.86 and 4.07 m. The second core created a vacuum, and the bolt holding the barrel had to be removed. It could not be reinserted again, so a new bolt is being inserted during transit.
11-07-20	22:35	Added diversion to track a tunnel valley with multibeam swaths outside of the Mareano dataset
12-07-20	07:23	Coring at lake site 7. 30 cm and 0 recovery. Likely due to a hard bottom. Tried surveying over basins further east, but these do not look better for recovery from EK60/chirp. Headed east.
12-07-20	12:00	Did not take cores around site 2 due to hard bed and lack of available sediments in chirp.
12-07-20	17:30	Successful coring at upper Sentralbankrenna GZW of 2-3 m at site 3. Pockmarks in Mareano indicate soft muds.

12-07-20	22:14	Collected 3 cores in upper Sentralbankrenna of around 4 m at site 4. Still pockmarked surface.
13-07-20	02:11	Collected 2 cores in upper Sentralbankrenna of 2 m+ at site 5.
13-07-20	03:30	On survey line southwest, en route to additional site 12.
13-07-20	10:45	After discussion with Mariana we divert south to reattempt coring around site 2.
13-07-20	14:55	Recovered 2m+ cores at site 2, proceeding with local MB swath then transit onto Sentralbanken.
14-07-20	00:15	Begin surveying for flares from Sentralbanken towards eastern central Bjørnøyrenna. CHIRP and EK60 turned off, and ping frequency on EM320 increased from 0.33 to 0.71 in order to increase water column data resolution while also travelling faster at 10 knots.
14-07-20	03:35	Begin first dense swath survey over northern Hopendjupet
14-07-20	11:21	Begin long transit lines to potential pingo area in northeast Hopendjupet, to map extent of flaring in this sector.
14-07-20	17:37	Begin surveying of potential pingo field.
14-07-20	18:30	Leaving area – pingos were in fact a beaded esker. Now surveying long lines south and west to map extent of the intense flaring along the rock outcrop.
15-07-20		Continued long multibeam survey lines to explore the extent of flaring from the outcropping Sentralbanken High in Hopendjupet
16-07-20	06:43	Begin two detailed surveys with large overlap (1.5 x depth) of structurally controlled flaring along eastern flanks of Hopendjupet (line 74 onward).
16-07-20	19:27	Started surveying over discovered 'pingo' site area, first with CHIRP & EK60.
16-07-20	20:14	Attempted two cores over Pingo 1 within the area of gas flaring on top – recovered hydrate on second attempt within c. 1 m of sediments. Zero recovery in first.
16-07-20	21:30	Tried starting up seismic system for 2D and had several problems: 1) IP address of the controller PC was incorrect, this was corrected and the software was then able to start 2) Error message "Eels not responding 1-4" this problem was resolved with several power cycles of the Deck Unit and restarts of Geoeel software 3) All channels were overdriven once system was up and running.
17-07-20	02:20	Started multibeam lines over Hopendjupet pingo field in search for any other similar features.
17-07-20	05:13	Begin long swathes across Hopendjupet surveying for flare activity.
17-07-20	14:42	Bearing south towards Mjølnir impact crater

17-07-20	20:31	Begin tracking ploughmarks/MSGLS in mouth of Sentralbankrenna. CHIRP on.
18-07-20	02:07	Begin transit northwest across Hopendjupet
18-07-20	06:15	Begin reconnaissance lines of gas flaring across western flank of Hopendjupet, crossing into the old crater area. CHIRP off.
18-07-20	11:29	Begin detailed surveying for flare activity on western flank of Hopendjupet.
19-07-20	12:27	End of surveying over western Hopendjupet and beginning of transit south towards the Maud Basin.
19-07-20	22:08	Arrived at the Wisting Area/Maud Basin. CTD winch wire became tangled – possibly due to rust.
20-07-20	22:31	Surveying area for flares and over the pingos mapped in the Maud Basin on CAGE_16-2 cruise
20-07-20	06:00	Gravity coring over flaring pingo in Maud Basin.
20-07-20	07:30	Transit to Tromsø, taking minor deviations to map flare activity over know hydrocarbon discoveries.
20-07-20	12:00	Shifts ended.
21-07-20	10:00	Arrived in Tromsø.
21-07-20	13:00	Cores in the cooling room transported to Fløya storage.

7.2. Station log

Location	Station Id	Date	Time (UTC)	Lat. [N] Long. [E]	Bottles fired [#]	Water Depth [m]	Notes
Ingøydjupet	CAGE20-2-HH-310-CTD	08/07	17:43	71°08.825' 22°07.946'	1	310	
Sentralbankrenna	CAGE20-2-HH-320-GC	10/07	21:10	73°31.350' 30°48.253'	356	372	
Sentralbankrenna	CAGE20-2-HH-321-GC	10/07	22:07	73°31.365' 30°48.212'	364	372	
Sentralbankrenna	CAGE20-2-HH-322-GC	11/07	05:20	73°26.563' 33°36.927'	164	328	Top 5 cm of core became detached, but is in the liner.
Sentralbankrenna	CAGE20-2-HH-323-GC	11/07	06:11	73°26.584' 33°36.673'	458	324	
Sentralbankrenna	CAGE20-2-HH-324-GC	11/07	10:14	73°23.296' 35°01.587'	0	268	Sediments fell out. Try again.

Sentralbankrenna	CAGE20-2-HH-325-GC	11/07	10:45	73°23.300' 35°01.663'	210	267	
Sentralbankrenna	CAGE20-2-HH-326-GC	11/07	12:57	73°36.818' 34°50.243'	53	253	plus 10 cm from the base in an extra core. Barrel was bent
Sentralbankrenna	CAGE20-2-HH-327-GC	11/07	18:54	73°53.469' 32°10.433'	386	343	
Sentralbankrenna	CAGE20-2-HH-328-GC	11/07	19:53	73°53.453' 32°10.360'	407	342	
Sentralbankrenna	CAGE20-2-HH-329-GC	12/07	07:43	73°59.809' 33°34.050'	35	332	
Sentralbankrenna	CAGE20-2-HH-330-GC	12/07	08:32	73°59.779' 33°34.177'	0	333	
Sentralbankrenna	CAGE20-2-HH-331-CTD	12/07	16:04	74°09.029' 35°37.786'	1	286	
Sentralbankrenna	CAGE20-2-HH-332-GC	12/07	17:52	74°20.906' 35°54.441'	220	270	

Sentralbankrenna	CAGE20-2-HH-333-GC	12/07	18:45	74°20.861' 35°54.441'	271	271	
Sentralbankrenna	CAGE20-2-HH-334-GC	12/07	22:14	74°41.951' 36°05.462'	439	269	
Sentralbankrenna	CAGE20-2-HH-335-GC	12/07	22:51	74°41.948' 36°05.384'	392	268	
Sentralbankrenna	CAGE20-2-HH-336-GC	12/07	23:35	74°41.953' 36°05.372'	433	268	
Sentralbankrenna	CAGE20-2-HH-337-GC	13/07	02:11	74°57.912' 36°29.336'	264	192	
Sentralbankrenna	CAGE20-2-HH-338-GC	13/07	02:50	74°57.955' 36°29.369'	220	193	
Sentralbankrenna	CAGE20-2-HH-339-CTD	13/07	03:13	74°57.910' 36°29.207'	1	192	
Sentralbankrenna	CAGE20-2-HH-340-CTD	13/07	08:50	74°29.630' 03°55.278'		273	

Sentralbankrenna	CAGE20-2-HH-341-GC	13/07	13:12	07°44.057' 34°48.833'	265	292	
Sentralbankrenna	CAGE20-2-HH-342-GC	13/07	13:54	74°04.063' 34°48.506'	234	291	
Sentralbankrenna	CAGE20-2-HH-343-CTD	13/07	14:23	74°03.765' 34°48.137'	1	297	
Hopendjupet	CAGE20-2-HH-344-CTD	14/07	04:22	75°29.111' 31°56.541'		328	
Hopendjupet	CAGE20-2-HH-345-CTD	15/07	06:20	74°32.417' 31°44.838'		211	
Hopendjupet	CAGE20-2-HH-346-GC	16/07	20:14	74°39.546' 30°12.750'	0	362	
Hopendjupet	CAGE20-2-HH-347-GC	16/07	20:49	74°39.543' 30°12.735'	122	362	Recovered layers of hydrate, mostly within the lower 50 cm of the core
Hopendjupet	CAGE20-2-HH-348-CTD	17/07	19:01	73°54.740' 29°10.734'		360	

Hopendjupet	CAGE20-2-HH-349-CTD	18/07	07:56	74°43.899' 27°47.380'		360	
Maud Basin	CAGE20-2-HH-350-CTD	19/07	22:08	73°29.285' 24°18.523'		415	Problem with CTD winch
Maud Basin	CAGE20-2-HH-351-GC	20/07	06:22	73°10.970' 24°16.308'	172	404	Bivalves within core, split core on deck -> freezer
Maud Basin	CAGE20-2-HH-352-GC	20/07	07:22	73°11.000' 24°16.367'	190	403	Hydrate flakes within corecatcher -> fridge

7.3. 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)**
Ingøydjupet	CAGE20-2-HH-001-MB	08/07	18:00	07°18.846' 22°08.114'	19:27	71°18.371' 22°18.052'			8
Ingøydjupet	CAGE20-2-HH-002-MB	08/07	23:20	72°00.358' 22°17.537'	01:25	72°08.032' 22°40.243'			8
Ingøydjupet	CAGE20-2-HH-003-MB	09/07	04:05	72°17.766' 24°13.395'	05:11	72°20.904' 24°33.764'			8
Ingøydjupet	CAGE20-2-HH-004-MB	09/07	06:40	72°37.246' 24°47.142'	07:57	72°39.967' 25°21.041'			8
Ingøydjupet	CAGE20-2-HH-005-MB	09/07	10:04	72°55.297' 25°44.463'	10:34	72°56.219' 25°57.398'			8

Ingøydjupet	CAGE20-2-HH-006-MB	09/07	11:34	72°54.225' 26°26.430'	12:30	72°51.288' 26°52.933'			8
Sentralbankrenna	CAGE20-2-HH-007-MB	09/07	12:31	72°59.824' 28°12.203'	21:12	73°42.301' 29°44.666'			8
Sentralbankrenna	CAGE20-2-HH-008-MB	09/07	21:12	73°42.301' 29°44.666'	22:05	73°49.141' 29°34.365'			8
Sentralbankrenna	CAGE20-2-HH-009-MB	09/07	22:39	73°49.391' 29°35.272'	23:04	73°46.348' 29°39.941'			8
Sentralbankrenna	CAGE20-2-HH-010-MB	09/07	23:10	73°46.532' 29°41.115'	23:35	73°49.559' 29°36.575'			8
Sentralbankrenna	CAGE20-2-HH-011-MB	09/07	23:39	73°49.788' 29°37.666'	00:05 +1 day	73°46.761' 29°42.354'			8
Sentralbankrenna	CAGE20-2-HH-012-MB	10/07	00:10	73°47.018' 29°43.721'	00:30	73°49.403' 29°39.767'			8
Sentralbankrenna	CAGE20-2-HH-013-MB	10/07	00:36	73°49.421' 29°41.180'	01:23	73°42.376' 29°43.198'			8

Sentralbankrenna	CAGE20-2-HH-014-MB	10/07	01:28	73°42.505' 29°44.757'	03:40	73°57.536' 30°19.835'			8
Sentralbankrenna	CAGE20-2-HH-015-MB	10/07	03:45	73°56.964' 30°19.778'	10:43	72°59.774' 30°20.000'			8
Sentralbankrenna	CAGE20-2-HH-016-MB	10/07	10:43	72°59.774' 30°20.000'	13:27	73°15.840' 31°10.496'			8
Sentralbankrenna	CAGE20-2-HH-017-MB	10/07	13:27	73°15.840' 31°10.496'	15:38	72°59.988' 31°39.323'			8
Sentralbankrenna	CAGE20-2-HH-018-MB	10/07	15:38	72°59.988' 31°39.323'	17:45	73°18.130' 31°56.844'			8
Sentralbankrenna	CAGE20-2-HH-019-MB	10/07	17:47	73°18.131' 31°56.844'	20:55	73°31.690' 30°48.120'			8
Sentralbankrenna	CAGE20-2-HH-020-MB	10/07	22:18	73°31.690' 30°48.120'	05:00	73°26.583' 33°36.862'			08 to 10
Sentralbankrenna	CAGE20-2-HH-021-MB	11/07	06:35	73°26.745' 33°38.840'	09:05	73°23.170' 03°53.000'			10 to 8

Sentralbankrenna	CAGE20-2-HH-022-MB	11/07	09:08	73°23.015' 03°52.730'	09:59	73°23.219' 03°52.375'			8
Sentralbankrenna	CAGE20-2-HH-023-MB	11/07	11:06	73°23.472' 03°51.847'	12:37	73°36.802' 34°49.166'			
Sentralbankrenna	CAGE20-2-HH-024-MB	11/07	13:30	73°37.324' 34°46.189'	18:54	73°53.470' 32°10.449'			
Sentralbankrenna	CAGE20-2-HH-025-MB	11/07	20:27	73°54.722' 03°26.040'	21:46	74°03.555' 31°35.752'			
Sentralbankrenna	CAGE20-2-HH-026-MB	11/07	21:47	74°03.555' 31°35.752'	23:55	74°06.745' 32°35.583'			
Sentralbankrenna	CAGE20-2-HH-027-MB	11/07	23:58	74°06.331' 32°36.432'	00:30 +1 day	74°01.770' 32°29.619'			
Sentralbankrenna	CAGE20-2-HH-028-MB	12/07	00:35	74°01.888' 32°31.818'	01:12	74°07.209' 32°39.927'			9 to 10
Sentralbankrenna	CAGE20-2-HH-029-MB	12/07	01:18	74°07.404' 32°41.843'	01:58	74°01.619' 32°33.108'			9 to 10

Sentralbankrenna	CAGE20-2-HH-030-MB	12/07	02:04	74°01.464' 32°34.683'	02:40	74°06.857' 32°42.926'			9 to 10
Sentralbankrenna	CAGE20-2-HH-031-MB	12/07	02:51	74°05.323' 32°42.200'	03:20	74°01.094' 32°36.330'			9 to 10
Sentralbankrenna	CAGE20-2-HH-032-MB	12/07	03:32	74°01.055' 32°38.199'	03:53	74°04.310' 32°42.806'			9 to 10
Sentralbankrenna	CAGE20-2-HH-033-MB	12/07	03:55	74°04.443' 32°43.754'	04:11	74°05.428' 32°52.215'			9 to 10
Sentralbankrenna	CAGE20-2-HH-034-MB	12/07	04:16	74°05.046' 32°52.840'	04:33	74°03.871' 32°44.063'			9 to 10
Sentralbankrenna	CAGE20-2-HH-035-MB	12/07	04:40	74°03.306' 32°44.109'	05:01	74°04.761' 32°55.388'			9 to 10
Sentralbankrenna	CAGE20-2-HH-036-MB	12/07	05:07	74°04.195' 32°54.930'	05:31	74°02.579' 32°42.310'			9 to 10
Sentralbankrenna	CAGE20-2-HH-037-MB	12/07	05:38	74°01.894' 32°42.490'	07:15	73°59.664' 33°35.135'			9 to 10

Sentralbankrenna	CAGE20-2-HH-038-MB	12/07	10:03	73°59.110' 34°09.323'	11:53	73°58.313' 34°55.670'			9 to 10
Sentralbankrenna	CAGE20-2-HH-039-MB	12/07	11:56	73°58.628' 34°55.110'	13:15	74°06.089' 34°30.549'			9 to 10
Sentralbankrenna	CAGE20-2-HH-040-MB	12/07	13:17	00°74.060' 34°31.370'	15:36	74°08.333' 35°36.823'			9 to 10
Sentralbankrenna	CAGE20-2-HH-041-MB	12/07	16:08	74°08.960' 35°37.729'	17:28	74°21.258' 35°54.635'			9 to 10
Sentralbankrenna	CAGE20-2-HH-042-MB	12/07	17:28	74°20.880' 35°53.943'	19:44	74°24.830' 35°43.831'			9 to 10
Sentralbankrenna	CAGE20-2-HH-043-MB	12/07	19:47	74°25.250' 35°44.320'	21:58	74°42.184' 03°66.092'			8
Sentralbankrenna	CAGE20-2-HH-044-MB	12/07	23:55	74°42.205' 03°65.955'	02:05 +1 day	74°57.877' 36°29.282'			8
Sentralbankrenna	CAGE20-2-HH-045-MB	13/07	02:05	74°57.837' 36°28.885'	04:09	74°57.475' 36°43.300'			9 to10

Sentralbankrenna	CAGE20-2-HH-046-MB	13/07	04:12	74°57.475' 36°43.300'	06:11	74°41.580' 36°15.192'			9 to 10
Sentralbankrenna	CAGE20-2-HH-047-MB	13/07	06:11	74°41.580' 36°15.192'	10:45	74°21.959' 34°22.215'			10
Sentralbankrenna	CAGE20-2-HH-048-MB	13/07	10:45	74°21.959' 34°22.215'	12:50	74°03.849' 34°49.315'			10
Sentralbankrenna	CAGE20-2-HH-049-MB	13/07	14:55	07°43.873' 34°48.861'	15:12	74°05.397' 34°53.970'			8
Sentralbankrenna	CAGE20-2-HH-050-MB	13/07	15:15	74°05.702' 34°53.100'	15:40	74°03.334' 34°42.526'			8
Sentralbankrenna	CAGE20-2-HH-051-MB	13/07	15:47	74°03.012' 34°43.790'	16:10	74°04.806' 34°43.502'			8
Sentralbankrenna	CAGE20-2-HH-052-MB	13/07	16:17	07°44.325' 34°55.021'	16:44	74°02.472' 34°43.515'			8
Sentralbankrenna	CAGE20-2-HH-053-MB	13/07	16:46	07°42.555' 34°42.444'	22:14	74°47.950' 34°28.306'		0.33	10

Sentralbanken	CAGE20-2-HH-054-MB	14/07	22:14	74°48.878' 34°27.770'	03.33.00 +1 day	75°22.261' 31°52.213'		0.77	10
Hopendjupet	CAGE20-2-HH-055-MB	14/07	03:34	75°22.261' 31°52.213'	04:25	75°29.066' 31°56.401'			10
Hopendjupet	CAGE20-2-HH-056-MB	14/07	04:47	75°29.066' 31°56.401'	08:05	75°13.663' 03°03.499'			10
Hopendjupet	CAGE20-2-HH-057-MB	14/07	08:08	75°13.577' 30°05.350'	11:18	75°28.777' 31°52.408'			10
Hopendjupet	CAGE20-2-HH-058-MB	14/07	11:21	75°28.443' 31°57.625'	13:59	07°52.480' 31°57.237'			10
Hopendjupet	CAGE20-2-HH-059-MB	14/07	14:01	07°52.663' 31°57.640'	16:12	75°16.483' 32°26.570'			10
Hopendjupet	CAGE20-2-HH-060-MB	14/07	16:30	75°16.605' 32°26.754'	17:31	75°23.543' 32°44.302'			8 to 10
Hopendjupet	CAGE20-2-HH-061-MB	14/07	17:37	75°23.871' 32°43.020'	18:30	75°16.237' 32°24.698'			10

Hopendjupet	CAGE20-2-HH-062-MB	14/07	18:30	75°16.237' 32°24.698'	19:38	75°04.569' 32°27.960'			10
Hopendjupet	CAGE20-2-HH-063-MB	14/07	19:42	75°04.514' 32°26.879'	22:32	75°22.370' 31°01.649'			10
Hopendjupet	CAGE20-2-HH-064-MB	14/07	22:35	75°22.175' 31°00.691'	03:48 +1 day	74°29.147' 31°11.117'			10
Hopendjupet	CAGE20-2-HH-065-MB	15/07	03:49	74°29.147' 31°11.117'	06:04	74°48.062' 31°46.510'			10
Hopendjupet	CAGE20-2-HH-066-MB	15/07	06:06	74°47.928' 31°46.123'	09:13	75°07.728' 30°29.967'			10
Hopendjupet	CAGE20-2-HH-067-MB	15/07	09:14	75°07.347' 30°30.250'	11:37	75°04.798' 32°02.774'			10
Hopendjupet	CAGE20-2-HH-068-MB	15/07	11:40	75°04.994' 32°02.935'	13:20	75°14.745' 31°11.376'			10
Hopendjupet	CAGE20-2-HH-069-MB	15/07	14:40	75°15.216' 31°21.427'	18:15	75°41.731' 29°21.875'			10

Hopendjupet	CAGE20-2-HH-070-MB	15/07	18:25	74°40.850' 29°24.411'	20:00	74°56.821' 29°21.160'			10
Hopendjupet	CAGE20-2-HH-071-MB	15/07	20:15	74°55.540' 29°15.793'	22:50	73°35.840' 30°18.757'			10
Hopendjupet	CAGE20-2-HH-072-MB	15/07	23:02	74°35.610' 30°13.180'	02:03 +1 day	75°04.838' 30°07.712'			10
Hopendjupet	CAGE20-2-HH-073-MB	16/07	02:16	75°04.838' 30°07.712'	06:26	74°32.548' 31°44.785'			10
Hopendjupet	CAGE20-2-HH-074-MB	16/07	06:43	74°33.030' 31°44.191'	07:53	74°42.045' 31°20.718'			10
Hopendjupet	CAGE20-2-HH-075-MB	16/07	07:57	74°42.075' 31°21.620'	08:38	74°36.450' 31°36.161'			10
Hopendjupet	CAGE20-2-HH-076-MB	16/07	08:42	74°36.637' 31°36.504'	09:23	74°42.170' 31°22.417'			10
Hopendjupet	CAGE20-2-HH-077-MB	16/07	09:28	74°42.379' 31°22.661'	10:08	74°36.718' 31°37.096'			10

Hopendjupet	CAGE20-2-HH-078-MB	16/07	10:13	74°36.999' 31°37.156'	10:54	74°42.684' 31°22.918'			10
Hopendjupet	CAGE20-2-HH-079-MB	16/07	10:56	74°42.594' 31°23.808'	11:36	74°37.031' 31°37.873'			10
Hopendjupet	CAGE20-2-HH-080-MB	16/07	11:40	74°37.263' 31°38.095'	12:02	74°40.280' 31°30.668'			10
Hopendjupet	CAGE20-2-HH-081-MB	16/07	12:05	74°40.153' 31°31.542'	12:21	74°37.865' 31°37.210'			10
Hopendjupet	CAGE20-2-HH-082-MB	16/07	12:24	74°38.050' 31°37.397'	12:58	74°42.770' 31°25.540'			10
Hopendjupet	CAGE20-2-HH-083-MB	16/07	12:58	74°42.770' 31°25.540'	13:18	74°46.010' 31°24.720'			10
Hopendjupet	CAGE20-2-HH-084-MB	16/07	13:18	74°46.010' 31°24.720'	00:13	74°46.910' 31°19.060'			10
Hopendjupet	CAGE20-2-HH-085-MB	16/07	13:31.00	74°46.910' 31°19.060'	14:03	74°43.286' 31°04.256'			10

Hopendjupet	CAGE20-2-HH-086-MB	16/07	14:09	74°42.824' 31°05.257'	14:42	74°46.790' 31°20.648'			10
Hopendjupet	CAGE20-2-HH-087-MB	16/07	14:45	74°46.447' 31°19.870'	15:19	74°42.486' 31°05.461'			10
Hopendjupet	CAGE20-2-HH-088-MB	16/07	15:21	74°42.395' 31°06.057'	00:15	74°46.470' 31°21.923'			10
Hopendjupet	CAGE20-2-HH-089-MB	16/07	15:56	74°46.195' 31°21.523'	16:22	74°43.096' 31°10.826'			10
Hopendjupet	CAGE20-2-HH-090-MB	16/07	16:24	74°42.998' 31°11.461'	16:49	74°46.167' 31°22.805'			10
Hopendjupet	CAGE20-2-HH-091-MB	16/07	16:52	74°45.856' 31°22.733'	17:06	74°44.125' 31°16.639'			10
Hopendjupet	CAGE20-2-HH-092-MB	16/07	17:09	74°44.027' 31°17.614'	17:26	74°46.165' 31°25.259'			10
Hopendjupet	CAGE20-2-HH-093-MB	16/07	17:28	74°46.379' 31°24.775'	17:36	74°47.256' 31°21.043'			10

Hopendjupet	CAGE20-2-HH-094-MB	16/07	17:37	74°47.191' 31°20.622'	17:14::00	74°43.018' 31°04.750'			10
Hopendjupet	CAGE20-2-HH-095-MB	16/07	17:14	74°43.018' 31°04.750'	19:27	74°40.418' 30°19.985'			10
Hopendjupet	CAGE20-2-HH-096-MB	16/07	19:27	74°40.418' 30°19.985'	19:46	74°39.338' 03°01.759'			8
Hopendjupet	CAGE20-2-HH-097-MB	17/07	01:02	74°42.019' 03°09.700'	02:18	74°41.100' 30°17.841'			10
Hopendjupet	CAGE20-2-HH-098-MB	17/07	02:22	74°40.717' 30°16.940'	02:46	74°38.980' 30°02.935'			10
Hopendjupet	CAGE20-2-HH-099-MB	17/07	02:50	74°39.782' 30°03.876'	03:20	74°40.153' 30°17.417'			10
Hopendjupet	CAGE20-2-HH-100-MB	17/07	03:20	74°40.153' 30°17.417'	03:45	74°38.392' 30°03.400'			10
Hopendjupet	CAGE20-2-HH-101-MB	17/07	03:48	74°38.220' 30°04.145'	04:14	74°40.033' 30°19.040'			10

Hopendjupet	CAGE20-2-HH-102-MB	17/07	04:17	74°39.762' 30°18.610'	04:43	74°37.911' 30°03.880'			10
Hopendjupet	CAGE20-2-HH-103-MB	17/07	04:43	74°37.911' 30°03.880'	05:14	74°40.048' 30°18.805'			10
Hopendjupet	CAGE20-2-HH-104-MB	17/07	05:14	74°39.785' 30°19.785'	05:43	74°37.918' 03°03.972'			10
Hopendjupet	CAGE20-2-HH-105-MB	17/07	05:43	74°37.918' 03°03.972'	06:11	74°33.920' 29°54.240'			10
Hopendjupet	CAGE20-2-HH-106-MB	17/07	06:13	74°33.981' 29°53.863'	09:54	07°59.938' 27°55.630'			10
Hopendjupet	CAGE20-2-HH-107-MB	17/07	09:54	07°59.938' 27°55.630'	10:30	07°55.773' 27°40.073'			10
Hopendjupet	CAGE20-2-HH-108-MB	17/07	10:31	07°55.773' 27°40.073'	14:42	74°33.130' 29°26.559'			10
Hopendjupet	CAGE20-2-HH-109-MB	17/07	14:43	74°33.130' 29°26.559'	16:33	74°14.472' 29°30.749'			10
Hopendjupet	CAGE20-2-HH-110-MB	17/07	16:33	74°14.472' 29°30.749'	18:43	73°54.856' 29°10.329'			10

Hopendjupet	CAGE20-2-HH-111-MB	17/07	19:06	73°54.584' 29°10.368'	20:28	73°41.341' 29°10.945'			10
Sentralbankrenna	CAGE20-2-HH-112-MB	17/07	20:31	73°40.932' 02°99.861'	21:48	73°30.973' 28°39.000'			10
Sentralbankrenna	CAGE20-2-HH-113-MB	17/07	21:49	73°30.973' 28°39.000'	22:20	73°25.900' 28°40.669'			10
Sentralbankrenna	CAGE20-2-HH-114-MB	17/07	22:20	73°25.900' 28°40.669'	23:03	73°26.587' 29°05.139'			10
Sentralbankrenna	CAGE20-2-HH-115-MB	17/07	23:04	73°26.668' 02°95.067'	23:52	73°29.873' 28°39.727'			10
Sentralbankrenna	CAGE20-2-HH-116-MB	17/07	23:55	73°29.944' 02°84.069'	01:06 +1 day	73°35.620' 29°12.500'			10
Sentralbankrenna	CAGE20-2-HH-117-MB	18/07	01:06	73°36.030' 29°12.332'	02:06	73°44.380'			11
Sentralbankrenna	CAGE20-2-HH-118-MB	18/07	02:07	73°44.568'	06:15	74°26.989' 27°49.971'			11
Hopendjupet	CAGE20-2-HH-119-MB	18/07	06:15	74°26.989' 27°49.971'	09:22	74°54.856' 27°44.952'			10

Hopendjupet	CAGE20-2-HH-120-MB	18/07	09:26	74°54.884' 27°46.556'	11:24	74°40.032' 28°35.138'			10
Hopendjupet	CAGE20-2-HH-121-MB	18/07	11:29	74°39.824' 28°34.114'	12:47	74°49.808' 28°01.573'			9 to 10
Hopendjupet	CAGE20-2-HH-122-MB	18/07	12:51	74°49.574' 28°00.715'	13:56	74°41.516' 28°26.429'			9 to 10
Hopendjupet	CAGE20-2-HH-123-MB	18/07	13:58	74°41.462' 28°25.788'	15:09	74°49.780' 27°57.788'			9 to 10
Hopendjupet	CAGE20-2-HH-124-MB	18/07	15:11	74°49.525' 27°57.945'	16:17	74°41.002' 28°25.296'			9 to 10
Hopendjupet	CAGE20-2-HH-125-MB	18/07	16:21	74°40.850' 28°24.303'	17:36	74°49.906' 27°54.827'			9 to 10
Hopendjupet	CAGE20-2-HH-126-MB	18/07	17:39	74°49.626' 27°54.352'	18:25	74°43.870' 28°13.093'			10
Hopendjupet	CAGE20-2-HH-127-MB	18/07	18:30	74°43.778' 28°11.829'	19:15	74°49.331' 27°53.761'			10
Hopendjupet	CAGE20-2-HH-128-MB	18/07	19:17	74°49.161' 27°52.976'	20:04	74°43.280' 28°12.157'			10

Hopendjupet	CAGE20-2- HH-129-MB	18/07	20:08	74°43.160' 28°11.312'	20:43	74°47.713' 27°56.443'			10
Hopendjupet	CAGE20-2- HH-130-MB	18/07	20:48	74°47.233' 27°56.505'	21:24	74°42.882' 28°10.883'			10
Hopendjupet	CAGE20-2- HH-131-MB	18/07	21:27	74°42.682' 28°10.271'	22:03	74°47.252' 27°55.377'			10
Hopendjupet	CAGE20-2- HH-132-MB	18/07	22:06	74°47.050' 27°54.777'	22:44	74°42.246' 28°10.236'			10
Hopendjupet	CAGE20-2- HH-133-MB	18/07	22:47	74°42.310' 28°08.922'	23:22	74°46.694' 27°54.489'			10
Hopendjupet	CAGE20-2- HH-134-MB	18/07	23:26	74°46.423' 27°53.962'	00:01 +1 day	74°41.953' 28°08.666'			10
Hopendjupet	CAGE20-2- HH-135-MB	19/07	00:04	74°41.687' 28°08.330'	00:40	74°46.190' 27°53.501'			10
Hopendjupet	CAGE20-2- HH-136-MB	19/07	00:43	74°46.061' 27°52.653'	02:18	74°33.781' 28°33.316'			10.5
Hopendjupet	CAGE20-2- HH-137-MB	19/07	02:20	74°34.046' 28°33.337'	03:55	74°50.132' 28°30.990'			10.5

Hopendjupet	CAGE20-2-HH-138-MB	19/07	03:59	74°49.676' 28°31.881'	04:51	74°40.890' 28°33.357'			10
Hopendjupet	CAGE20-2-HH-139-MB	19/07	04:55	74°40.976' 28°34.411'	05:56	74°51.311' 28°32.685'			10
Hopendjupet	CAGE20-2-HH-140-MB	19/07	06:00	74°51.241' 28°33.676'	06:38	74°44.795' 28°34.898'			10
Hopendjupet	CAGE20-2-HH-141-MB	19/07	06:43	74°44.960' 28°36.047'	07:25	74°52.093' 28°34.828'			10
Hopendjupet	CAGE20-2-HH-142-MB	19/07	07:27	74°52.080' 28°33.638'	07:41	74°50.006' 28°29.714'			10
Hopendjupet	CAGE20-2-HH-143-MB	19/07	07:42	74°49.897' 28°30.176'	07:57	74°47.367' 28°29.975'			10
Hopendjupet	CAGE20-2-HH-144-MB	19/07	07:58	74°47.231' 28°29.586'	08:19	74°45.307' 28°18.122'			10
Hopendjupet	CAGE20-2-HH-145-MB	19/07	08:23	74°45.562' 28°17.566'	08:46	74°47.622' 28°30.040'			10
Hopendjupet	CAGE20-2-HH-146-MB	19/07	08:49	74°47.836' 28°29.405'	09:14	74°45.703' 28°16.513'			10

Hopendjupet	CAGE20-2-HH-147-MB	19/07	09:17	74°45.929' 28°15.870'	09:43	74°48.257' 28°29.935'			10
Hopendjupet	CAGE20-2-HH-148-MB	19/07	09:46	74°48.478' 28°29.230'	10:12	74°46.135' 28°15.260'			10
Hopendjupet	CAGE20-2-HH-149-MB	19/07	10:17	74°46.471' 28°15.293'	10:44	74°48.881' 28°29.864'			10
Hopendjupet	CAGE20-2-HH-150-MB	19/07	10:47	74°49.073' 28°29.158'	11:14	74°46.786' 28°15.148'			10
Hopendjupet	CAGE20-2-HH-151-MB	19/07	11:15	74°46.873' 28°14.501'	12:20	74°55.075' 27°47.165'			10
Hopendjupet	CAGE20-2-HH-152-MB	19/07	12:27	74°54.810' 27°43.032'	20:05	73°49.218' 24°40.319'			10 to 12
Hopendjupet	CAGE20-2-HH-153-MB	19/07	20:05	73°49.218' 24°40.319'	22:05	73°29.215' 24°18.458'			10 to 11
Maud Basin	CAGE20-2-HH-154-MB	19/07	22:37	73°29.028' 24°18.127'	22:52	73°29.942' 24°09.420'			10
Maud Basin	CAGE20-2-HH-155-MB	19/07	22:56	73°29.509' 24°08.977'	23:21	73°28.061' 24°23.337'			10

Maud Basin	CAGE20-2-HH-156-MB	19/07	23:22	73°27.876' 24°23.422'	23:48	73°23.834' 24°18.475'			10
Maud Basin	CAGE20-2-HH-157-MB	19/07	23:52	73°23.760' 24°20.059'	00:32 +1 day	73°29.045' 24°31.827'			10
Maud Basin	CAGE20-2-HH-158-MB	20/07	00:32	73°29.045' 24°31.827'	01:08	73°23.464' 24°25.827'			10
Maud Basin	CAGE20-2-HH-159-MB	20/07	01:09	73°23.236' 24°26.278'	01:19	73°21.868' 24°30.019'			10
Maud Basin	CAGE20-2-HH-160-MB	20/07	01:20	73°21.777' 24°29.834'	01:41	73°18.597' 24°24.854'			10
Maud Basin	CAGE20-2-HH-161-MB	20/07	01:43	73°18.446' 24°25.322'	02:06	73°15.394' 24°34.775'			10
Maud Basin	CAGE20-2-HH-162-MB	20/07	02:09	73°15.568' 24°35.131'	02:28	73°18.004' 24°27.673'			10
Maud Basin	CAGE20-2-HH-163-MB	20/07	02:32	73°17.652' 24°26.821'	02:50	73°15.335' 24°34.111'			10
Maud Basin	CAGE20-2-HH-164-MB	20/07	02:51	73°15.202' 24°34.003'	03:11	73°12.152' 24°28.093'			10

Maud Basin	CAGE20-2-HH-165-MB	20/07	03:12	73°12.070' 24°27.561'	03:38	73°10.822' 24°13.835'			10
Maud Basin	CAGE20-2-HH-166-MB	20/07	03:40	73°10.622' 24°14.387'	04:05	73°11.981' 24°28.329'			10
Maud Basin	CAGE20-2-HH-167-MB	20/07	04:08	73°12.324' 24°27.723'	04:34	73°11.017' 24°13.408'			10
Maud Basin	CAGE20-2-HH-168-MB	20/07	04:40	73°10.343' 24°14.516'	04:53	73°10.793' 24°21.950'			10
Maud Basin	CAGE20-2-HH-169-MB	20/07	04:56	73°10.527' 24°21.754'	05:10	73°10.131' 24°13.709'			10
Maud Basin	CAGE20-2-HH-170-MB	20/07	05:12	73°09.966' 24°14.043'	05:25	73°10.299' 24°21.141'			10
Maud Basin	CAGE20-2-HH-171-MB	20/07	05:28	73°09.977' 24°20.783'	05:40	73°09.582' 24°13.697'			10
Maud Basin	CAGE20-2-HH-172-MB	20/07	07:45	73°10.810' 24°17.297'	11:11	72°45.348' 23°17.450'			10
Ingøydjupet	CAGE20-2-HH-173-MB	20/07	11:11	72°45.348' 23°17.450'	11:43	72°40.489' 23°10.004'			10

Ingøydjupet	CAGE20-2-HH-174-MB	20/07	11:43	72°40.489' 23°10.004'	16:04	72°08.906' 02°20.642'			10
Ingøydjupet	CAGE20-2-HH-175-MB	20/07	16:04	72°08.906' 02°20.642'	17:38	71°56.181' 21°37.541'			10

8. Appendix

8.1. R/V Helmer Hanssen stasjonslapper (File: Stasjonslapper_CAGE_20-2.pdf)

8.2. Flare count database (File: Flare-counting_MB-lines.xlsx)