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CRUISE REPORT

Marine Geological Cruise to Storfjordrenna and Bjørnøyrenna

R/V Helmer Hanssen 28th July – 4th August, 2013

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N-9037 Tromsø, Norway

1. Introduction and scientific objectives

The cruise was part of the GlaciBar (Glaciations in the Barents Sea Area) project (PetroMaks project funded by The Norwegian Research Council, Statoil, Det Norske and BG Norway) and the recently funded Center of Excellence for Gas Hydrate Environments and Climate (CAGE) (funded by The Norwegian Research Council)

The objectives of this cruise were:

- Examine and map marine features connected to the last deglaciation of the Svalbard/Barents Sea Ice Sheet (SBIS) in the northwestern part of the Barents Sea, within the Storfjordrenna, south of Spitsbergen. • Mapping spatial distribution of glacial rafts in the central Barents Sea.
- Map and study the field of depressions/craters in the central Barents Sea, which are linked to gas hydrate eruptions following the deglaciation of the region.
- Perform coring in order to improve 1) the postglacial chronology and 2) understanding of the dynamics related to the deglaciation of the Barents Sea area.
- Perform subsampling of free "head_space" gas for further geochemical studies within sediment cores.

2. Cruise participants

Karin Andreassen, Prof. University of Tromsø (Cruise leader; Sh1)

Steiner Iversen, Engineer University of Tromsø (Sh1)

Anoop Mohanan Nair, Engineer University of Tromso (Sh2)

Steffen Aagaard Sørensen, PostDoc University of Tromsø (Sh1)

Katharina Streuff, Research assistant University of Tromsø (Sh2)

Eythor Gudlaugsson, PhD Student University of Tromsø (Sh1)

Mariana Esteves, PhD Student University of Tromsø (Sh2)

Denise Rüther, Ass. Prof. Sogn og Fjordane University College (Sh2)

Brit Vatne, Bachelor student Sogn og Fjordane University College (Sh2)

Tove Knutsen, Bachelor student Sogn og Fjordane University College (Sh2)

Monica Hultiin, Bachelor student Sogn og Fjordane University College (Sh2)

Øyvind Hole, Bachelor student Sogn og Fjordane University College (Sh2)

Aslak Bøygard, Bachelor student Sogn og Fjordane University College (Sh2)

Are Hoff, Bachelor student Sogn og Fjordane University College (Sh2)

Gregory Akhmanov, Ass. Prof. Moscow State University (Sh1)

Anna Yurchencko, PhD student Moscow State University (Sh1)

Anastasia Fokina, Master Student Moscow State University (Sh1)

Dina Giliazetdinova, Master student Moscow State University (Sh1)
Dmitry Korost, Senior Researcher Moscow State University (Sh1)
Nikolai Kozupitca, Bachelor student Moscow State University (Sh1)

Shifts
Sh1 = Shift 1: working 08:00-14:00 and 20:00-02:00 Sh2
= Shift 2: working 14:00-20:00 and 02:00-08:00

3. Equipment

3.1 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.

During this cruise, we image the morphology of the ocean floor and its shallow sub-bottom sedimentary layers and structures using the subbottom profiler. This can be used for deciding the location from where to extract the gravity cores.

3.2 Multibeam Echosounder

In the hull of R/V Helmer Hansen has been installed a Kongsberg Simrad EM 300 multi-beam echo sounder. The multi-beam system measures the two-way travel time that a sound wave initiated by a transmitter needs to reach the sea floor and come back. These waves have a frequency of 30 kHz, which is too high to penetrate the seafloor sediments, but gives a high resolution for a bathymetric map.

A number of piezo-electric transmitters, mounted in the hull, transmit 135 beams producing a fan arc, perpendicular to the ship track. Each beam has a width as narrow as one vertical degree by one horizontal degree.

The swath width, dependent on seabed sediments, in shallow water (<500 m) is typically 4 times the water depth. Down to 2000 m, a swath width of 4-5 km is common. The maximum width is 5000 m. The swath width, dependent on seabed sediments, in shallow water (<500 m) is typically 4 times the water depth. Down to 2000 m, a swath width of 4-5 km is common. The maximum width is 5000 m. The multibeam system has been used to map the seafloor morphology and its acoustic backscatter.

We have to take into account that the amplitudes recorded are slightly attenuated (~6 dB) because of protective housing installed around the hardware to avoid damage of ice contact. The outer beams of the EM300 swath can be of low quality, due to speed and signal reception errors because of the great travel distance, large propagation angle and low angle of reflection. That is why we usually have an overlap of 7-25% between the connecting lines. Ship turns also produce unevenly spaced swaths and so, data logging is normally paused during turns.

Once data have been acquired, we used programs such as, Neptune, Fledermaus and ArcGIS to visualize, clean, filter and process them.

3.3 CTD

CTD (Conductivity, Temperature, Depth) sensors measure or evaluate the physical properties of seawater. In addition to measuring the conductivity, temperature and pressure (from which depth is calculated), the CTD sensors can measure or calculate salinity of seawater, density, P-wave velocity, turbidity, fluorescence/chlorophyll, and oxygen content. Furthermore, it is possible to collect water samples from any depth of choice.

R/V Helmer Hanssen uses SBE 9plus CTD for producing vertical profiles of seawater properties (Fig. 3.3.1). A winch is used to lower the CTD system into the water. The SBE 9plus 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 9plus 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. If required, 12 water bottles can be attached to the CTD instrument set up to collect the water samples from any depth.

A single conductor cable supplies the power to the system and transmits data from and to the CTD system real time.

During our cruise, we used the sound velocity profiles from different CTD stations to calibrate depth calculations in the swath bathymetry data.

3.4 2D Reflection Seismic

The 2D reflection seismic method is widely used to study deeper subsurface which cannot be easily studied by other methods. It uses the acoustic energy reflected by various lithological interfaces to obtain an image of the subsurface geology, which can then be interpreted. A reflection seismic survey typically involves generating seismic events or shots, using various methods, at different locations and recording the reflected waves using sensors or receivers. The sensors convert the ground motion, resulting from the seismic event, to electric voltage which is then recorded.

The major components of a 2D marine reflection survey are the seismic source and the streamer, which houses the receivers/sensors.

Source: During this cruise we used mini GI (Generator-Injector) air gun as the seismic source. It is especially suited for high resolution surveys. The air gun generates seismic waves by releasing compressed air in to the water. The total volume of the gun is 30 in^3 and is operated in the harmonic mode (e.g., Marine Sources, Sercel), i.e., 15 in^3 each for generator and injector. This generates a high frequency signal which is suited to studying shallow subsurface in detail, which is the region of interest in our studies. A compressor is used to supply air at high pressure (maximum of 210 bars) to the air gun.

Streamer: In marine surveys, the seismic receivers or hydrophones are enclosed in oil –filled tube known as the streamer. The streamer used during this cruise is 16m long with one channel consisting of 20 sensors (piezoelectric material) spread over 6 meters (active section). The streamer is manufactured by Fjord Instruments.

Operation: The streamer is towed at a distance of 64 meters behind the ship. The mini-GI gun is towed at a distance of 32 meters behind the ship, at a depth of 2 meters below mean sea level and is fired every 3 seconds at 160 bar air pressure. The ship speed is maintained at 4 knots per hour. The data collected in the streamer is analog and converted to digital by the Fjord Instruments system and the software Delphseismic, which also provides a real-time display of acquired data.

3.5 Coring

Coring is the primary tool for ground truthing, studying sediment types, paleontology, and paleo-climate. R/V Helmer Hanssen has a piston corer, box corer, multi corer and a gravity corer. During our cruise we used only gravity corer for sampling sediments. The gravity corer onboard Helmer Hanssen consists of a 6m long iron barrel with iron weights attached on top of it. The whole apparatus weigh close to 2 tons. The gravity corer has an inner diameter of 11cm. A plastic liner with outer diameter of 11cm and inner diameter of 10.2 cm is inserted in to the iron barrel. During the coring operation, a core catcher and core cutter is attached to the lower end of the gravity corer. Core catcher keeps the sediments from falling out of the core, whereas core cutter helps the penetration of the core in to the sediments.

The gravity corer lies on a rail, which, during operation, is lifted vertically and the gravity corer is lowered to around 20m away from the seabed using a winch. When at the chosen core location the gravity corer is then dropped. The winch has a wire length of 2900 meters. When the gravity corer is lifted from the seabed and is brought to deck, the core catcher and core cutter are sampled first, if there are sediments present in them. Then, the plastic liner is taken out, cleaned, cut to 1 meter sections, labeled and stored in a cold room.

Some of the cores were split in the lab onboard and sediment samples were taken for degasation sampling. Core logs are also prepared. These samples can be used for various types of gas analysis and various other sedimentological analyses.

3.6 Single Beam Echo sounder

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 keelmounted 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 single beam echo sounder can also be used for detecting gas leakages from the seafloor using 18KHz and 38KHz transducers.

3.7 Gas Sampling

Gas from sediments at different depths was collected for further determination of molecular and isotopic composition of hydrocarbon (HC) gases, using "head-space" technique. 40 ml of sediment was taken from each 15-20 cm of the core, according to lithological characteristics, using a syringe. The sediment was put into bottles (120 ml), filled with distilled water (50 ml). Thus, 30 ml of each bottle was left for free gas from the sediment.

By shaking the bottles, the sediment was mechanically broken down to obtain equilibrium in the system "sediment-water-gas". Afterwards the free gas was collected into 20 ml vials, filled with concentrated salt dissolution (NaCl). Collected gas was stored in upturned vials for further analyses in the laboratories of the Department of Petroleum Geology and Geochemistry of the Faculty of Geology of the Moscow State University.

4. Cruise narrative

Sunday 28th July

Departure from Longyearbyen around 19:20 and begin transit to first study location in Storfjordrenna. Wind speed between 0-1 m/s, temp 6-7 degrees.

Monday 29th July

Arrive to Storfjordrenna and initiate new multibeam and chirp line project. Survey Storfjordrenna with multibeam and chirp all day. Decide on core locations for Tuesday. Weather is consistent and calm, with wind speeds of 5m/s and temp only ranging between 5-7 degrees.

Tuesday 30th July

Continue surveying in Storfjordrenna with the multibeam and chirp lines. Recover six gravity cores throughout the day. Wind 8-11m/s, temp ~6 degrees. Initiate transit from Storfjordrenna to Bjørnøyrenna.

Wednesday 31st July

Arrived to upper Bjørnøyrenna and began to survey the large craters in this area using multibeam and chirp lines, as well as, using the single beam echo sounder to detect any flares. Wind 9 m/s, temp 8-9 degrees. Several flares found and various potential core sites suitable to gain further information about the composition of the craters and flares were marked.

Thursday 1st August

We undertook several seismic lines over the craters and flare fields in upper Bjørnøyrenna in order to gain a better overview of the subsurface sediment properties of our core locations. A total of 20 cores were collected from several locations in this area. The majority of the cores did not recover any sediment samples other than a small quantity which was trapped in the core catcher most likely bedrock or very stiff till. However, the few cores that did recover some sediment were split and prepared for the degazation analysis. Following the coring we moved into a new location further up the Bjørnøyrenna trough to survey with the multibeam and chirp lines the potential glacial raft chains. A further two core sites were chosen. By the end of the day, wind speeds picked up to 11/12 m/s, temp 9-10 degrees.

Friday 2nd August

Whilst still in the glacial rafts location, two gravity cores were taken; however, both contained very little sediment. Following this, we then moved back to the crater locations to continue with more multibeam and chirp line surveys. Weather still a bit unsteady, wind 8-10 m/s, temp ~9 degrees.

Saturday 3rd August

Further multibeam and chirp line surveys at crater field. Transit to Tromsø while doing multibeam and chirp line surveys along the route initiated at ca. 10 o`clock. Wind 5-9 m/s, temp ~10 degrees.

Sunday 4th August

Transit to Tromsø. Arrival at ca. 1 o'clock at night. Refueling at ca. 9 o`clock.
Wind 9-11 m/s, temp ~12 degrees.

5. Ship tracks and study areas

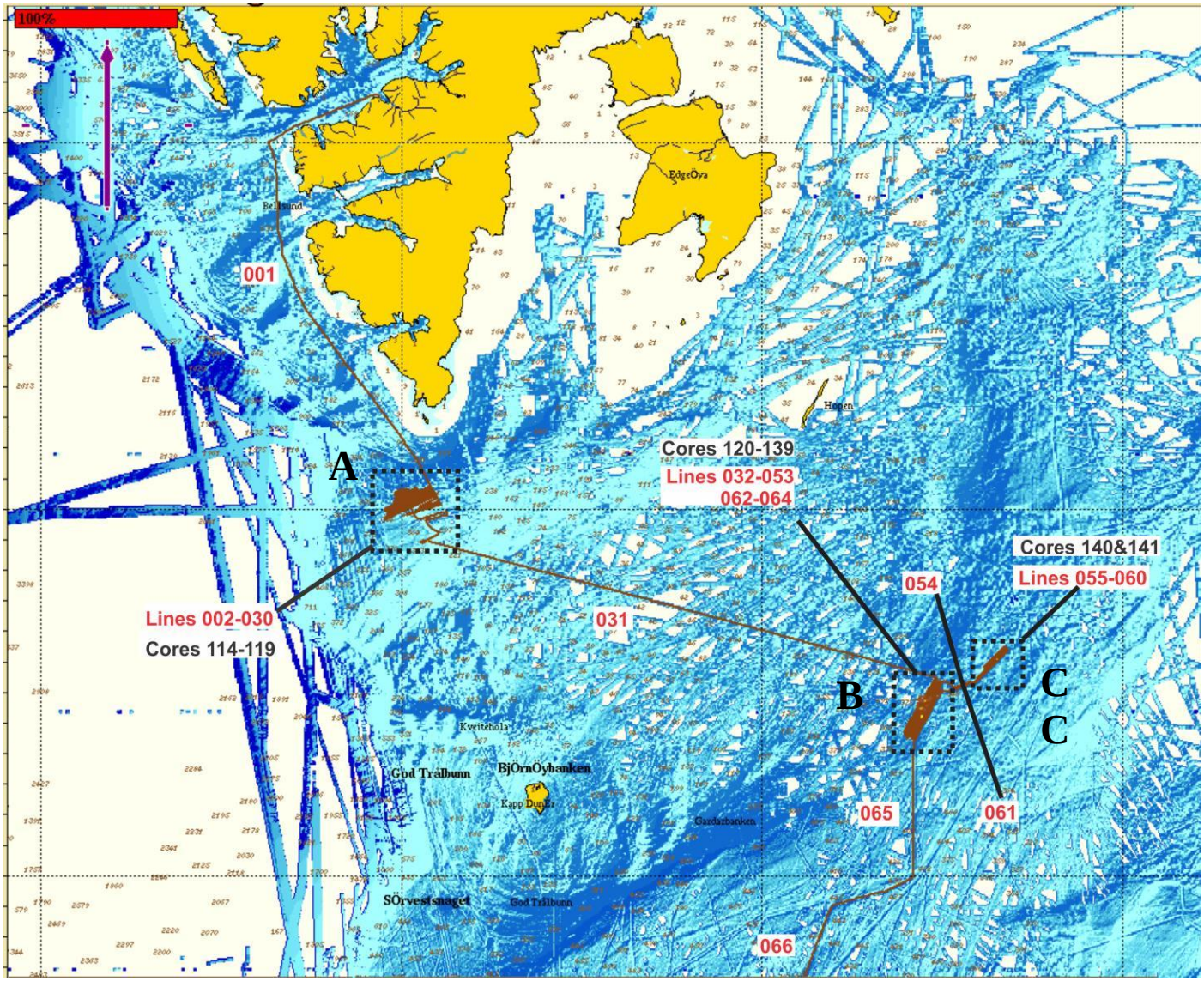
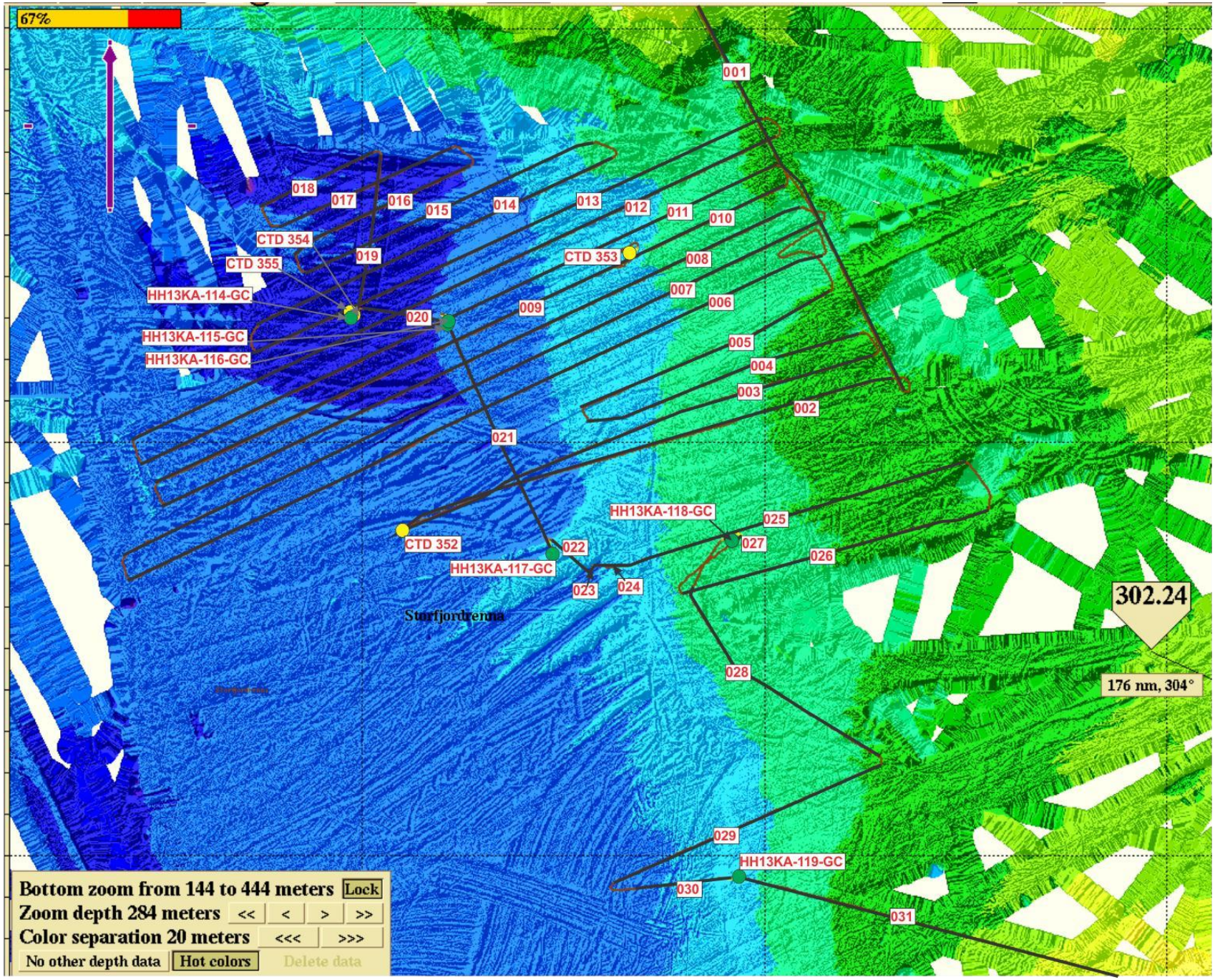


Figure 1. Overview map of ship tracks, coring and chirp line areas (A: Storfjordrenna; B: Crater area; C: Glacial Rafts area)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001
018
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016
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CTD 354
CTD 355
019
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008
HH13KA-114-GC
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006
009
020
HH13KA-115-GC
HH13KA-116-GC
005
004
003
002
021
HH13KA-118-GC
025
CTD 352
022
027
026
HH13KA-117-GC
023
024
Storfjordrenna
302.24
176 nm, 304°
028
029
HH13KA-119-GC
030
031
Bottom zoom from 144 to 444 meters
Lock
Zoom depth 284 meters
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Color separation 20 meters
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No other depth data
Hot colors
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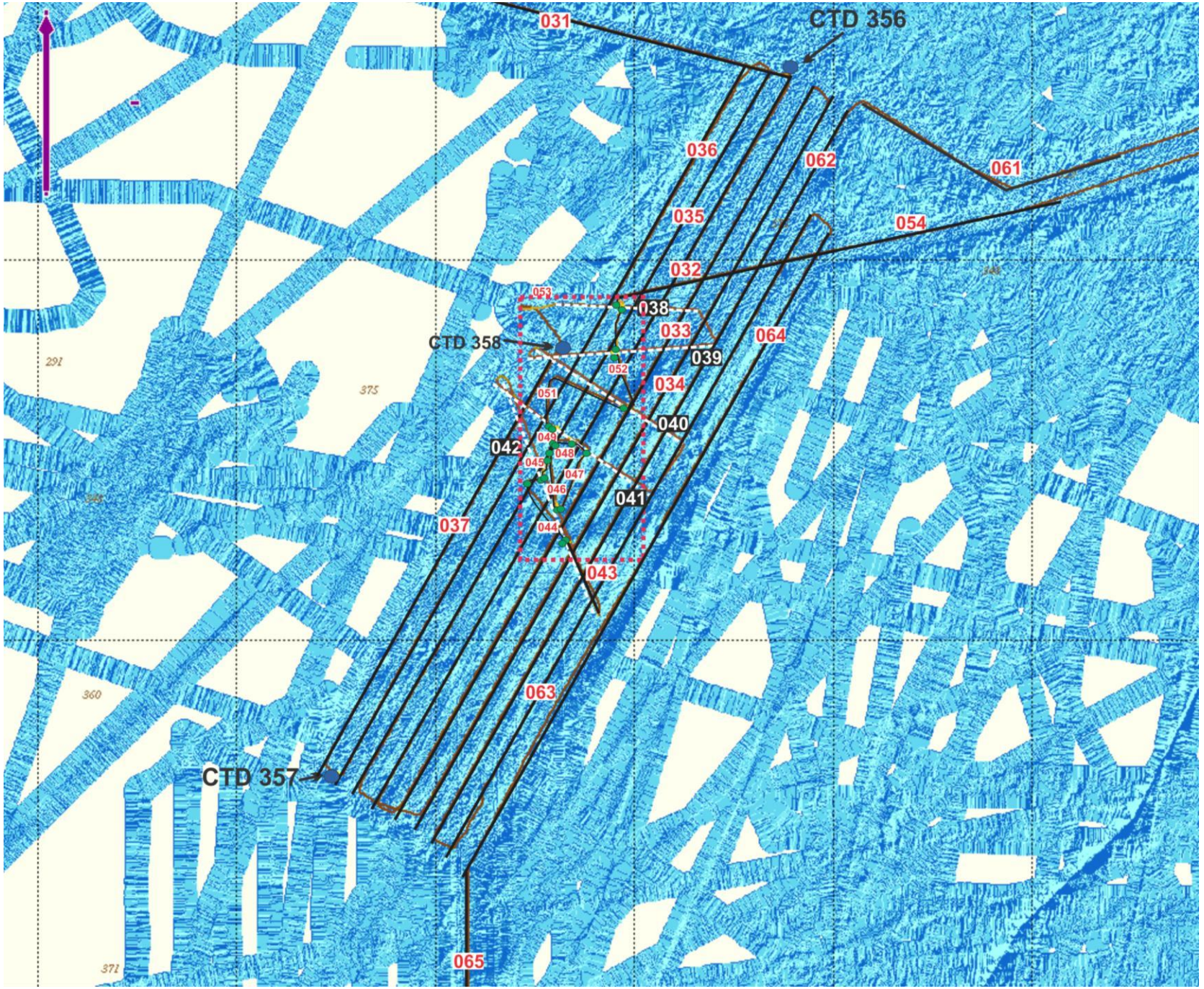
Figure 2. Zoom in on area A (Fig. 1) with chirp lines, core and CTD locations (Storfjordrenna).


031
CTD 356
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034
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048
045
047
046
041
037
044
043
063
CTD 357
065
291
375
348
360
371

Figure 3. Zoom in on area B (Fig. 1) with chirp lines, core and CTD locations (Crater area, Bjørnøyrenna). Red dotted rectangle indicates coring area (See Fig. 4.)

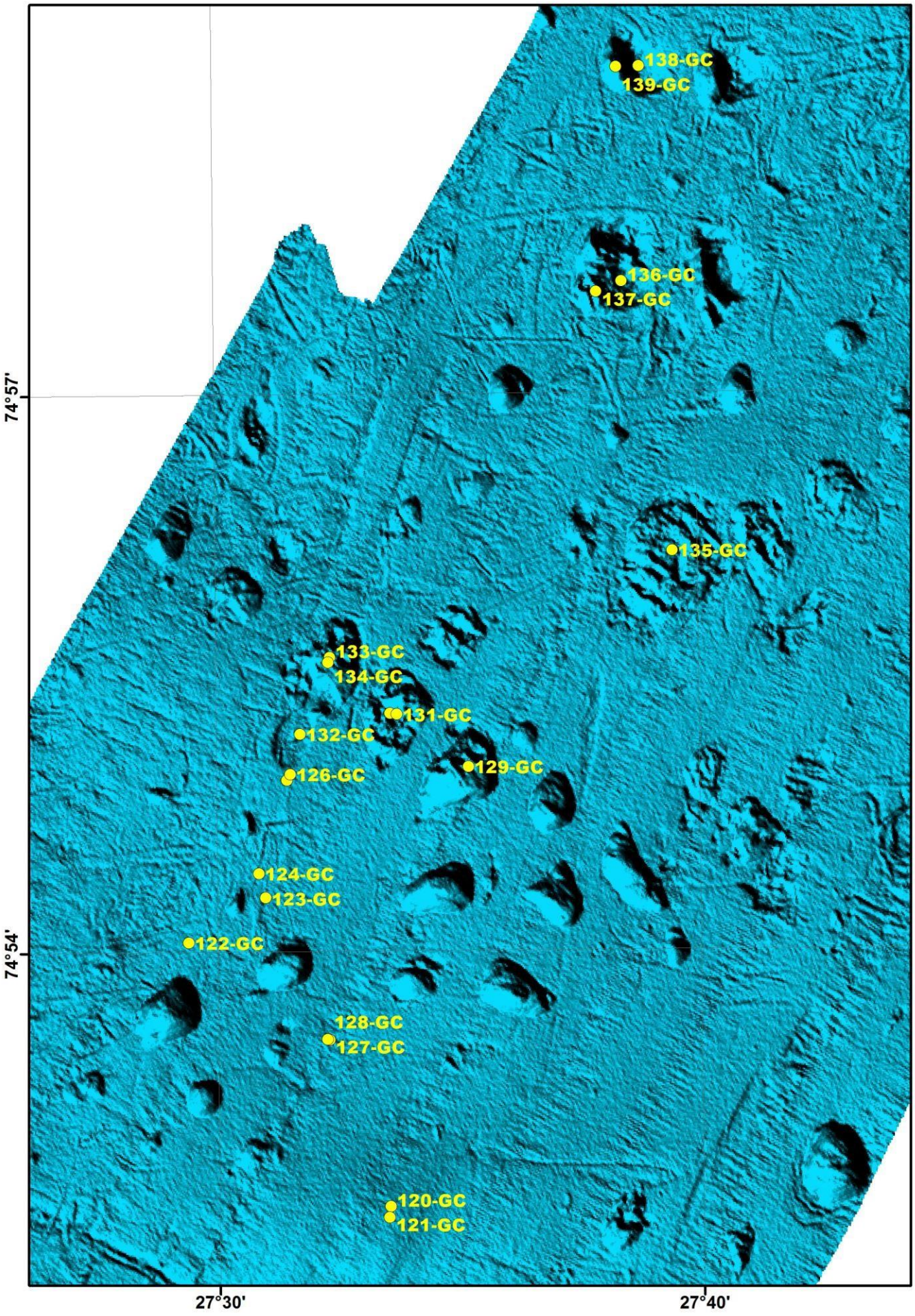

Figure 4. Zoom in on coring area (See Fig. 3) with core locations (Crater area,

Bjørnøyrenna).

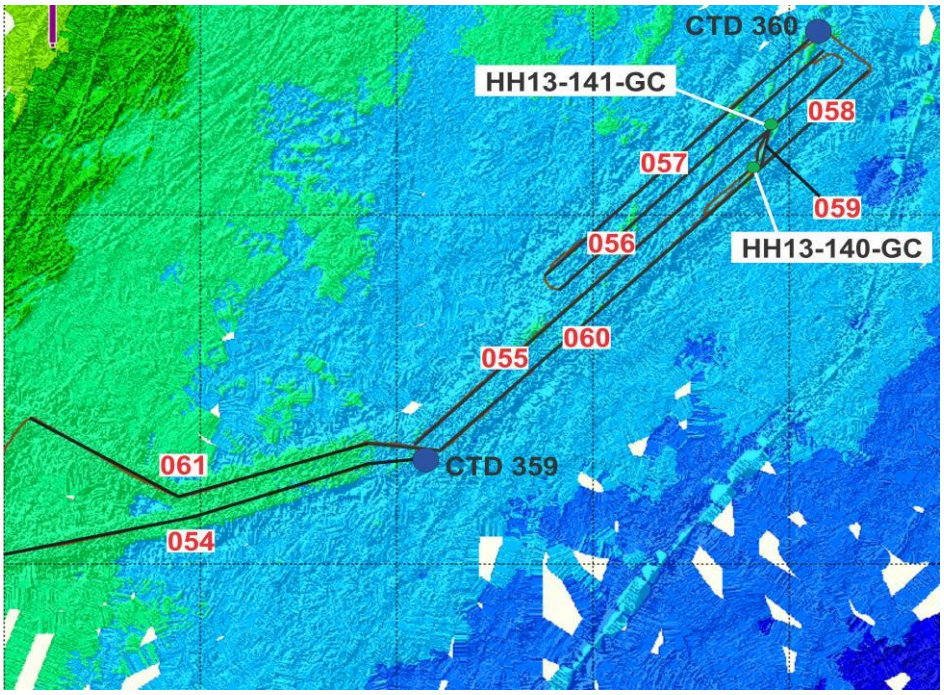

Figure 5. Zoom in on area C (Fig. 1) with chirp lines, core and CTD locations (Glacial Rafts area, Bjørnøyrenna).

6. Logs, cores and preliminary results of the bottom sampling

6.1. Eventlog on RV Helmer Hanssen July 28-4 August. 2013 Storfjordrenna, Bjørnøyrenna

Core location numbering starting on HH13-114- GC, following the numbering on the bridge of 'other stations' and CTD station numbering starts at 352, following the CTD numbering on the bridge. Use UTC time (2 hrs after local time)

Date	UTC	Position	Event
28/7	19:20 UTC		Departure from Longyearbyen. Wind ca 0-1 m/s, temp 6-7 degrees
29/7	07:55 UTC	76º20.886N 16º08.059E	End old project (G8144-3144)multibeam Storfjorden
29/7	08:08 UTC	76º19.020N 16º13.592E	Start new project (HH13KA) Start Multibeam 0000
29/7	08:42 UTC	76º14.019N 16º25.738E	Stop Multibeam 0001
29/7	08:42 UTC	76º14.019N 16º25.738E	Start Multibeam 0002 and Chirp Line HH13KA-001 Storfjordrenna
29/7	10:11 UTC	76º01.232N 16º53.771E	End Multibeam and Chirp Line HH13KA-001 Storfjordrenna
29/7	10:15 UTC	76º01.558N 16º53.630E	Start Multibeam 0008 and Chirp Line HH13KA-002 Storfjordrenna. Wind 5m/s, temp 5.5 degrees
29/7	11:31 UTC	75º58.199N 16º05.895E	End Multibeam and Chirp Line HH13KA-002 Storfjordrenna
29/7	11:34 UTC	75º57.866 N 16º04.353 E	CTD station 352
29/7	12:10 UTC	75º58.368 N 16º08.700 E	Start Multibeam 0013 and Chirp Line HH13KA-003, Wind 4 m/s, temp. 7 degrees
29/7	13:17 UTC	76º02.107N 16º51.063E	End Multibeam and Chirp Line HH13KA-003 Storfjordrenna
29/7	13:23 UTC	76º02.599N 16º49.261E	Start Multibeam 0017 and Chirp Line HH13KA-004 Storfjordrenna. Wind 5m/s, temp 5.5 degrees
29/7	13:58 UTC	76 º00 º594N 16º25.756E	End Multibeam and Chirp line HH13KA-004
29/7	14: 07UTC	76 º00.955N 16º23.108E	Start Multibeam 0020 and Chirp Line HH13KA-005, Storfjordrenna. Wind 3-4m/s, temp 7.3 degrees
29/7	14:44 UTC	76 º03.666N 16º46.641E	End Multibeam and chirp line HH13KA-005
29/7	15:10 UTC	76 º04.458N 16º44.475E	Start Multibeam 0023 and Chirp Line HH13KA-006, Storfjordrenna. Wind 4m/s, temp 7 degrees
29/7	16:53 UTC	75 º56.695N 15º37.168E	End Multibeam and chirp line HH13KA-006
29/7	16:59 UTC	75 º57.405N 15º37.247E	Start Multibeam 0028 and Chirp Line HH13KA-007, Storfjordrenna. Wind 4-5m/s, temp 7 degrees
29/7	18:46 UTC	76 º 05.293 N 16 º 45.282 E	End Multibeam and chirp line HH13KA-007

29/7	18:51 UTC	76 º 05.665N 16 º 43.671E	Start Multibeam 0033 and Chirp Line HH13KA-008, Storfjordrenna. Wind 5m/s, temp 6 degrees

29/7	20:30 UTC	75 º 58.682N 15º42.198E	End Multibeam and chirp line HH13KA-008
29/7	20:38 UTC	75 º 59.136N 15º40.576E	Start Multibeam 0038 and Chirp Line HH13KA-009, Storfjordrenna. Wind 6m/s, temp 6 degrees
29/7	21:48 UTC	76 º04.463N 16 º26.910E	End Multibeam and chirp line HH13KA-009
29/7	21:48 UTC	76 º04.463N 16 º26.910E	CTD station 353
29/7	22:19 UTC	76 º04.360N 16 º26.363E	Start Multibeam 0043 and Chirp Line HH13KA-010, Storfjordrenna. Wind 6m/s, temp 5 degrees
29/7	22:43 UTC	76 º06.213N 16 º42.167E	End Multibeam and chirp line HH13KA-010
29/7	22:46 UTC	76 º06.672N 16 º41.585E	Start Multibeam 0045 and Chirp Line HH13KA-011, Storfjordrenna. Wind 5m/s, temp 5 degrees
29/7	00:30 UTC	75 º59.511N 15 º38.452E	End Multibeam and chirp line HH13KA-011
29/7	00:37 UTC	76 º00.219N 15 º38.256E	Start Multibeam 0050 and Chirp Line HH13KA-012, Storfjordrenna. Wind 6m/s, temp 5.5 degrees
29/7	02:01 UTC	76 º06.488N 16 º33.245E	Crash singlebeam echosounder
30/7	02:14 UTC	76 º 07411N 16 º 41377E	End Multibeam and chirp line HH13KA-012
30/7	02:18 UTC	76 º 07.819N 16 º 40.017E	Start Multibeam 0055 and Chirp Line HH13KA-013, Storfjordrenna. Wind 6/7m/s, temp 4.5 degrees
30/7	03:36 UTC	76 º 02.212N 15 º 49.833E	End Multibeam and chirp line HH13KA-013
30/7	03:39 UTC	76 º02.593N 15º 49.031E	Start Multibeam 0059 and Chirp Line HH13KA-014, Storfjordrenna. Wind 9m/s, temp 5.5 degrees
30/7	04:38 UTC	76 º 06.904N 16 º 25.16.6	End Multibeam and chirp line HH13KA-014
30/7	04:44 UTC	76 º07.183N 16 º21.758E	Start Multibeam 0062 and Chirp Line HH13KA-015, Storfjordrenna. Wind 9 m/s, temp 5.3 degrees
30/7	05:28 UTC	76 º04.124N 15 º54.104E	End Multibeam and chirp line HH13KA-015
30/7	05:32 UTC	76 º04.699N 15 º54.075E	Start Multibeam 0065 and Chirp Line HH13KA-0016, Storfjordrenna. Wind 8.7 m/s, temp 5.1 degrees
30/7	06:02 UTC	76 º07.075N 16 º09.050E	Start Multibeam 0067 and Chirp Line HH13KA-0017, Storfjordrenna. Wind 8.1 m/s, temp 5.6 degrees
30/7	06:29 UTC	76 º05.213N 15 º51.790E	End Multibeam and chirp line HH13KA-017
30/7	06:33 UTC	76 º05.601N 15 º46.319E	Start Multibeam 0069 and Chirp Line HH13KA-0018, Storfjordrenna. Wind 8.0 m/s, temp 5.3 degrees
30/7	06:54 UTC	76 º05.697N 16 º01.902E	End Multibeam and chirp line HH13KA-018
30/7	06:56 UTC	76 º06.681 N 16 º01.881 E	Start Multibeam 0073 and Chirp Line HH13KA-0019, Storfjordrenna. Wind 8.0 m/s, temp 5.3 degrees
30/7	07:22 UTC	76 º03.081N 15 º59.597E	End Multibeam and chirp line HH13KA-019

30/7	07:23 UTC	76 º03.065N 15 º59.773E	Start CTD station 354
30/7	07:36 UTC	76 º03.227N 15 º59.450E	Start CTD station 355
30/7	07:54 UTC	76 º03.036N 15 º59.522E	Core station HH13KA-114-GC Storfjordrenna

30/7	08:06 UTC	76 º03.209N 16 º00.627E	Start Multibeam 0077 and Chirp Line HH13KA-0020, Storfjordrenna. Wind 9 m/s, temp 6 degrees
30/7	08:25 UTC	76 º02.899N 16 º08.511E	End Multibeam and chirp line HH13KA-020
30/7	08:33 UTC	76 º02.988N 16 º08.851E	Core station HH13KA-115-GC Storfjordrenna
30/7	08:58 UTC	76 º03.036N 16 º08.406E	Core station HH13KA-116-GC Storfjordrenna
30/7	09:14 UTC	76 º03.058N 16 º08.196E	Start Multibeam 0080 and Chirp Line HH13KA-0021, Storfjordrenna. Wind 10 m/s, temp 6 degrees
30/7	09:58 UTC	75 º57.248N 16 º19.087E	End Multibeam and Chirp line HH13KA-021
30/7	10:04 UTC	75 º57.326N 16 º19.151E	Core station HH13KA-117-GC Storfjordrenna
30/7	10:24 UTC	75 º57.672N 16 º18.669E	Start Multibeam 0084 and Chirp Line HH13KA-0022, Storfjordrenna. Wind 10.5 m/s, temp 6 degrees
30/7	10:34 UTC	75 º56.877N 16 º22.499E	End Multibeam and Chirp line HH13KA-022
30/7	10:34 UTC	75 º56.877N 16 º22.499E	Start Multibeam 0086 and Chirp Line HH13KA-0023, Storfjordrenna. Wind 8 m/s, temp 6 degrees
30/7	10:44 UTC	75 º57.023N 16 º23.138E	End Multibeam and Chirp line HH13KA-023
30/7	10:44 UTC	75 º57.023N 16 º23.138E	Start Multibeam 0088 and Chirp Line HH13KA-0024, Storfjordrenna.
30/7	10:50 UTC	75 º57.012N 16 º26.256E	End Multibeam and Chirp line HH13KA-024
30/7	10:50 UTC	75 º57.012N 16 º26.256E	Start Multibeam 0090 and Chirp Line HH13KA-0025, Storfjordrenna. Wind 11 m/s, temp 6 degrees
30/7	11:41 UTC	75 º59.521N 16 º59.868E	End Multibeam and Chirp line HH13KA-025
30/7	11:50 UTC	75 º58.339N 17 º02.127E	Start Multibeam 0093 and Chirp Line HH13KA-026, Storfjordrenna. Wind 9 m/s, temp 6 degrees
30/7	12:35 UTC	75 º56.348N 16 º32.177E	Stop Multibeam and Chirp line HH13KA-026
30/7	12:51 UTC	75 º57.723N 16 º37.727E	Start CTD station strnr0355
30/7	13:02 UTC	75 º57.782N 16 º37.458E	Stop CTD station strnr0355
30/7	13:08 UTC	75 º57.801N 16 º37.117E	Start Chirp line HH13KA-027 (core station HH13-118-GC), Storfjordrenna. Wind 9 m/s, temp. 6.5
30/7	13:19 UTC	75 º57.648N 16 º37.218E	Core station HH13KA-118-GC Storfjordrenna
30/7	13:26 UTC	75 º57.648N 16 º36.866E	Stop Chirp line HH13KA-027 (core station HH13-118-GC)

30/7	13:59 UTC	75 º56.537N 16 º32.995E	Start Chirp Line HH13KA-028, Storfjordrenna. Wind 10 m/s, temp 6.6 degrees (14:01 UTC Start Multibeam line 0096, 14:13 UTC line count Mulibeam 0098)
30/7	14:39 UTC	75 º52.349N 16 º51.678E	Stop Chirp line HH13KA-028
30/7	14:40 UTC	75 º52.188N 16 º51.466E	Start Multibeam 0100 and Chirp Line HH13KA-029, Storfjordrenna. Wind 7 m/s, temp 7 degrees
30/7	15:20 UTC	75 º49.330N 16 º24.330E	Stop Chirp line HH13KA-029

30/7	15:27 UTC	75 º49.245N 16 º28.437E	Start Multibeam 0100 and Chirp Line HH13KA-030 (core station HH13-119-GC), Storfjordrenna. Wind 8 m/s, temp 7 degrees
30/7	15:58 UTC	75 º49.428N 16 º37.152E	Core station HH13KA-119-GC Storfjordrenna
30/7	16:06 UTC	75 º49.496N 16 º37.176E	Stop Chirp line HH13KA-030
30/7	16:36 UTC	75 º49.444N 16 º38.317E	Start Multibeam 0105 and Chirp Line HH13KA-031, Transit. Wind 8 m/s, temp 7 degrees
31/7	09:44 UTC	75 º04.857N 27 º55.091E	End Multibeam and Chirp line HH13KA-031
31/7	09:45 UTC	75 º04.915N 27 º55.486E	Start CTD station 356
31/7	09:53 UTC	75 º04.970N 27 º55.654E	End CTD station 356
31/7	10:20 UTC	75 º05.172N 27 º56.092E	Start Multibeam 0143 and Chirp Line HH13KA-032. Wind 6 m/s, temp 9 degrees
31/7	12:32 UTC	74 º45.739N 27 º14.216E	End Multibeam and Chirp line HH13KA-032. Wind 6 m/s, temp 9 degrees
31/7	12:36 UTC	74 º45.553N 27 º16.181E	Start Multibeam 0149 and Chirp Line HH13KA-033. Wind 6 m/s, temp 9 degrees
31/7	14:50 UTC	75 º03.521N 27 º58.076E	End Multibeam and Chirp line HH13KA-033. Wind 9 m/s, temp 8 degrees
31/7	14:54 UTC	75 º04.089N 27 º59.438E	Start Multibeam 0155 and Chirp Line HH13KA-034. Wind 9 m/s, temp 9 degrees
31/7	16:59 UTC	74 º45.476N 27º18.672E	End Multibeam and Chirp line HH13KA-034. Wind 7 m/s, temp 9 degrees
31/7	17:13 UTC	74º.46.436N 27º12.831E	Start Multibeam 0162 and Chirp Line HH13KA-035. Wind 9 m/s, temp 9 degrees
31/7	19:22 UTC	75 º04.871N 27 º53.578E	End Multibeam and Chirp line HH13KA-035. Bjørnøyrenna
31/7	19:27 UTC	75 º05.055N 27 º51.746E	Start Multibeam 0168 and Chirp Line HH13KA-036. Wind 9 m/s, temp 8 degrees
31/7	21:35 UTC	74º46.515N 27 º10.728E	End Multibeam and Chirp line HH13KA-036. Bjørnøyrenna
31/7	21:36 UTC	74º 46.482N 27 º 10.345E	Start CTD station 357

31/7	21:56 UTC	74 º47.305N 26 º47.116E	Start Multibeam 0173 and Chirp Line HH13KA-037. Wind 12 m/s, temp 9 degrees
31/7	23:14 UTC	74º54.056N 27º35.27E	End Multibeam and Chirp line HH13KA-037. Bjørnøyrenna
31/7	23:24 UTC	74º 57.621N 27º 32.693E	start CTD station 358
1/8	00:07 UTC	74º 58.822N 27º 31.941E	Start Multibeam 0180 and Chirp Line HH13KA-038. Wind 11 m/s, temp 9 degrees
1/8	00:15 UTC	74º 58.814N 27º 34.307E	**Start seismic line HH13KA-038** Wind 11 m/s, temp 9 degrees. dominant frequencies (100-550)
1/8	00:59 UTC	74 º58.687N 27 º46.410E	End Multibeam and Chirp line HH13KA-038. Bjørnøyrenna
1/8	01:15 UTC	74 º 59.082N 27 º 46.127E	Start Multibeam 0183 and Chirp Line HH13KA-039. **Seismic** Wind 11 m/s, temp 9 degrees

1/8	02:10 UTC	74 º57.443N 27 º29.803E	End Multibeam and Chirp line HH13KA-039. Bjørnøyrenna
1/8	02:19 UTC	74 º 57.580N 27 º 31.060E	Start Multibeam 0186 and Chirp Line HH13KA-040. **Seismic** Wind 12 m/s, temp 9 degrees
1/8	03:15 UTC	74 º55.234N 27 º44.878E	End Multibeam and Chirp line HH13KA-040. Bjørnøyrenna.
1/8	03:39 UTC	74 º 54.042N 27 º 41.048E	Start Multibeam 0189 and Chirp Line HH13KA-041. **Seismic** Wind 12 m/s, temp 10 degrees
1/8	04:39 UTC	74 º 56.766N 27 º 26.313E	End Multibeam and Chirp line HH13KA-041. Bjørnøyrenna
1/8	04:47 UTC	74 º 56.736N 27 º 27.482E	Start Multibeam 0192 and Chirp Line HH13KA-042. **Seismic** Wind 11 m/s, temp 10 degrees
1/8	06:05 UTC	74 º 50.712N 27 º 36.361E	**End Seismic.** End Multibeam 0195 and Chirp line HH13KA-042. Bjørnøyrenna
1/8	06:28 UTC	74 º 50.712N 27 º 26.313E	Start Multibeam 0196 and Chirp line HH13KA-043. Bjørnøyrenna. Transit to core station
1/8	06:46 UTC	74 º 52.550N 27 º 33.374E	End Multibeam and Chirp line HH13KA-043. Bjørnøyrenna
1/8	06:52 UTC	74 º52.626N 27 º33.533E	Core station HH13-120-GC empty
1/8	07:17 UTC	74 º52.566N 27 º33.507E	Core station HH13-121-GC empty
1/8	07:54 UTC	74 º54.053N 27 º29.400E	Core station HH13-122-GC almost empty Flare
1/8	08:11 UTC	74 º 54.188N 27 º 29.281E	Start Multibeam 0199 and Chirp line HH13KA-044. Bjørnøyrenna. Transit to core station HH13KA-123-GC
1/8	08:24 UTC	74 º54.294N 27 º30.993E	Core station HH13-123-GC Flare
1/8	08:30 UTC	74 º 54.302N 27 º 30.701E	End Multibeam and Chirp line HH13KA-044. Bjørnøyrenna. Transit and core station HH13KA-123-GC
1/8	08:38 UTC	74 º 54.376N 27 º 30.861E	Start Multibeam 0201 and Chirp line HH13KA-045. Bjørnøyrenna.

1/8	08:45 UTC	74 º54.424N 27 º30.861E	Core station HH13-124-GC Flare
1/8	09:00 - 09:12		Transit to core station HH13-125-GC
1/8	09:13	74 º54.926N 27 º31.454E	Stop pinging and logging Multibeam
1/8	09:14	74 º54.925N 27 º31.456E	Core station HH13-125-GC Flare
1/8	09:29	74 º 55.011N 27 º 31.635E	End Chirp line HH13KA-045. Bjørnøyrenna
1/8	09:31	74 º 54.970N 27 º 31.559E	Start Chirp line HH13KA-046. Bjørnøyrenna
1/8	09:37	74 º54.957N 27 º31.528E	Core station HH13-126-GC
1/8	09:53	74 º55.029N 27 º31.609E	Start transit to core station HH13-127-GC

1/8	10:09	74 º53.537N 27 º32.295E	End transit to core station HH13KA-127-GC
1/8	10:12	74 º53.525N 27 º32.294E	Core station HH13-127-GC Flare
1/8	10:33	74 º53.527N 27 º32.257E	Core station HH13-128-GC Flare
1/8	10:47	74 º 53.523N 27 º 32.483E	End Chirp line HH13KA-046
1/8	10:47	74 º 53.523N 27 º 32.483E	Start Chirp line HH13KA-047. Bjørnøyrenna. Transit to core station HH13KA-129-GC
1/8	11:02	74 º 54.871N 27 º 35.011E	End transit
1/8	11:09	74 º54.991N 27 º35.217E	Core station HH13-129-GC Crater
1/8	11:24	74 º55.255N 27 º34.436E	Transit to core station HH13-130-GC Another crater
1/8	11:36	74 º55.281N 27 º33.599E	Core station HH13-130-GC Crater
1/8	11:46	74 º55.345N 27 º 33.488E	End Chirp line HH13KA-047
1/8	11:46	74 º55.345N 27 º 33.488E	Start Chirp line HH13KA-048
1/8	12:03	74 º55.276N 27 º33.743E	Core station HH13-131-GC
1/8	12:13	74 º55.312N 27 º33.962E	End Chirp line HH13KA-048
1/8	12:29	74 º55.180N 27 º31.784E	Start Chirp line HH13KA-049
1/8	12:48	74 º55.173N 27 º31.734E	Core station HH13-132-GC

1/8	13:08	74 º55.441N 27 º32.109E	Start Chirp line HH13KA-050
1/8	13:32	74 º55.585N 27 º32.357E	Core station HH13-133-GC
1/8	13:53	74 º 55.558N 27 º 32.324E	Core station HH13-134-GC
1/8	14:07	74 º55.622N 27 º31.702E	End Chirp line HH13KA-050
1/8	14:08	74 º55.620N 27 º31.653E	Start Chirp line HH13KA-051
1/8	14:50	74 º56.148N 27 º39.477E	Core station HH13-135-GC
1/8	15:04	74 º56.152N 27 º39.521E	End Chirp line HH13KA-051
1/8	15:05	74 º56.116N 27 º39.890E	Start Chirp line HH13KA-052
1/8	15:37	74º57.601N 27º38.481E	Core station HH13-136-GC
1/8	16:08	74 º57.545N 27 º37.957E	Core station HH13-137-GC
1/8	16:16	75 º57.638N 27º38.286E	End Chirp line HH13KA-052

1/8	16:17	74 º57.664N 27º38.334E	Start Chirp line HH13KA-053
1/8	16:41	74 º 58.757N 27 º38.886E	Core station HH13-138-GC
1/8	17:11	74 º58.754N 27º38.414 E	Core station HH13-139-GC
1/8	17:20	74 º58.853N 27º38.682E	End Chirp line HH13KA-053
1/8	17:32	74 º59.256N 27º42.365E	Start Chirp line HH13KA-054
1/8	17:56	75º00.107N 27 º57.429E	Start multibeam line 0203
1/8	19:05	75º03.017N 28º42.519E	End Multibeam and Chirp line HH13KA-054
1/8	19:10	75º02.956N 28º42.998E	Start CTD station 359
1/8	19:33	75º03.452N 28º41.933E	Start multibeam line 0206 Chirp line HH13KA-055
1/8	21:04	75º14.274N 29º25.320E	End Chirp line HH13KA-055
1/8	21:09	75º14.489N 29º23.398E	Start multibeam line 0211 Chirp line HH13KA-056
1/8	22:08	75 º07.917N 28º56.886	End Chirp line HH13KA-056

1/8	22:16	75 º08.484N 28º55.731E	Start multibeam line 0214 Chirp line HH13KA-057
1/8	23:11	75 º15.090 N 29º23.181E	End Chirp line HH13KA-057
1/8	23:13	75º15.086 N 29º23.383E	Start CTD station 0360
1/8	23:26	75º15.200 N 29º23.798E	End CTD station 0360
1/8	23:41	75º14.073 N 29º28.138E	Start multibeam line 0218 Chirp line HH13KA-058
2/8	00:18	75 º10.021N 29º11.624 E	End multibeam, end chirp line HH13KA-058
2/8	00:31	75º11.219 N 29º15.955E	Start chirp line HH13KA-059 (line across core locations)
2/8	00:50	75º11.344 N 29º16.430E	Core station HH13-140-GC
2/8	01:39	75º12.581N 29º18.186E	Core station HH13-141-GC
2/8	02:03	75 º11.311 N 29º16.798E	End Chirp Line HH13KA-059
2/8	02:03	75 º11.311 N 29º16.798E	Start chirp line HH13KA-060, start multibeam 0223
2/8	03:09	75 º 03.255N 28 º 44.084E	End multibeam, end chirp line HH13KA-060
2/8	03:12	75 º 03.255N 28 º 44.084E	Start chirp line HH13KA-061, start multibeam 0226 Wind 8 m/s, temp 9.3 degrees
2/8	04:20	75 º 03.901N 28 º 01.661E	End multibeam, end chirp line HH13KA-061
2/8	04:20	75 º 03.901N 28 º 01.661E	Start chirp line HH13KA-062, start multibeam 0229 Wind 10 m/s, temp 9.5 degrees
2/8	06:33	74 º 44.910N 27 º 19.999E	End multibeam, end chirp line HH13KA-062
2/8	06:39	74 º 44.622N 27 º 22.031	Start chirp line HH13KA-063, start multibeam 0235
2/8	08:24	75 º 01.173N 27 º 57.886E	End multibeam and Chirp line HH13KA-063
2/8	08:29	75 º 00.778N 27 º 59.852E	Start multibeam line 0240 Chirp line HH13KA-064. Bjørnøyrenna. Wind 9m/s, temp 9 degrees
2/8	09:21	74 º 54.039N 27 º 44.952E	Keel lowered
2/8	10:47	74 º 44.072N 26 º 23.440E	End multibeam and Chirp line HH13KA-064
2/8	10:47	74 º 44.072N 26 º 23.440E	Start multibeam line 0246 Chirp line HH13KA-065. Bjørnøyrenna. Wind 9m/s, temp 10 degrees
2/8	15:06	73 º 59.447N 27 º 21.223E	End multibeam and Chirp line HH13KA-065
2/8	15:06	73 º 59.447N 27 º 21.223E	Start multibeam line 0246 Chirp line HH13KA-066. Bjørnøyrenna. Wind 7m/s, temp 10 degrees

2/8	16:21	73 º 54.640N 26 º 39.585E	CTD station 361
2/8	16:50	73 º 54.871N 26 º 38.641E	Start multibeam line 0246 Chirp line HH13KA-067. Bjørnøyrenna. Wind 6 m/s, temp 10 degrees
2/8	18:41	73 º 50.360N 25 º 33.343E	End multibeam and Chirp line HH13KA-067
2/8	18:44	73 º 50.000N 25 º 32.649E	Start multibeam line 0263 Chirp line HH13KA-068. Bjørnøyrenna. Transit home. Wind 5 m/s, temp 9 degrees

6.2. Core Stations on RV Helmer Hanssen July 28-4 August. 2013 Storfjordrenna, Bjørnøyrenna.

Gravity core (HH13_319-GC) was split and described. The first half was subsampled for further analyses (free "head_space" gas, grain size analysis and mineral composition) in the laboratories of the Department of Petroleum Geology and Geochemistry of the Faculty of Geology of the Moscow State University. The second half was stored in cooling room and transported to the Geological Department, University of Tromsø for further analyses.

Gravity cores (HH13_124, 126, 137, 139, 140 and 141_GC) were subsampled for free "head_space" gas immediately after core retrieval by sampling through boreholes (predrilled in gravity corer liner and covered by extra strong tape prior to coring) at 20-40cm intervals. Subsequently the cores underwent same procedures as described above.

The remaining Gravity cores were stored whole in cooling room and transported to the Geological Department, University of Tromsø for further analyses.

Station	Date	Location	Time (UTC)	Position Latitude [N] Longitude [E]	Penetration (GC)	Recovery (GC)	Water depth [m]	Comment
HH13-114- GC	30/7	Storfjordrenna	07:54	76 º03.036N 15 º59.522E	Full	310 cm	395 m	Sediments from core catcher were collected. Whole core stored

HH13-115- GC	30/7	Storfjordrenna	08:33	76 º02.988N 16 º08.851E	Full	161 cm	380 m	Sediments from core catcher were collected. Whole core stored
HH13-116- GC	30/7	Storfjordrenna	08:58	76 º03.036N 16 º08.406E	Full	434 cm	381 m	Retry of the previous. Sediments from core cutter and catcher and below core cutter were collected. Whole core stored
HH13-117- GC	30/7	Storfjordrenna	10:04	75 º57.326N 16 º19.151E	5 m	382 cm	362 m	No sediments in core cutter and core catcher. Whole core stored
HH13-118- GC	30/7	Storfjordrenna	13:19	75 º57.648N 16 º36.866E	full	345 cm	333 m	Core cutter and core catcher sampled, overconsolidated grey mud, relatively water-rich, slightly disturbed surface due to sawing . Whole core stored
HH13-119- GC	30/7	Storfjordrenna	15:58	75 º49.428N 16 º37.152E	full	391 cm	352 m	Overconsolidated, relatively water-rich sediments from core cutter and catcher and below core cutter were collected This was a test of the “holemethod”. Core halved and stored
HH13-120- GC	01/8	Bjørnøyrenna	06:52	74 º52.626N 27 º33.533E	No	0	351.78m	No samples
HH13-121- GC	01/8	Bjørnøyrenna	07:17	74 º52.566N 27 º33.507E	No	0	353m	Core catcher sampled
HH13-122- GC	01/8	Bjørnøyrenna	07:54	74 º54.053N 27 º29.400E	53cm	0	334m	Core cutter and catcher sampled.
HH13-123- GC	01/8	Bjørnøyrenna	08:24	74 º54.294N 27 º30.993E	No	0	336m	No samples
HH13-124- GC	01/8	Bjørnøyrenna	08:45	74 º54.424N 27 º30.861E	1m	51cm	335m	Core cutter and catcher sampled. Core halved and stored
HH13-125- GC	01/8	Bjørnøyrenna	09:14	74 º54.925N 27 º31.456E	No	0	336m	Core cutter sampled (Very little)

HH13-126- GC	01/8	Bjørnøyrenna	09:37	74 º54.957N 27 º31.528E	50cm	2cm	336m	Core cutter and catcher sampled. Strong smell. Core halved and stored
HH13-127- GC	01/8	Bjørnøyrenna	10:12	74 º53.525N 27 º32.294E	No	0	337.6m	Core cutter and catcher sampled. Strong smell
HH13-128- GC	01/8	Bjørnøyrenna	10:33	74 º53.527N 27 º32.257E	No	0	337.79m	Rock clasts sampled
HH13-129- GC	01/8	Bjørnøyrenna	11.09	74 º54.991N 27 º35.217E	No	0	348.75m	Core cutter sampled (very little)
HH13-130- GC	01/8	Bjørnøyrenna	11:36	74 º55.281N 27 º33.599E	No	0	330m	Core cutter sampled (very little)
HH13-131- GC	01/8	Bjørnøyrenna	12:03	74 º55.276 N 27 º33.743 E	No	0	334m	Core cutter sampled and catcher sampled (very little)
HH13-132-GC	01/8	Bjørnøyrenna	12:48	74 º55.173 N 27 º31.734 E	No	0	330m	Core cutter sampled (very little)
HH13-133-GC	01/8	Bjørnøyrenna	13:32	74 º55.585N 27 º32.357E	No	0	348	Core catcher sampled (very little)
HH13-134-GC	01/8	Bjørnøyrenna	13:53	74 º 55.558N 27 º 32.324E	No	0	349	Core catcher sampled (very little)
HH13-135-GC	01/8	Bjørnøyrenna	14:50	74 º56.148N 27 º39.477E	No	0	344	Core catcher sample (very little - possible bedrock)
HH13-136-GC	01/8	Bjørnøyrenna	15:37	74º57.601N 27º38.481E	1/1.5m	58	307	Core catcher and cutter sampled. Whole core sampled (5cm intervals).
HH13-137-GC	01/8	Bjørnøyrenna	16:08	74 º57.545N 27 º37.957E	1/1.5m	23	334	Core catcher and cutter . Core halved and stored
HH13-138-GC	01/8	Bjørnøyrenna	16:41	74 º 58.757N 27 º38.886E	50cm	0	302	Core catcher and cutter
HH13-139-GC	01/8	Bjørnøyrenna	17:11	74 º58.754N 27º38.414 E	Full penetration	244cm	344	Core catcher. Core halved and stored
HH13-140-GC	02/8	Bjørnøyrenna	00:50	75 º 11.344N 29 º16.430E	Full penetration?	24	338	Core cutter and catcher. Core halved and stored

HH13-141-GC	02/8	Bjørnøyrenna	01:39	75º12.581N 29º18.186E	1.5m	21	333	Very small amounts from core catcher/cutter . Core halved and stored

6.3. Preliminary results of the bottom sampling

Three main areas were designated for the bottom sampling during the HH13KA cruise in accordance with the main research targets of the expedition (Fig. 6):

1) A system of deglaciation-related lobes within the Storfjordrenna, south of Spitsbergen;
2) A field of densely distributed depressions in the central Barents Sea, that are probably formed due to rapid and explosive gas hydrate dissociation;
3) A system of NE elongated ridges on the seafloor (possible ice stream rafted mega-blocks) in Bjørnøyrenna.

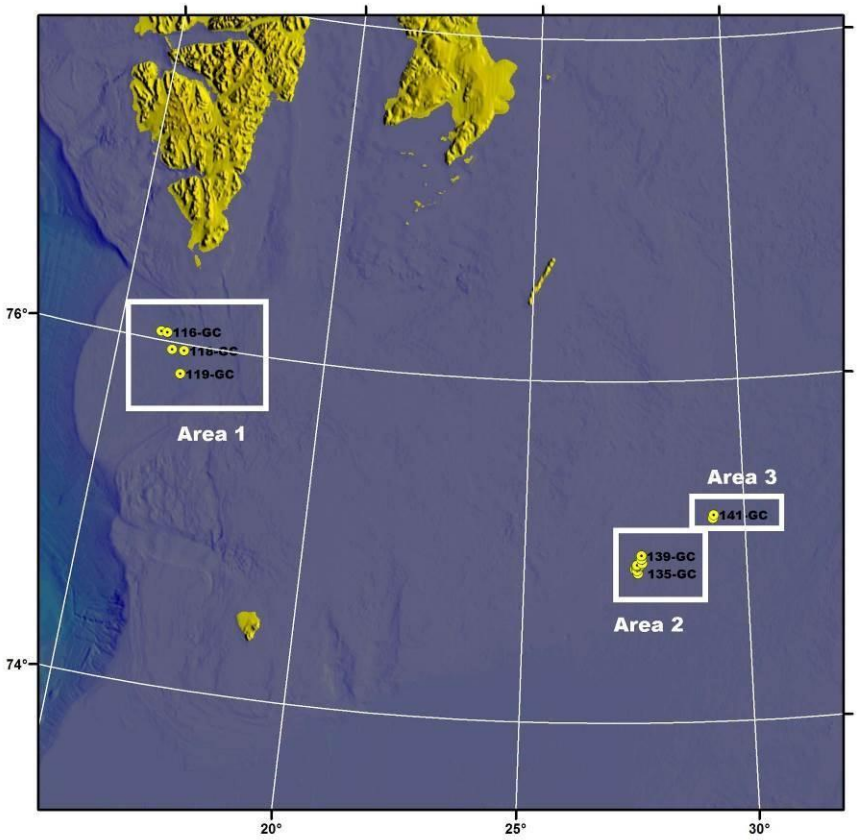

Figure 6. Location map of the bottom sampling areas in the HH13KA cruise

Area 1

Sampling stations HH13-114GC, HH13-115GC, HH13-116GC, HH13-117GC, HH13-118GC, and HH13-119GC

Five cores were taken with the aim of dating a formation of two well-expressed lobes on the seafloor, possibly related to some stage of glacier retreat in the region (Fig.2). The cores HH13-114GC and HH13117GC sampled sediments just in front of the lobes. The cores HH13-115GC, HH13-116GC and HH13118GC sampled edges of the lobes. All these cores were carefully packed without opening for further studies.

The core HH13-119GC was taken, most probably, from the very edge of the southernmost studied lobe.The recovered sediments are represented by intercalation of several intervals of clay with varying amount of rock fragments and sandy admixture (Fig. 7**Figure**). Sediments from the upper part of the core show some indications of re-deposition of material by water flow. The lowermost part of the succession is typical till diamicton.

At the site HH13-119GC, a new method of gas subsampling from the core was tested successfully. This method was then applied at several coring locations during the cruise, allowing for an accelerated gas extraction procedure.

Area 2 (Fig.4)

Sampling stations HH13-120GC and HH13-121GC

A highly regularly shaped depression on the seafloor, in the south of study area 2, was cored in order to get material, which hopefully will shed some light on its origin.

The core HH13KA-120GC arrived almost empty. Only the core catcher contained a small amount of very dark grey, silty clay with tube warms and one fragment of well lithified rock.

The second attempt to sample this depression (the station HH13KA-121GC) was equally successful. Only small amounts of dark grey, sandy, silty clay was obtained from the core catcher.

The sampling results suggest that the sedimentary veneer is probably extremely thin in the targeted depression but that its origin still needs to be clarified.

Sampling stations HH13-122GC, HH13-123GC, HH13-124GC, HH13-125GC, HH13-126GC, HH13-127GC, and HH13-128GC

Intensive bottom sampling was undertaken in the area of very dense gas seepage on the seafloor (Figure 8, Figure 9). Focused fluid flows were distinguished and mapped with echo sounder profiling, that showed many characteristic gas flares in the water column along its lines. It is worth mentioning that identified gas flares were located not in the crated-like structures but were concentrated roughly between two main chains of them.

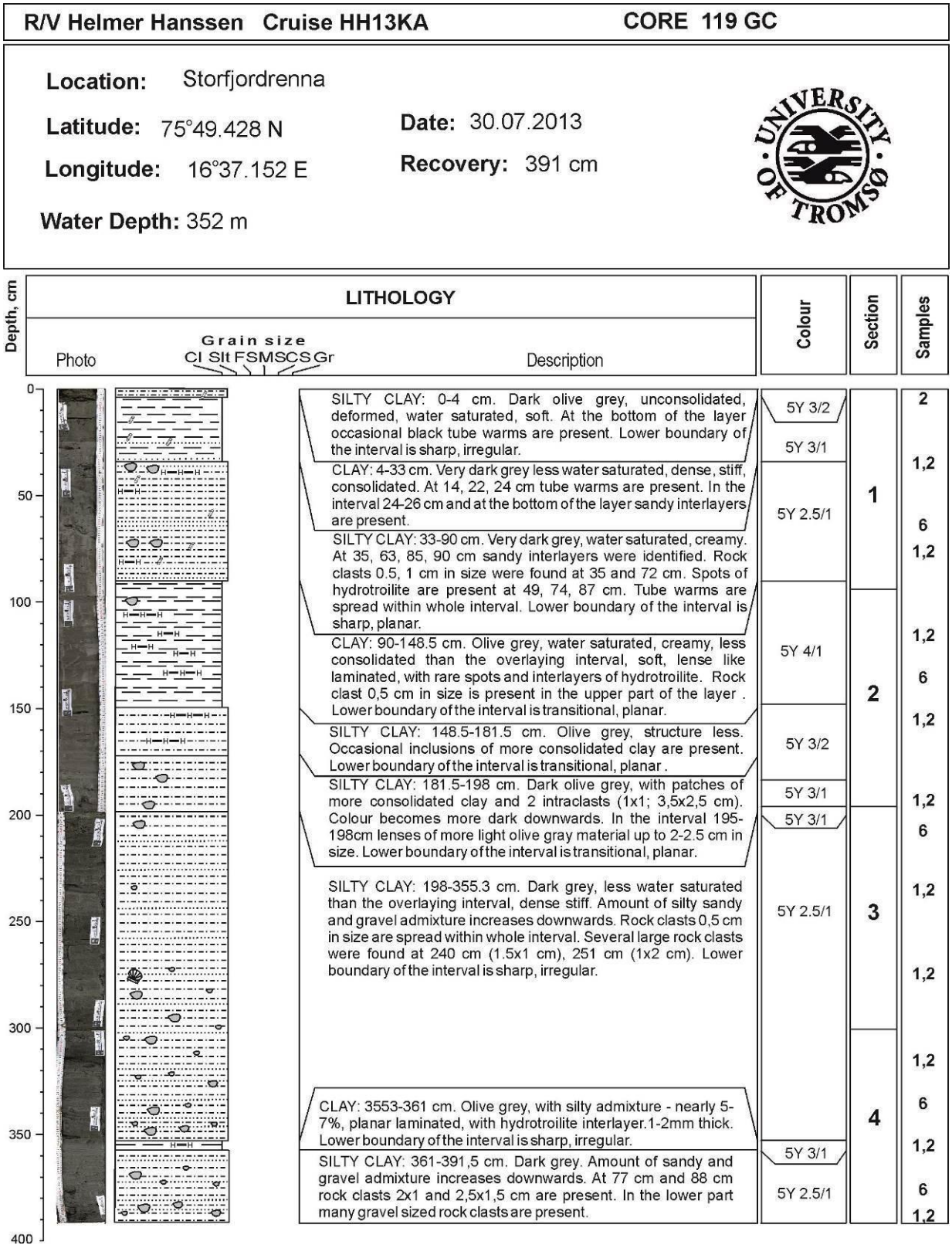

Figure 7. Core log of the HH13KA-119GC

Only small amount of grey clayey sediments and some rock clasts in the core catcher were recovered from nearly all of the stations, indicating a very thin sedimentary veneer and a hard bottom ground. The majority of the obtained rock fragments were collected for further analyses, which might show if they are ice-rafted material or characteristic for "outcropping" bed rocks.

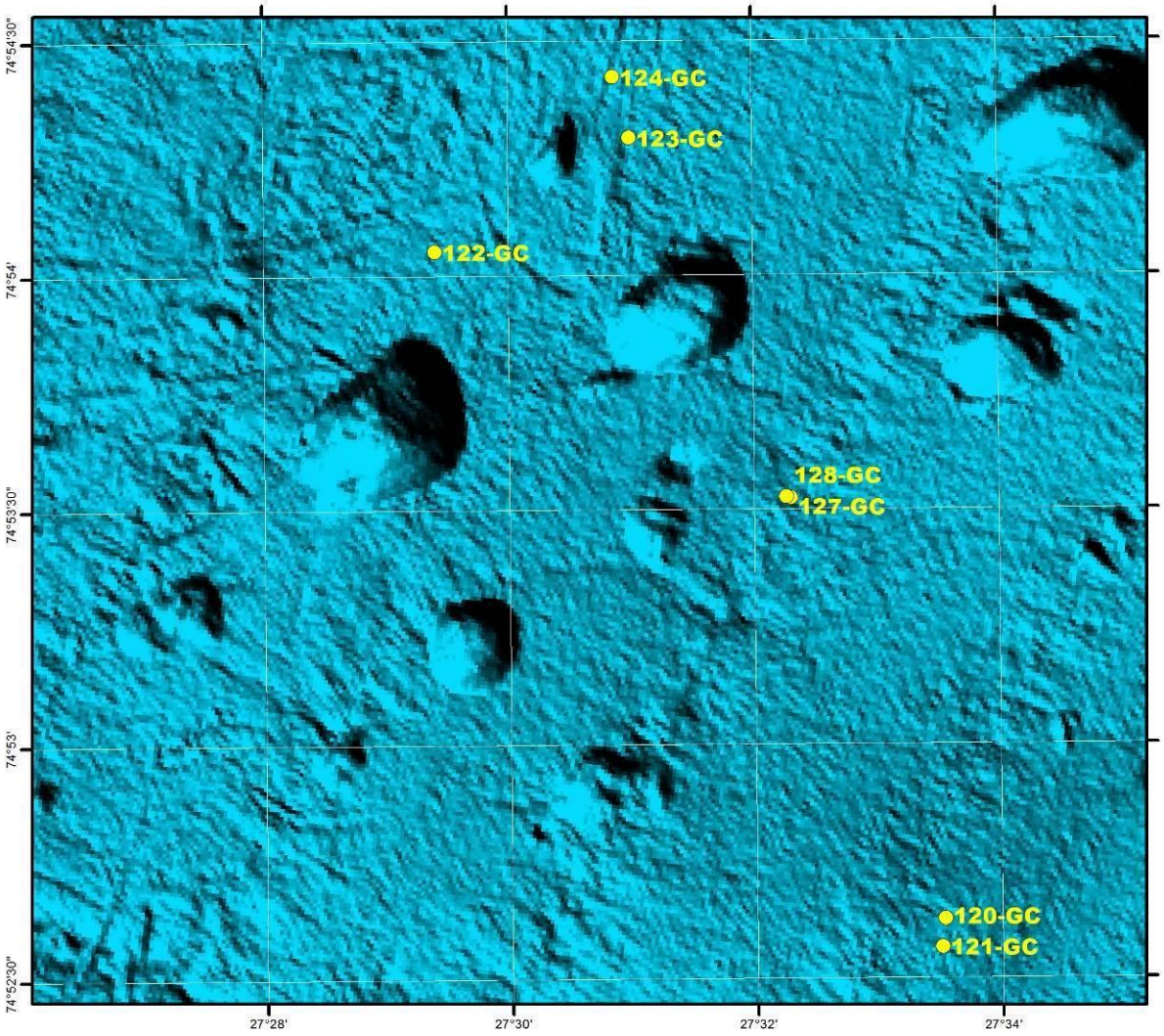

Figure 8. Some sampling site location within the area 2

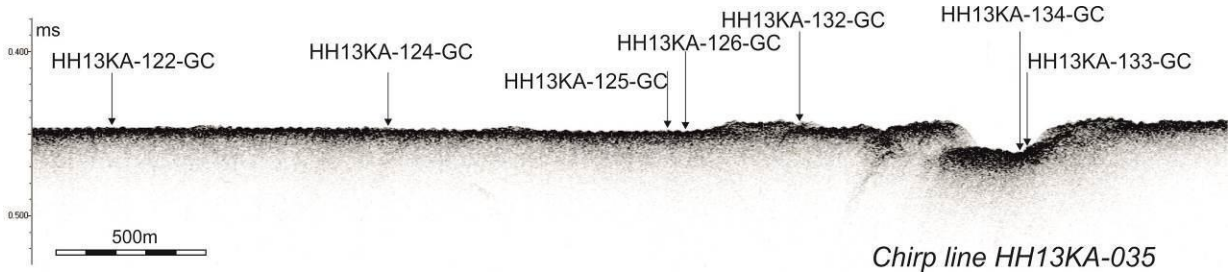

Figure 9. Location of the sampling sites on Chirp line 035

Material collected at the stations HH13-125GC, HH13-126GC, and HH13-127GC was characterized by a relatively strong odor of H_2S. Both sediments and rock fragments clearly smelled.

From this area, only at the station HH13-124GC was the recovery more than a few cm (Figure 10). It consisted of the uppermost oxidized brownish grey Holocene clay and dark grey, stiff clay with hydrotrolite lamina.

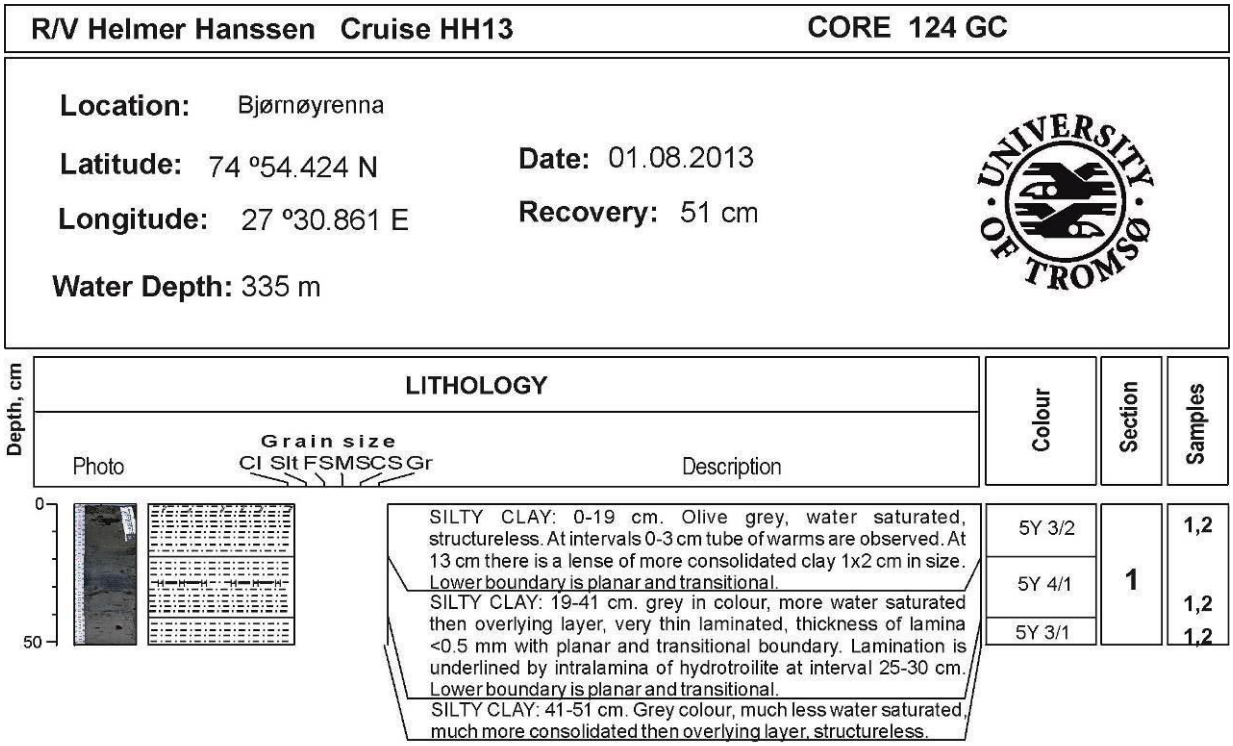

Figure 10. Core log of HH13KA-124GC

Sampling stations HH13-129GC, HH13-130GC, HH13-131GC, HH13-132GC, HH13-133GC, HH13-134GC, and HH13-135GC

A number of attempts were made to collect material from the crater-like structures, widely distributed in study area 2 (Figure 11, Figure 12). All coring attempts recovered only various rock fragments, sometimes immixed with a very small amount of sediments. The rock fragments are mainly angular in shape and often show a weathered surface. Among them, fragments of fine-grained sandstone, thin laminated marlstone and various mudstones were recognized.

The sampled crater-like structures show a quite differentiated inner morphology. Some of them are characterized by inner ridges and highs of various shapes and sizes. One crater borders with an outer, tongue-shaped (in planar view) ridge. Many of these features were sampled. However, no clear difference between the recovered material from different stations, was identified.

The sampling results imply that the craters are engraved in bed rock outcroppings on the seafloor surface. Previously mentioned, smaller-scale features inside and just outside the crater-like structures are, most probably, composed of large rock fragments of the same bed rock, transported at some distance during the crater formation.

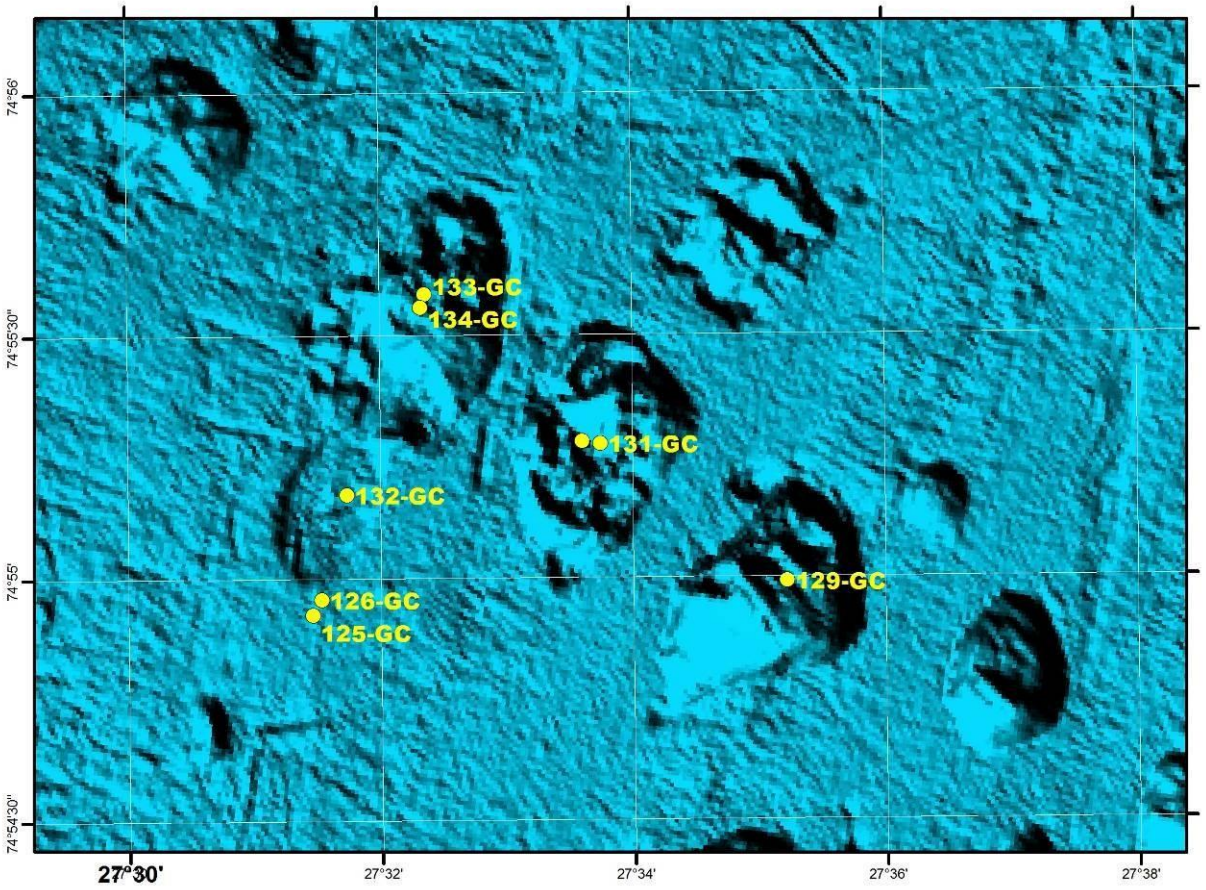

Figure 11. Sampling station location withing the area of crater-like structure dense distribution

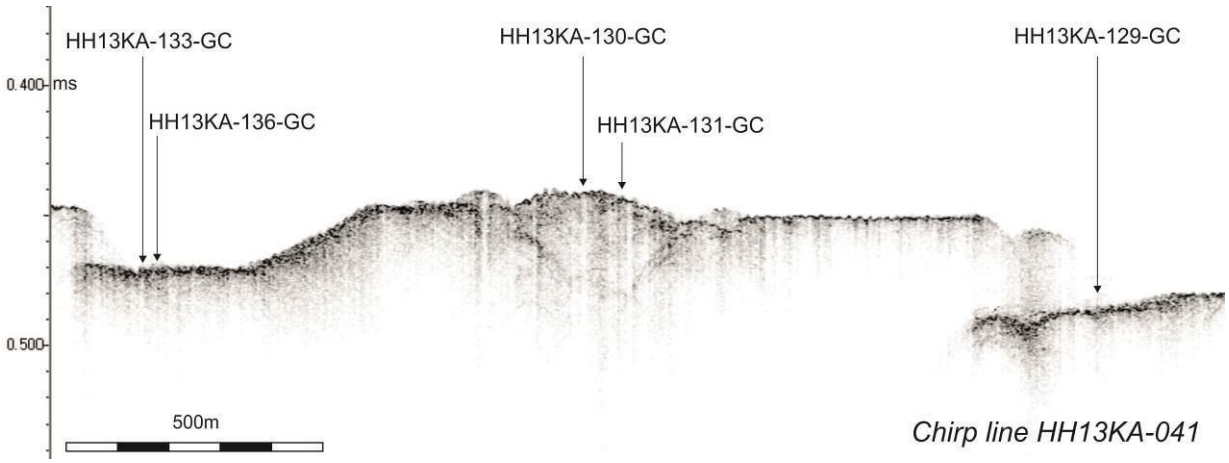

Figure 12. Location of the samplimg sites on Chirp line 041

Sampling stations HH13-136GC, HH13-137GC, HH13-138GC, and HH13-139GC

The multibeam survey has allowed recognition of four structures in the north of study area 2, which are similar to each other but different from all other craters (Figure 13, Figure 14, Figure 15). These four craters are accompanied, to their eastern limits, by well-expressed, N-S elongated ridges.

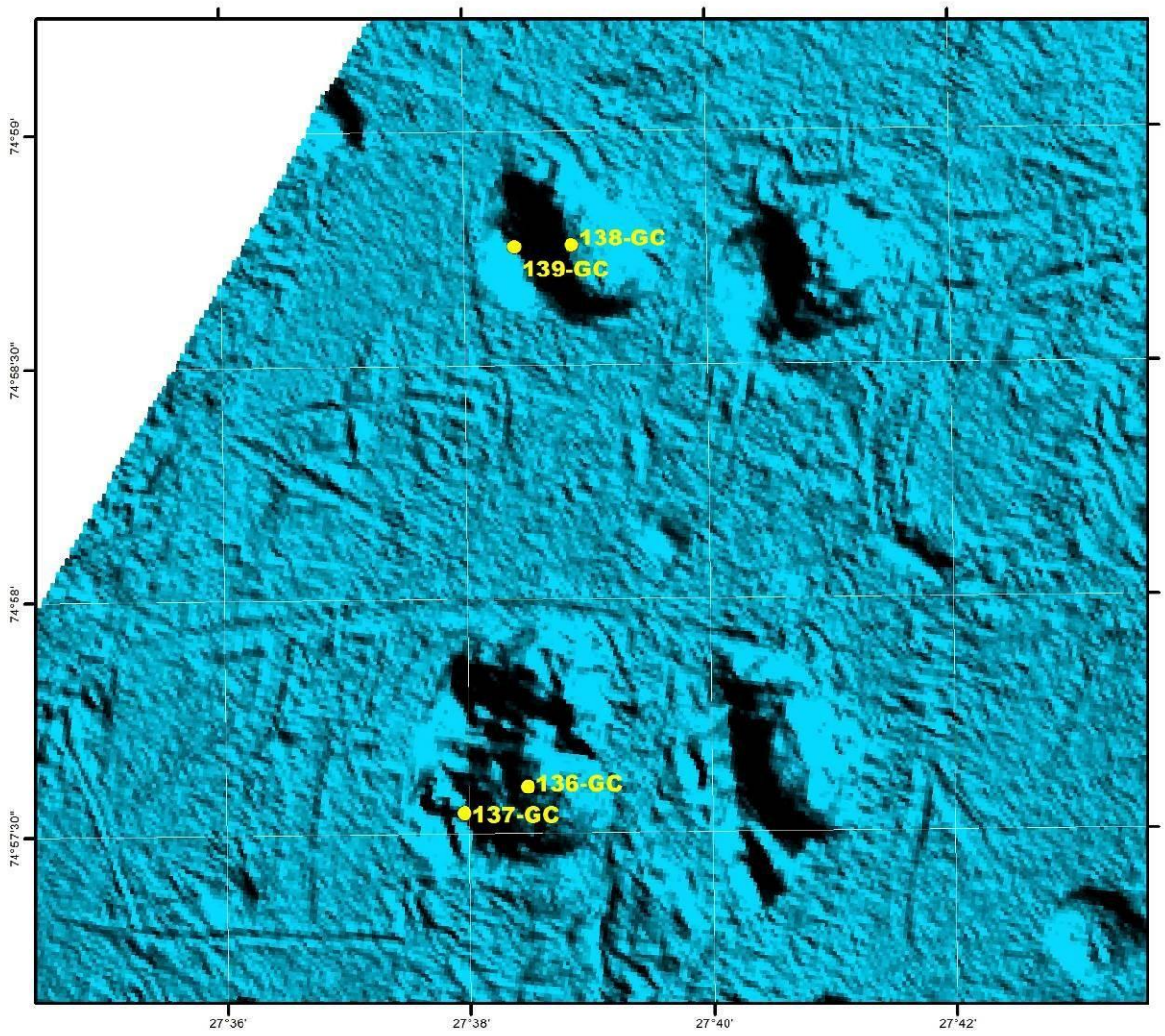

Figure 13. Sampling site location

Two of these features were chosen for bottom sampling, each of which sampled in the depression and at the most elevated point of the accompanying ridge.

At both the station HH13-136GC (from the ridge) and HH13-137GC (from the depression), collected from the southern structure, the cores consisted of stiff silty clay with many angular rock fragments (till diamicton), overlaid by a hydrotrolite-rich interval of less condensed clay and on top of that a brown, oxidized, Holocene, silty clay (Figure 16, Figure 17).

The core HH13-138GC sampled the ridge of the northern structure. It recovered only a small amount of sediment and some angular rock fragments in the core catcher. Overall the recovered material looked quite similar to till deposits mixed with Holocene clay.

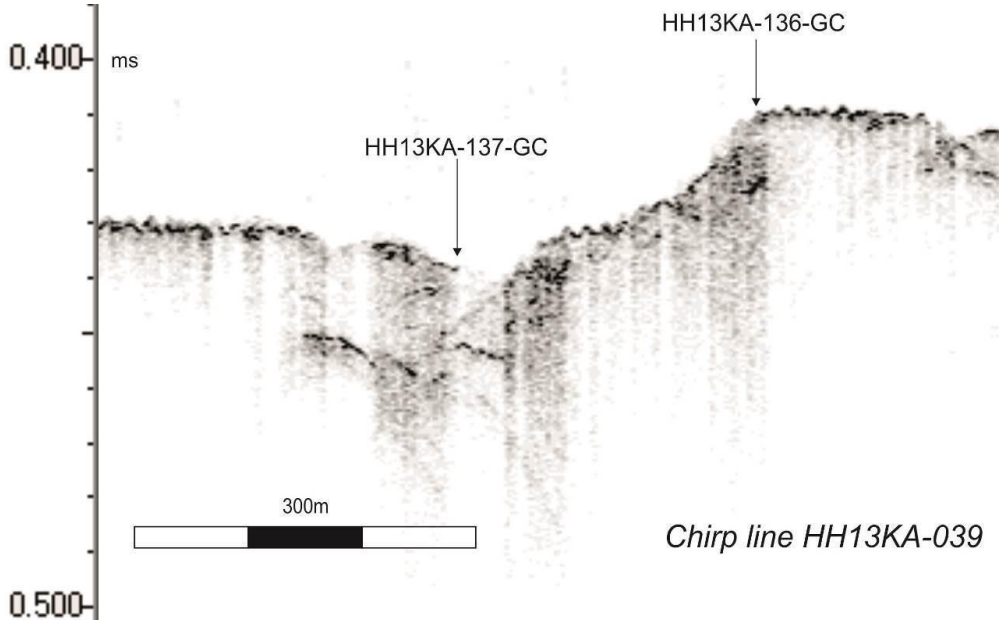

Figure 14. Location of sampling sites on Chirp line 039

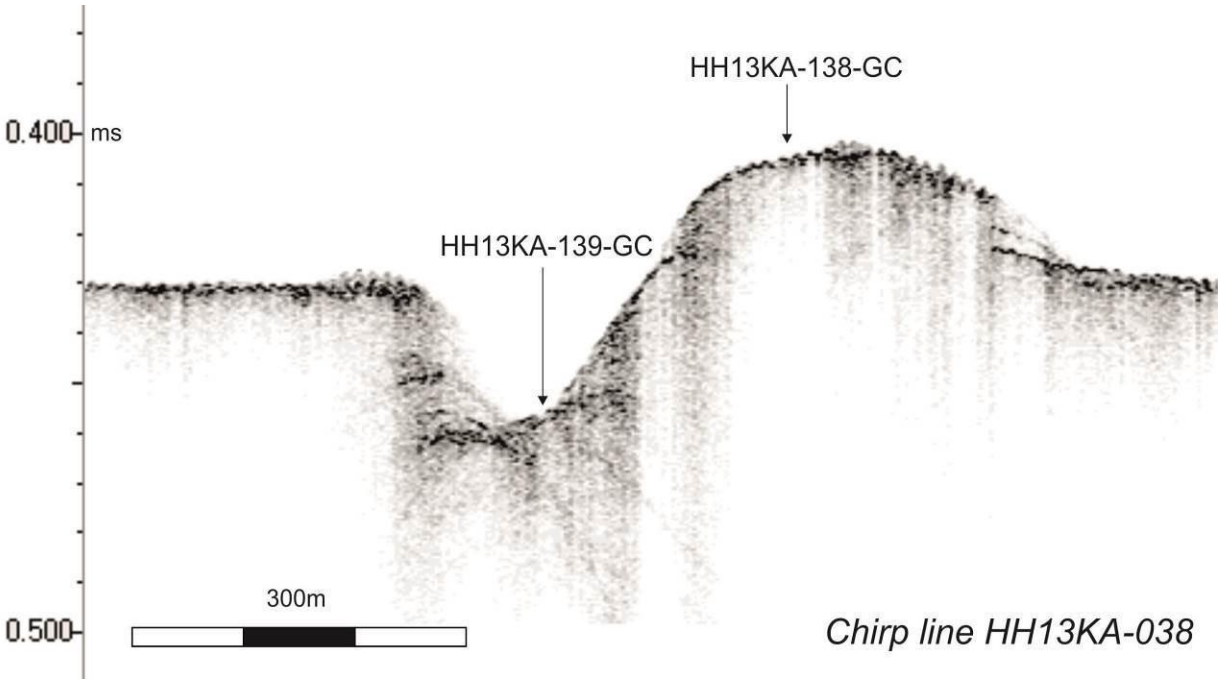

Figure 15. Location of sampling sites on Chirp line 038

The core HH13-139GC got a surprisingly a long recovery – 244 cm (Figure 18). The uppermost and lowermost intervals of the core were very similar to those from the station HH13-137GC. They consisted of Holocene, brown, silty clay and till diamicton, stiff clay like typically found in other cores from the area. This particular core was interlayered, unlike the others, with a very thick interval of almost homogeneous and well sorted, grey clay. Most probably, this interval was deposited by some kind of gravity flow within a relatively short period of time or even as result of one single sedimentary event (e.g. turbidite, slide deposit). However, it is not clear where this large amount of material could possibly come from, particularly in this area which all previous sampling showed, is characterized almost by a lack of soft sediments.

R/V Helmer Hanssen Cruise HH13 **CORE 136 GC**

Location: Bjørnøyrenna

Latitude: 74°57.601' N **Date:** 01.08.2013

Longitude: 27°38.481' E **Recovery:** 58 cm

Water Depth: 307 m

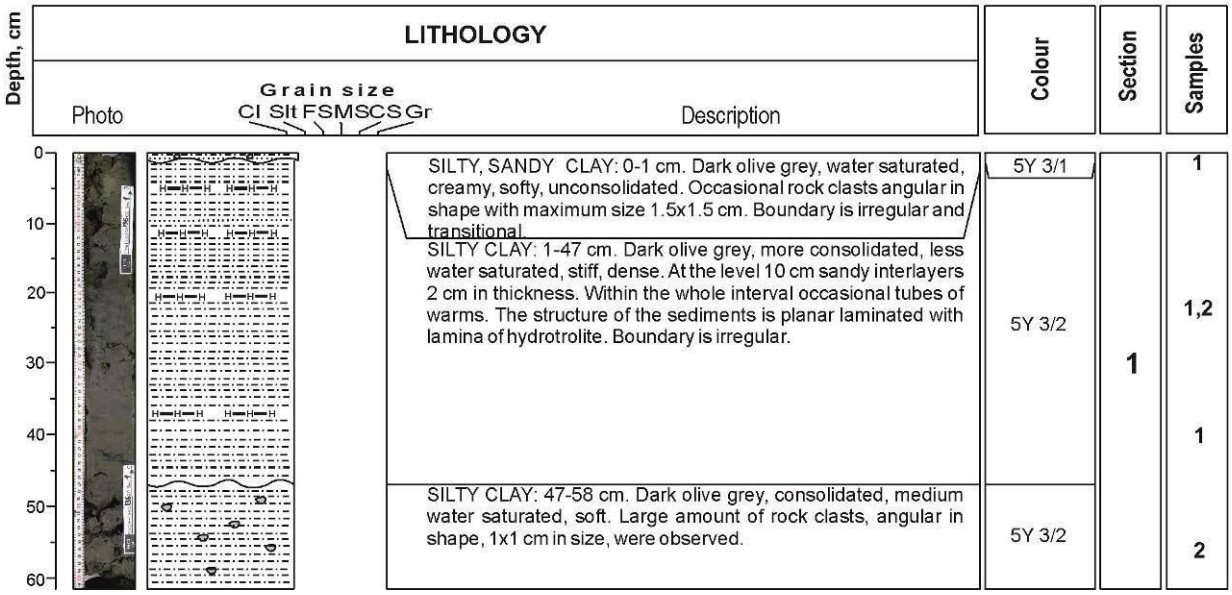

Figure 16. Core log HH13KA-136GC

R/V Helmer Hanssen Cruise HH13KA **CORE 137 GC**

Location: Bjørnøyrenna

Latitude: 74°57.545' N **Date:** 1.08.2013

Longitude: 27°37.957' E **Recovery:** 22 cm

Water Depth: 334 m

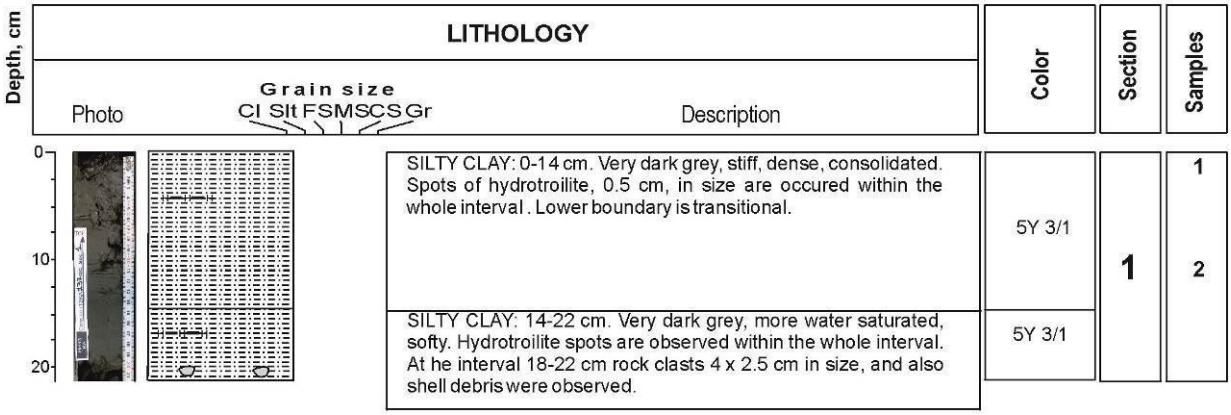

Figure 17. Core log HH13KA-137GC

Area 3

Sampling stations HH13-140GC and HH13-141GC

Several NW elongated, narrow and sub-parallel ridges with relatively flat tops were mapped with multi-beam in study area 3 (Fig. 5). The topmost part of two those ridges was cored (Figure 19) in order to validate the assumption that they could be ice rafted mega-blocks, continuing a chain of such structures known from the south-west.

Only a short recovery of mainly stiff, grey clay with many angular rock clasts, overlain by brown Holocene, silty clayey sediments was obtained at both sites, leaving the question about the origin of these ridges still open (Figure 20, Figure 21).

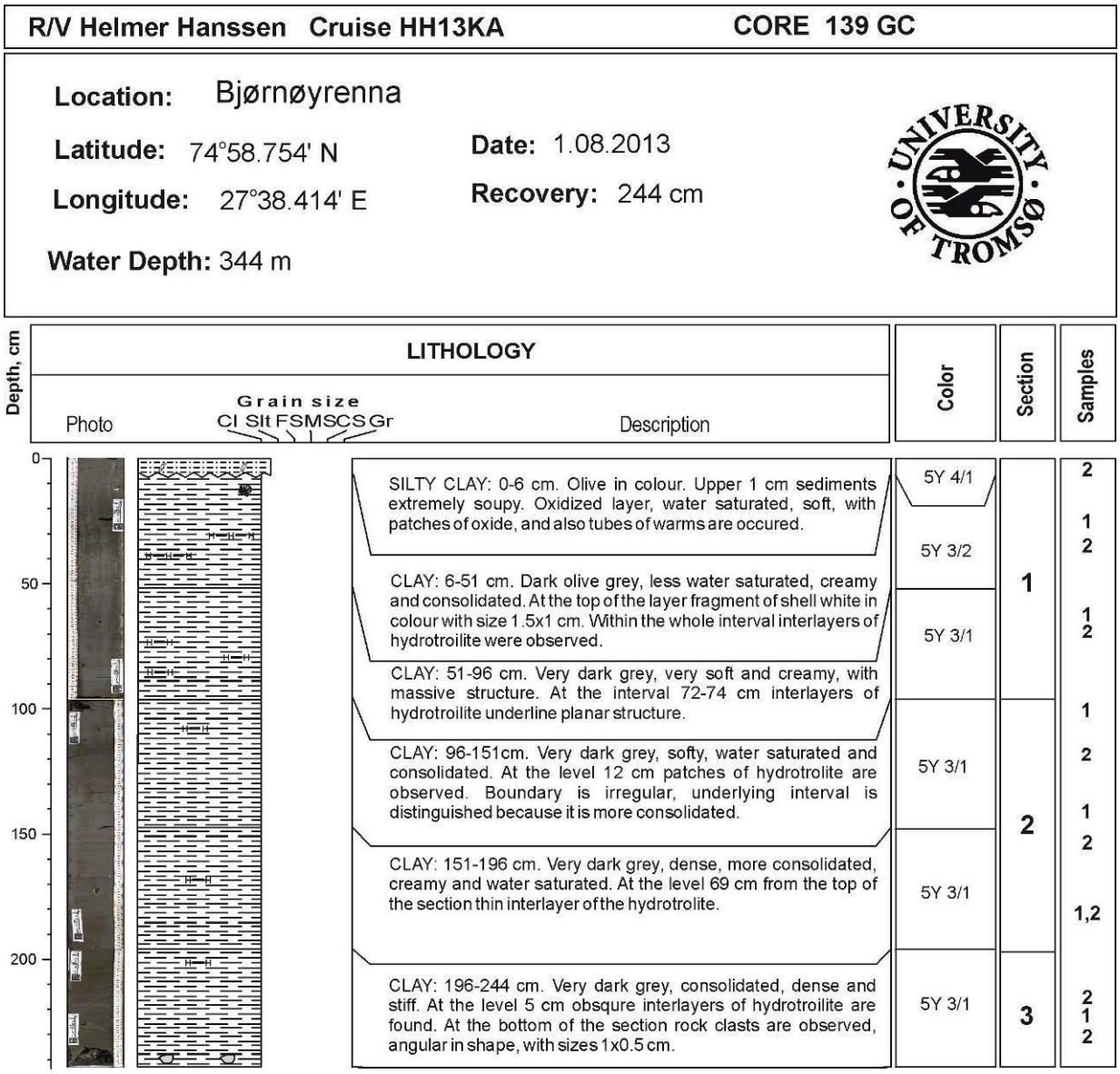

Figure 18. Core log HH13KA-139GC

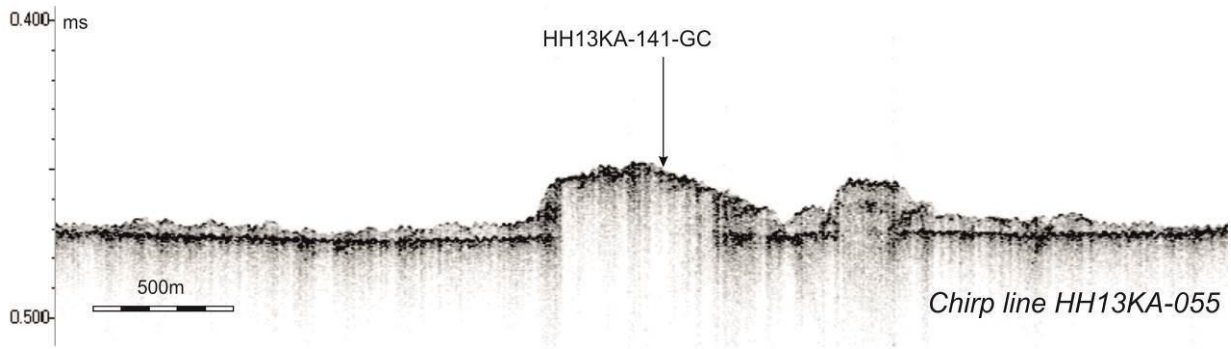

Figure 19. Location of the sampling site on Chirp line 055

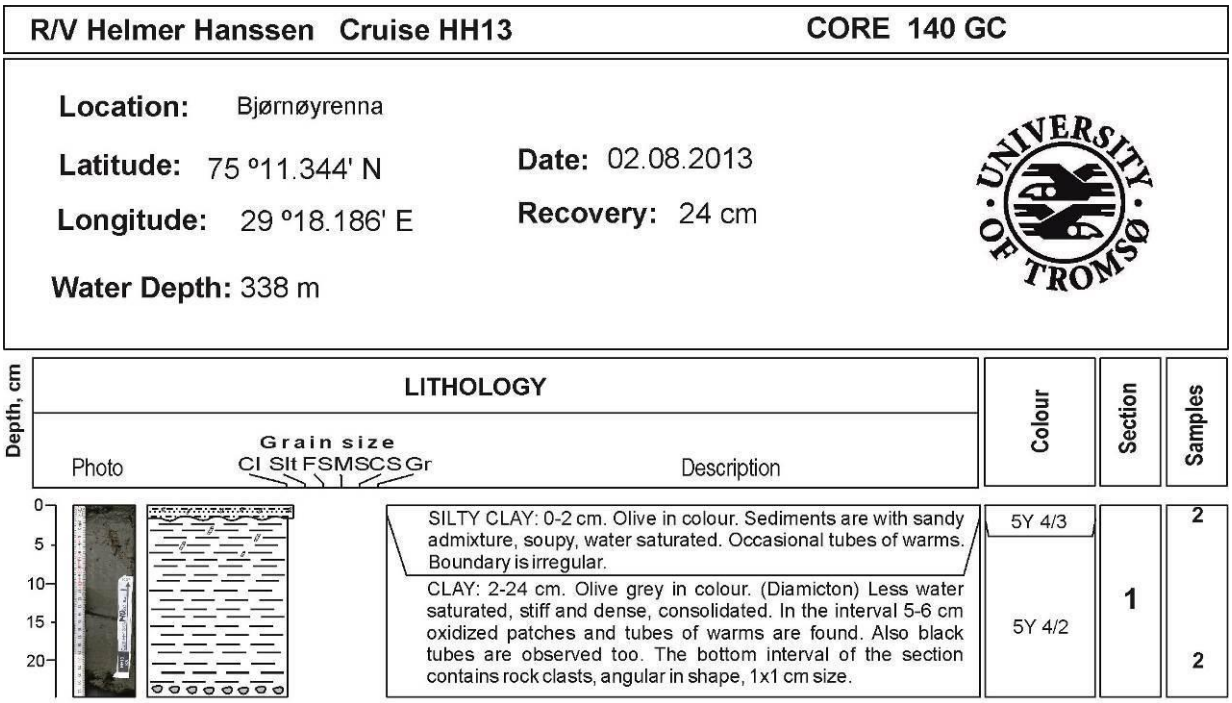

Figure 20. Core log HH13KA-140GC

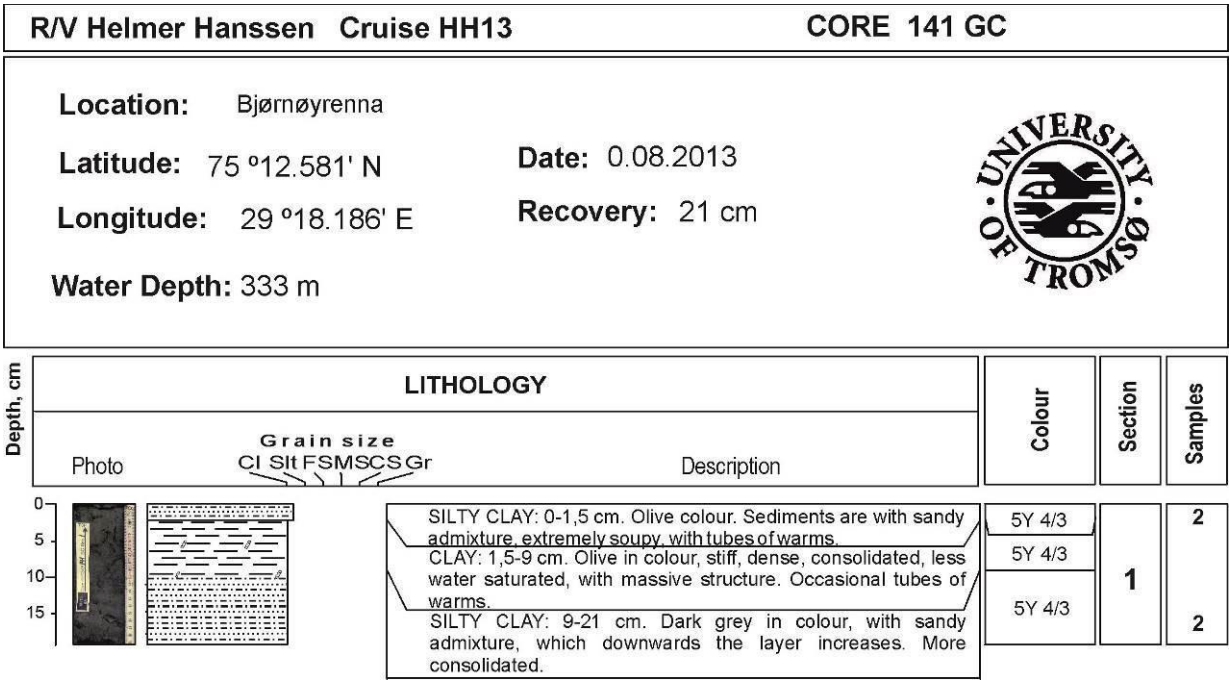

Figure 21. Core log HH13KA-141GC

6.3. Linelog on RV Helmer Hanssen July 28 – 4th August. 2013 Storfjordrenna, Bjørnøyrenna

Line name	Date	Location	Start (UTC)	Start Latitude North	Start Longitude East	End (UTC)	End Latitude North	End Longitude East	MB Line Count	Shot rate [sec]	Pulse mode Chirp	Ship's speed [kn]	Comments
Geo8144_064(?)	28/07	Transit Lyb-Storfjordrenna	19:20	78º13.7	15 º35.0	07:55	76º20.886	16º08.059	??-352	1	1.5-9khz,40ms	10	Transit to work area in Storfjorden
HH13KA000	29/07	Transit Lyb-Storfjordrenna	08:08	76º19.020	16º13.592	08:27	76º16.302	16º22.266	0000-0001	1	1.5-9khz,40ms	10	Transit to work area in Storfjorden (New project start)
HH13KA001	29/07	Storfjordrenna	08:42	76º14.019	16º25.738	10:11	76º01.232	16º53.771	0002-0006	1	1.5-9khz,40ms	10	Storfjorden
HH13KA002	29/07	Storfjordrenna	10:15	76º01.558	16º53.630	11:31	75º58.199	16º05.895	0008-0011	1	1.5-9khz,40ms	10	Storfjorden
HH13KA003	29/07	Storfjordrenna	12:10	75º58.368	16º08.700	13:17	76º02.107	16º51.063	0013-0015	1	1.5-9khz,40ms	9	Storfjorden
HH13KA004	29/07	Storfjordrenna	13:23	76º02.599	16º49.261	13:58	76 º00.594	16 º25.756	0017-0019	1	1.5-9khz,40ms	10	Storfjorden
HH13KA005	29/7	Storfjordrenna	14:07	76 º00.955	16 º23.108	14:44	76 º03.666	16 º46.641	0020-0021	1	1.5-9khz,40ms	10	Storfjorden
HH13KA006	29/7	Storfjordrenna	15:10	76 º04.458	16 º44.475	16:53	75 º56.695	15 º37.168	0023-0026	1	1.5-9khz,40ms	10	Storfjorden
HH13KA007	29/7	Storfjordrenna	16:59	75 º57.405	15 º 37.247	18:46	76º05.293	16º45.282	0028-0032	1	1.5-9khz,40ms	10	Storfjorden
HH13KA008	29/7	Storfjordrenna	18:51	76 º 05.665	16 º 43.671	20:30	75 º 58.682	15º42.198	0033-0037	1	1.5-9khz,40ms	10	Storfjorden
HH13KA009	29/7	Storfjordrenna	20:38	75 º 59.136	15º40.576	21:48	76 º04.463	16 º26.910	0038-0043	1	1.5-9khz,40ms	10	Storfjorden

HH13KA010	29/7	Storfjordrenna	22:19	76 º04.360	16 º26.363	22:43	76 º06.213	16 º42.167	0043-0044	1	1.5-9khz,40ms	10	Storfjorden
HH13KA011	29/7	Storfjordrenna	22:46	76 º06.672	16 º41.585	00:30	75 º59.511	15 º38.452	0045-0048	1	1.5-9khz,40ms	10	Storfjorden

Airgun: MiniGI (15/15 cu inch), ca 0.5 l, shotrate 3s, towed 35 meters behind vessel at 2m water depth

Subbottom profiler: Edgetech hullmount chirp 4x4 transducer array, freq.range 1.5-9kHz, 4kW, shot rate 1s.
Multibeam: Kongsberg EM300, 32 kHz.

HH13KA012	29/7	Storfjordrenna	00:37	76 º00.219	15 º38.256	02:14	76 º 07411	16 º 41377	0050-0054	1	1.5-9khz,40ms	10	Storfjorden
HH13KA013	30/7	Storfjordrenna	02:18	76 º07.819	16 º 40.017	03:36	76 º 02212	15 º 49 833	0055-0058	1	1.5-9khz,40ms	10	Storfjorden
HH13KA014	30/7	Storfjordrenna	03:39	76 º02.593	15º 49.031	04:38	76 º 06.904	16 º 25.166	0059-0061	1	1.5-9khz,40ms	10	Storfjorden
HH13KA015	30/7	Storfjordrenna	04:44	76º07.183	16º21.758	05:28	76 º04.124	15 º54.104	0062-64	1	1.5-9khz,40ms	10	Storfjorden
HH13KA016	30/7	Storfjordrenna	05:32	76 º04.699	15 º54.075	06:00	76 º06.681	16 º10.826	0065-66	1	1.5-9khz,40ms	10	Storfjorden
HH13KA017	30/7	Storfjordrenna	06:02	76 º07.075	16 º09.050	06:29	76 º05.213	15 º51.790	0067-0068	1	1.5-9khz,40ms	10	Storfjorden
HH13KA018	30/7	Storfjordrenna	06:33	76 º05.601	15 º46.319	06:54	76 º05.697	16 º01.902	0068-0072	1	1.5-9khz,40ms	10	Storfjorden
HH13KA019	30/7	Storfjordrenna	06:56	76 º06.681	16 º01.881	07:22	76 º03.081	15 º59.597	0073-0075	1	1.5-9khz,40ms	10	Storfjorden
HH13KA020	30/7	Storfjordrenna	08:06	76 º03.209	16 º00.627	08:25	76 º02.899	16 º08.511	0077-0078	1	1.5-9khz,40ms	10	Storfjorden
HH13KA021	30/7	Storfjordrenna	09:14	76 º03.058	16 º08.196	09:58	75 º57.248	16 º19.087	0080-0082	1	1.5-9khz,40ms	10	Storfjorden
HH13KA022	30/7	Storfjordrenna	10:24	75 º57.672	16 º18.669	10:34	75 º56.877	16 º22.499	0084-0085	1	1.5-9khz,40ms	10	Storfjorden
HH13KA023	30/7	Storfjordrenna	10:34	75 º56.877	16 º22.499	10:44	75 º57.023	16 º23.138	0086-0087	1	1.5-9khz,40ms	10	Storfjorden
HH13KA024	30/7	Storfjordrenna	10:44	75 º57.023	16 º23.138	10:50	75 º57.012	16 º26.256	0088-0089	1	1.5-9khz,40ms	10	Storfjorden
HH13KA025	30/7	Storfjordrenna	10:50	75 º57.012	16 º26.256	11:41	75 º59.521	16 º59.868	0090-0092	1	1.5-9khz,40ms	10	Storfjorden
HH13KA026	30/7	Storfjordrenna	11:50	75 º58.339	17 º02.127	12:35	75 º56.348	16 º32.177	0093-0095	1	1.5-9khz,40ms	10	Storfjorden
HH13KA027	30/7	Storfjordrenna	13:08	75º57.801	16º37.117	13:26	75 º57.648	16 º36.866	--	1	1.5-9khz,40ms	10	Storfjorden
HH13KA028	30/7	Storfjordrenna	13:59	75º56.537	16º32.995	14:39	75 º52.349	16 º51.678	0096-0098 (take out 0097)	1	1.5-9khz,40ms	10	Storfjorden

HH13KA029	30/7	Storfjordrenna	14:40	75 º52.188	16 º51.466	15:20	75 º49.330	16 º24.913	0100-0101	1	1.5-9khz,40ms	10	Storfjorden
HH13KA030	30/7	Storfjordrenna	15:27	75 º49.245	16 º28.437	16:06	75 º49.496	16 º37.17	0103	1	1.5-9khz,40ms	10	Storfjorden
HH13KA031	30/7	Transit	16:36	75 º49.444	16 º38.317	09:44	75 º04.857	27 º55.091	0105-0141	1	1.5-9khz,40ms	10	Transit to Bjørnøyrenna

HH13KA032	31/7	Bjørnøyrenna	10:20	75 º05.172	27 º56.092	12:32	74 º45.739	27 º14.216	0143-0147	1	1.5-9khz,40ms	10	Bjørnøyrenna
HH13KA033	31/7	Bjørnøyrenna	12:36	74 º45.553	27 º16.181	14:50	75 º03.521	27 º58.076	0149-0153	1	1.5-9khz,40ms	10	Bjørnøyrenna
HH13KA034	31/7	Bjørnøyrenna	14:54	75 º04.089	27 º59.438	16:59	74 º45.476	27 º18.672	0155-0159	1	1.5-9khz,40ms	10	Bjørnøyrenna
HH13KA035	31/7	Bjørnøyrenna	17:13	74 º46.436	27 º12.831	19:22	75 º04.871	27 º53.578	0162-0167	1	1.5-9khz,40ms	10	Bjørnøyrenna
HH13KA036	31/7	Bjørnøyrenna	19:27	75 º05.055	27 º51.746	21:35	74 º46.515	27 º10.728	0168-0172	1	1.5-9khz,40ms	10	Bjørnøyrenna
HH13KA037	31/7	Bjørnøyrenna	21:56	74 º47.305	26 º47.116	23:14	74 º54.056	27 º35.27	0173-0177	1	1.5-9khz,40ms	10	Bjørnøyrenna
HH13KA038	1/8	Bjørnøyrenna	00:15	74 º 58.814	27 º 34.307	00:59	74 º58.687	27 º46.410	0180-0182	1	1.5-9khz,40ms	10	Bjørnøyrenna **seismic**
HH13KA039	1/8	Bjørnøyrenna	01:15	74 º 59.082	27 º 46.127	01:15	74 º57.443	27 º29.803	0183-0185	1	1.5-9khz,40ms	10	Bjørnøyrenna **seismic**
HH13KA040	1/8	Bjørnøyrenna	02:19	74 º 57.580	27 º 31.060	03:15	74 º55.234	27 º44.878	0186-0188	1	1.5-9khz,40ms	10	Bjørnøyrenna **seismic**
HH13KA041	1/8	Bjørnøyrenna	03:39	74 º 54.042	27 º 41.048	04:39	74 º 56.766	27 º 26.313	0189-0191	1	1.5-9khz,40ms	10	Bjørnøyrenna **seismic**
HH13KA042	1/8	Bjørnøyrenna	04:47	74 º 56.736	27 º 27.482	06:05	74 º 50.712	27 º 36.361	0192-0195	1	1.5-9khz,40ms	10	Bjørnøyrenna **seismic**
HH13KA043	1/8	Bjørnøyrenna	06:28	74 º 50.712	27 º 26.313	06:46	74 º 52.550	27 º 33.374	0196-0197	1	1.5-9khz,40ms	10	Bjørnøyrenna, tansit to core station HH13KA120-GC, HH13KA-121-GC
HH13KA044	1/8	Bjørnøyrenna	08:11	74 º 54.188	27 º 29.281	08:30	74 º 54.302	27 º 30.701	0199-0200	1	1.5-9khz,40ms	10	Bjørnøyrenna, tansit to core station HH13KA123-GC

HH13KA045	1/8	Bjørnøyrenna	08:38	74 ° 54.376	27 ° 30.861	09:29	74 ° 55.011	27 ° 31.635	0201-0203	1	1.5-9khz,40ms	10	Bjørnøyrenna, core station HH13KA124-GC transit to core station HH13KA-125-GC
HH13KA046	1/8	Bjørnøyrenna	09:31	74 ° 54.970	27 ° 31.559	10:47	74 ° 53.523	27 ° 32.483	--	1	1.5-9khz,40ms	10	core station HH13KA-126-GC, HH13KA-127-GC, HH13KA-128-GC
HH13KA047	1/8	Bjørnøyrenna	10:47	74 ° 53.523	27 ° 32.483	11:46	74 ° 55.345	27 ° 33.488	--	1	1.5-9khz,40ms	10	Bjørnøyrenna, transit to core station HH13-129-GC, HH13-130-GC
HH13KA048	1/8	Bjørnøyrenna	11:46	74 ° 55.345	27 ° 33.488	12:13	74 ° 55.312	27 ° 33.962	--	1	1.5-9khz,40ms	10	Bjørnøyrenna core station HH13KA-131
HH13KA049	1/8	Bjørnøyrenna	12:29	74 ° 55.180	27 ° 31.784	13:02	74 ° 55.252	27 ° 31.677	--	1	1.5-9khz,40ms	10	Bjørnøyrenna core station HH13KA-132
HH13KA050	1/8	Bjørnøyrenna	13:08	74 ° 55.441	27 ° 32.109	14:07	74 º55.622	27 º31.702	--	1	1.5-9khz,40ms	10	Bjørnøyrenna core station HH13KA-133 HH13KA-134
HH13KA051	1/8	Bjørnøyrenna	14:08	74 º55.620	27 º31.653	15:04	74 º56.152	27 º39.521	--	1	1.5-9khz,40ms	10	Bjørnøyrenna core station HH13KA-135
HH13KA052	1/8	Bjørnøyrenna	15:05	74 º56.116	27 º39.890	16:16	75 º57.638	27º38.286	--	1	1.5-9khz,40ms	10	Bjørnøyrenna core station HH13KA-136 HH13KA-137
HH13KA053	1/8	Bjørnøyrenna	16:17	74 º57.664	27º38.334	17:20	74 º58.853	27º38.682	--	1	1.5-9khz,40ms	10	Bjørnøyrenna core station HH13KA-138 HH13KA-139
HH13KA054	1/8	Bjørnøyrenna	17:32	74 º59.256	27º42.365	19:05	75 º03.017	28º42.519	0204-0205	1	1.5-9khz,40ms	10	Bjørnøyrenna

HH13KA055	1/8	Bjørnøyrenna	19:33	75 º03.452	28º41.933	21:04	75 º14.274	29º25.320	0206-0209	1	1.5-9khz,40ms	10	Bjørnøyrenna
HH13KA056	1/8	Bjørnøyrenna	21:09	75 º14.489	29º23.398	22:08	75 º07.917	28º56.886	0211-213	1	1.5-9khz,40ms	10	Bjørnøyrenna
HH13KA057	1/8	Bjørnøyrenna	22:16	75 º08.484	28º55.731	23:11	75 º15.090	29º23.181	0214-0216	1	1.5-9khz,40ms	10	Bjørnøyrenna
HH13KA058	1/8-2/8	Bjørnøyrenna	23:41	75º14.073	29º28.138	00:18	75 º10.021	29º11.624	0217-0221	1	1.5-9khz,40ms	10	Bjørnøyrenna
HH13KA059	2/8	Bjørnøyrenna	00:31	75º11.219	29º15.955	02:03	75 º11.311	29º16.798	Em off	1	1.5-9khz,40ms	10	Bjørnøyrenna
HH13KA060	2/8	Bjørnøyrenna	02:03	75 º 11.311	29º16.798	03:09	75 º 03.255	28 º 44.084	0223-	1	1.5-9khz,40ms	10	Bjørnøyrenna, Multibeam off at first, logging from 02:10
HH13KA061	2/8	Bjørnøyrenna	03:12	75 º 03.255	28 º 44.084	04:20	75 º 03.901	28 º 01.661	0226-0228	1	1.5-9khz,40ms	10	Bjørnøyrenna
HH13KA062	2/8	Bjørnøyrenna	04:20	75 º 03.901	28 º 01.661	06:33	74 º 44.910	27 º 19.999	0229-234	1	1.5-9khz,40ms	10	Bjørnøyrenna
HH13KA063	2/8	Bjørnøyrenna	06:39	74 º 44.622	27 º 22.031	08:24	75 º 01.173	27 º 57.886	0235-0239	1	1.5-9khz,40ms	10	Bjørnøyrenna
HH13KA064	2/8	Bjørnøyrenna	08:29	75 º 00.778	27 º 59.852				0240-	1	1.5-9khz,40ms	10	Bjørnøyrenna