R/V Helmer Hanssen

(Leg 1) 29-06-2025 to 05-07-2025

Longyearbyen – Tromsø

(Leg 2) 07-07-2025 to 04-08-2025

Tromsø – Tromsø

(Leg 3) 05-08-2025 to 15-08-2025

Tromsø – Tromsø

UiT -IG25-10 Cruise Report

(The Norwegian Offshore Directorate Cruise name: 2025-NOD-02)

Bathymetric Survey in the Northern Greenland Sea and the Norwegian Sea, Knipovich and Mohns Ridge

Chief Scientist: Solveig Adine Osjord

Capt. R/V Roger Dahl Thoresen (Leg 1), Nils E. Tøllefsen (Leg 2), Roger Dahl Thoresen (Leg 3)

Report prepared by: Solveig Adine Osjord,

With contributions from: Harald Sund, Andreas Bjørnestad, Stormer Alexander Jensen, Knut Ola Dølven, Carl Ballantine, Richard Buvang

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Participants list

Knut Ola Dølven (Leg 1)	UiT The Arctic University of Norway
Stormer Alexander Jensen (Leg 1 and 2)	UiT The Arctic University of Norway
Solveig Adine Osjord (Leg 1 and 2)	The Norwegian Offshore Directorate
Harald Sund (Leg 1)	The Norwegian Offshore Directorate
Carl Ballantine (Leg 2 and 3)	UiT The Arctic University of Norway
Andreas Bjørnestad (Leg 3)	The Norwegian Offshore Directorate
Richard Buvang (Leg 3)	UiT The Arctic University of Norway

Preface and acknowledgement

This document reports on the acquisition of multibeam, gravimetry and magnetometry, and the production of multibeam data acquired during a two-leg cruise with the UiT research vessel RV Helmer Hanssen from 29th of June to 15th of August 2025. The cruise was a collaborative project between the Department of Geosciences at UiT Norway's Arctic University and the Norwegian Offshore Directorate (NOD)/Sokkeldirektoratet (Sodir).

We thank both captains and their crews of R/V Helmer Hanssen for their outstanding support during this hydrographic survey, and for their successful navigation.

Tromsø, 2025

Introduction and objectives

The cruise aimed to map the seafloor in the southwestern Knipovich area, and at the eastern flank of the Mohns Ridge in the Lofoten Basin (yellow outlines in Figure 1). Mapping of the Knipovich region consisted of a multibeam survey with additional water column data, whereas the mapping in the Lofoten Basin retrieved gravimetric and magnetic data in addition to multibeam and water column data.

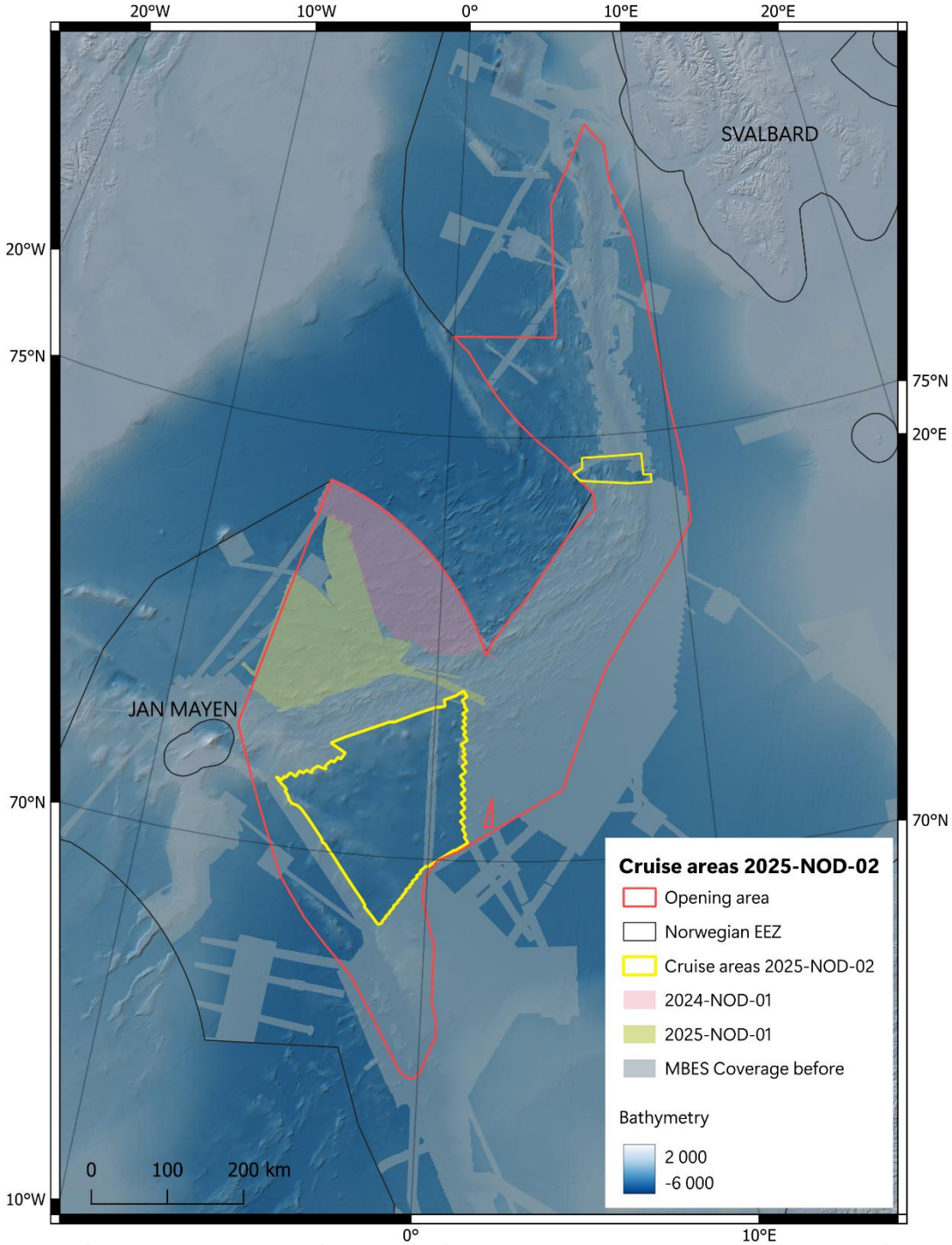


Figure 1: Location of the two study areas in the Norwegian and Greenland seas for the 2025-NOD-02 cruise. Multibeam data coverage in green and pink are the last two mapping cruises that NOD had in 2024 and 2025. Multibeam data coverage from other cruises (Mareano, NOD, UiT etc.) is outlined in grey. Polygons with yellow outline marks the two study areas for this cruise (2025-NOD-02).

Methods

Multibeam echosounder (EM302)

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

R/V Helmer Hanssen is equipped with the hull-mounted Kongsberg Simrad EM302 multibeam echosounder system designed to perform seabed mapping with high resolution and accuracy to a maximum depth of more than 7000 m. The nominal sonar frequency of the sound waves is 30 kHz.

The system has up to 432 beams per swath with pointing angles automatically adjusted according to achievable coverage or operator defined limits. With dual swath (up to 864 beams) the transmit fan is duplicated and transmitted with a small difference in along-track tilt. The applied tilt adjusts for depth, coverage and vessel speed to give a constant beam separation along track.

During this “2025-Sodir-02” survey, single swath was used for the whole area in the southwestern Knipovich (Leg 1) and the Lofoten basin (Leg 2 and 3). The opening angle was set to 40° /40° for the majority of the mapping. In shallower regions, the opening angle was increased to a maximum of 47°/47° for a very short time to avoid gaps in the data. The ping mode settings varied from “deep” to “very deep”.

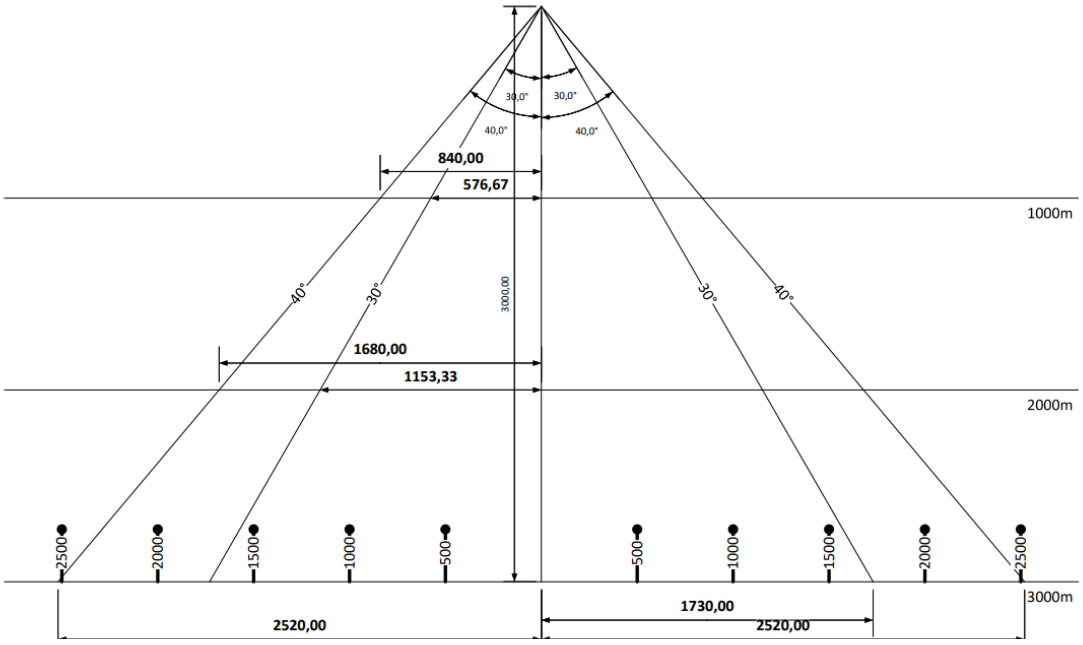


Figure 2: Schematic illustration of swath width at various depths and angles. (Figure: Bjørn Runar Olsen (UiT))

CTD

Conductivity, temperature and depth (CTD) measurements were taken before mapping started on all legs.

Leg 1

One CTD cast was conducted in the upper right corner (Northeast) of the Knipovich mapping polygon.

Coordinates: 74°44.90’ N, 08°45.26’ E

Time stamp (UTC): 04:13

Station: stnr0695

Bottom depth: 2845 m

Leg 2

One CTD cast was conducted in the middle of the eastern edge of the polygon before the mapping started. No more CTDs were necessary.

Coordinates: 74°03.18’ N, 01°12.07’ E

Time stamp (UTC): 06:34

Station: stnr0699

Bottom depth: 3126 m

Leg 3

Coordinates: 70°37.67’ N, 001°20.42’ E

Time stamp (UTC): 2025-08-07 03:50

Station: stnr0703

Bottom depth: 3146 m

Gravimeter

A ZLS Dynamic Gravity Meter, rented from University of Bergen (UiB), has been used for mapping the gravity (mGal) of the underlaying seabed during leg 2 and 3. The instrument was placed in the middle of the boat in the dry lab, to ensure as little wave movement as possible on the instrument. Before the cruise, the instrument was calibrated to a gravity

point in Tromsø with a known gravity count of 6020. The height difference of the sea and the top of the concrete at the harbor that the vessel was docked in was also measured and used for the calibration. After the last leg, the instrument was calibrated to the known absolute gravity in Tromsø again.

The gravimeter started logging the 8th of July when the vessel left Tromsø. Although it does not log well during transit speed (10-11 knots). The multibeam mapping at leg 2 started 10th of July at 9:39 (UTC), the gravimetric data should be used from then until 2nd of August 09:23 (UTC). For leg 3 the gravimetric data should be used from 7th of August 06:50 UTC - 13th of August 02:45 UTC.

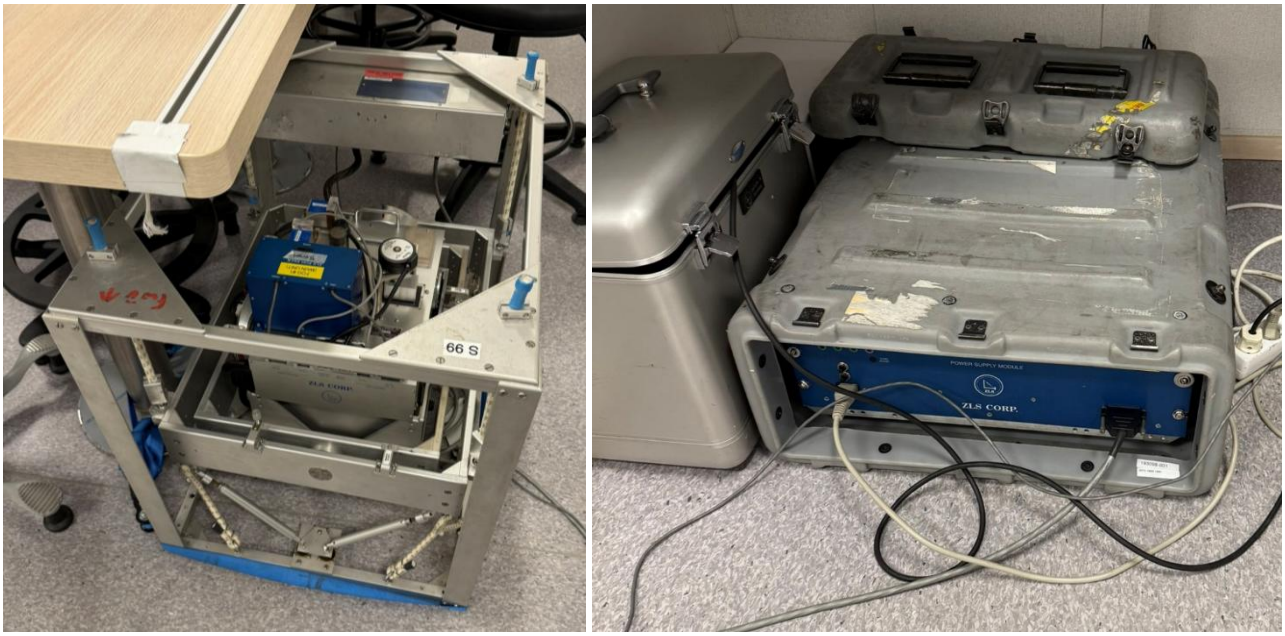


Figure 3: The gravimeter (rented from UiB).

Magnetometer

A G-882 Cesium Marine Magnetometer, rented from UiB, was used for mapping the magnetic signature of the underlaying seabed during leg 2 and 3 in nanotesla (nT). The instrument is a fish that was towed 200 meters behind the vessel during the mapping campaign, while the vessel has been keeping a speed of 7.5 knots. The instrument was first put in the sea upon arrival of the Lofoten basin mapping area. The cable that is connected to the magnetometer fish is connected to a winch that is mounted to the trawl deck.

The magnetometer data should be used from 10th of July at 9:39 (UTC), the magnetic data should be used from then until the multibeam survey ended 2nd of August 09:23 (UTC) from the second leg, and from 7th of august at 06:50 (UTC) to 12th of August at 02:45 (UTC) on the third leg.

The instrument has been pinging since it was setup when the vessel was still docked in Tromsø. It is therefore important to remove the data from the times where it has been pinging on deck (as these signals are faulty).

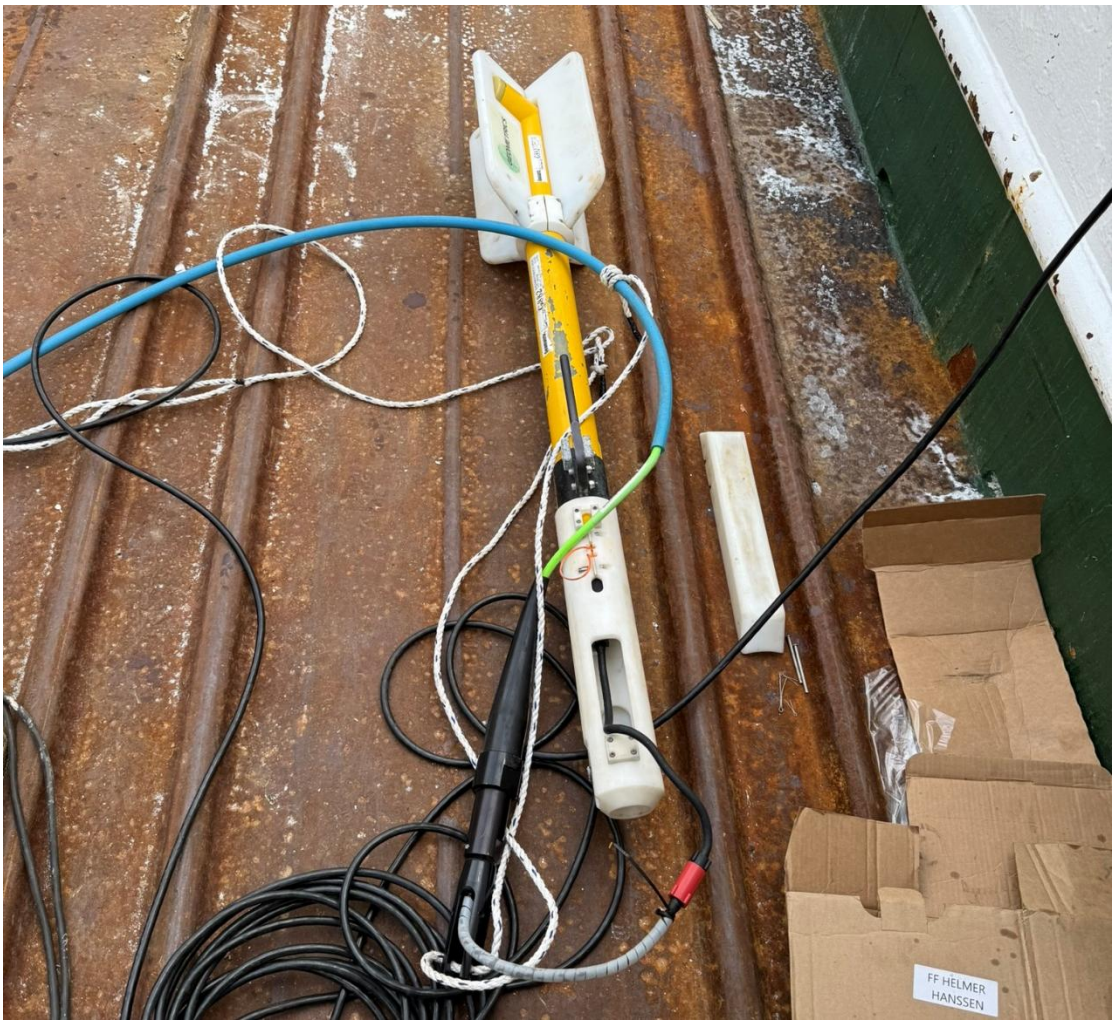


Figure 4. The magnetometer (rented from UiB).

Water column data

Multibeam water column data were collected throughout the survey and are available as *.wcd files.

Data

Multibeam data

Multibeam (MB) data was acquired in the southwestern Knipovich ridge area during leg 1. The two last legs, leg 2 and 3, acquired MB data in the Lofoten basin – in southeastern Mohns Ridge area.

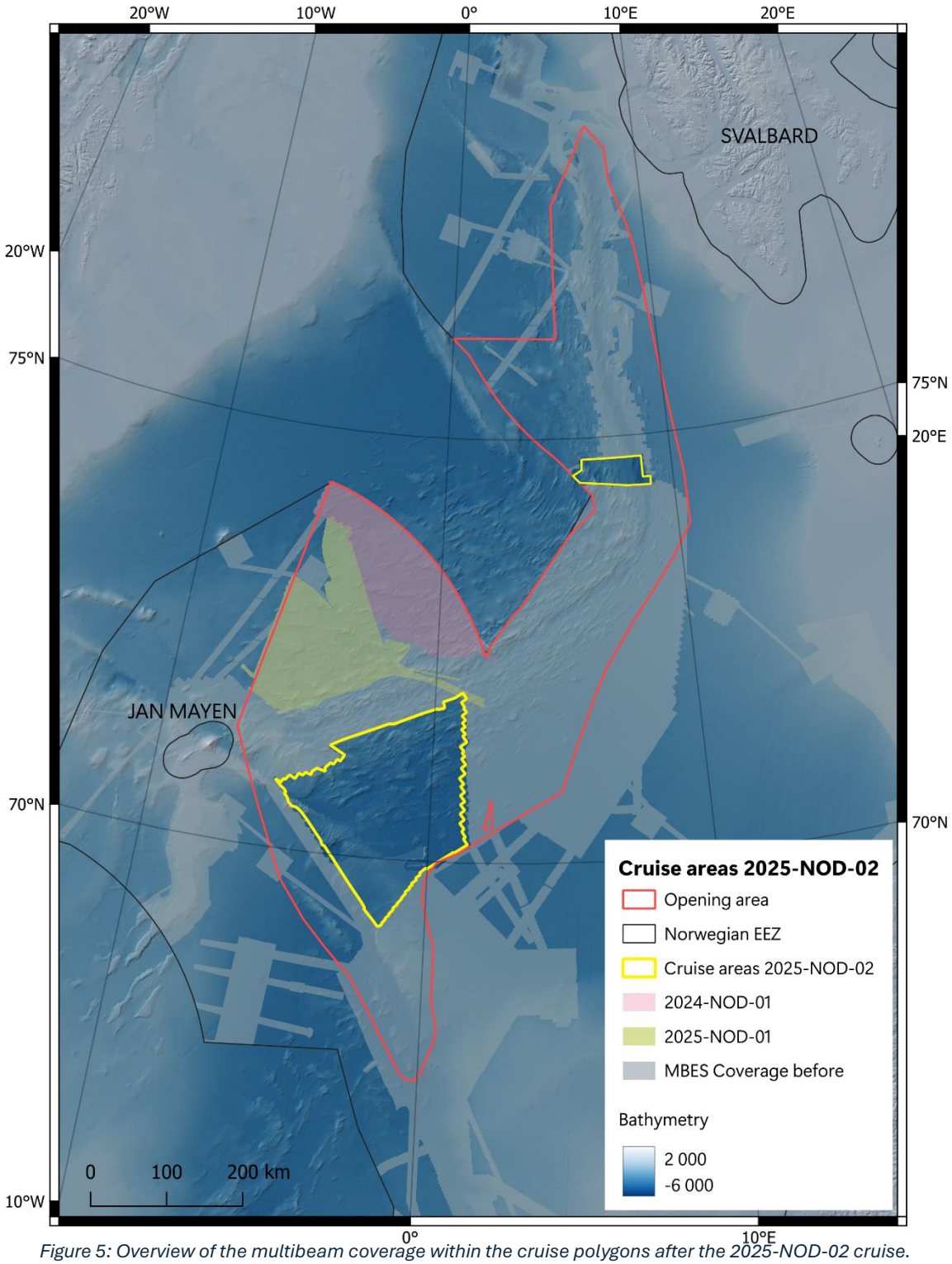


Figure 5: Overview of the multibeam coverage within the cruise polygons after the 2025-NOD-02 cruise.

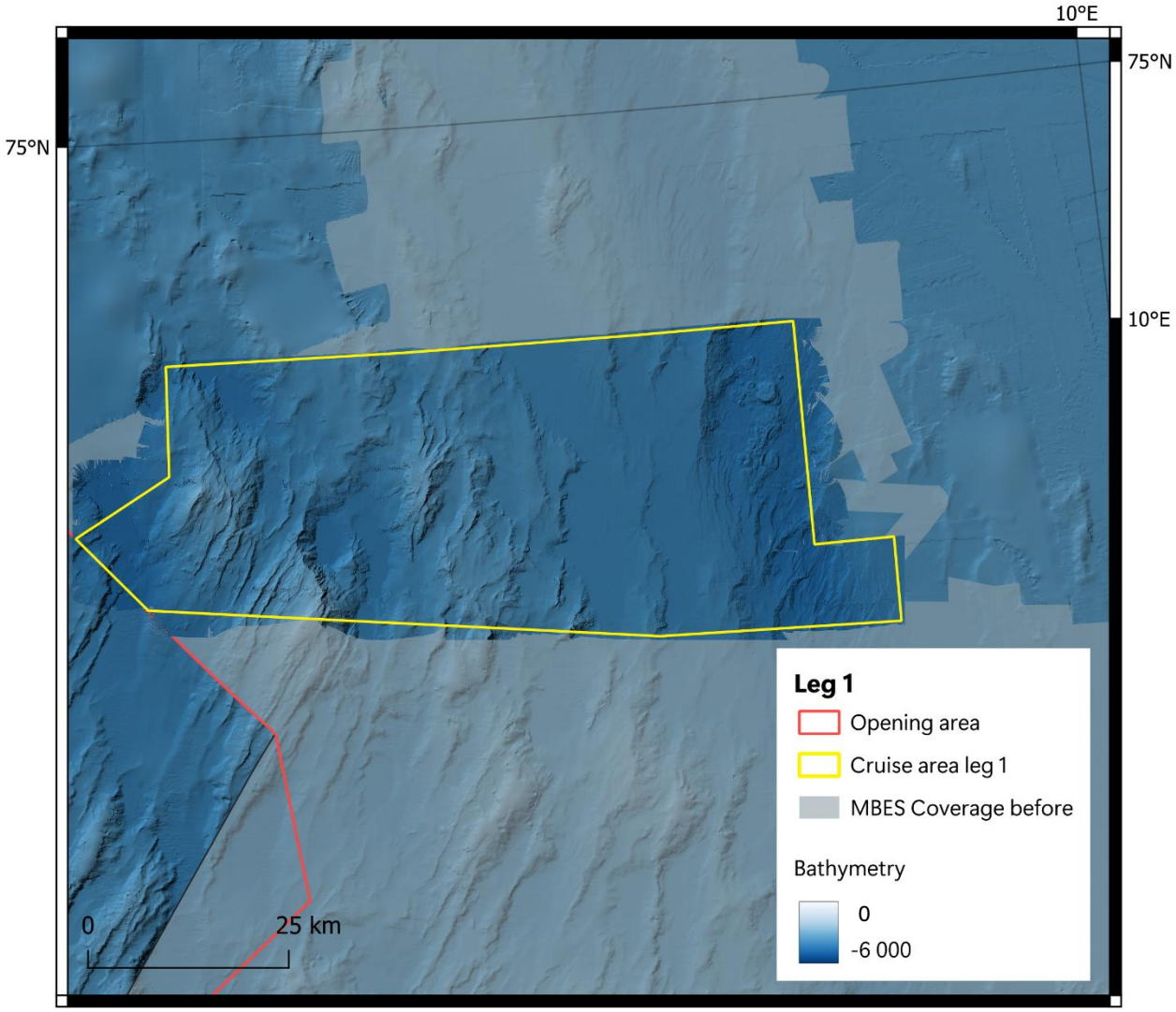


Figure 6: Map of the covered area at Leg 1 in the southern end of the Knipovich Ridge.

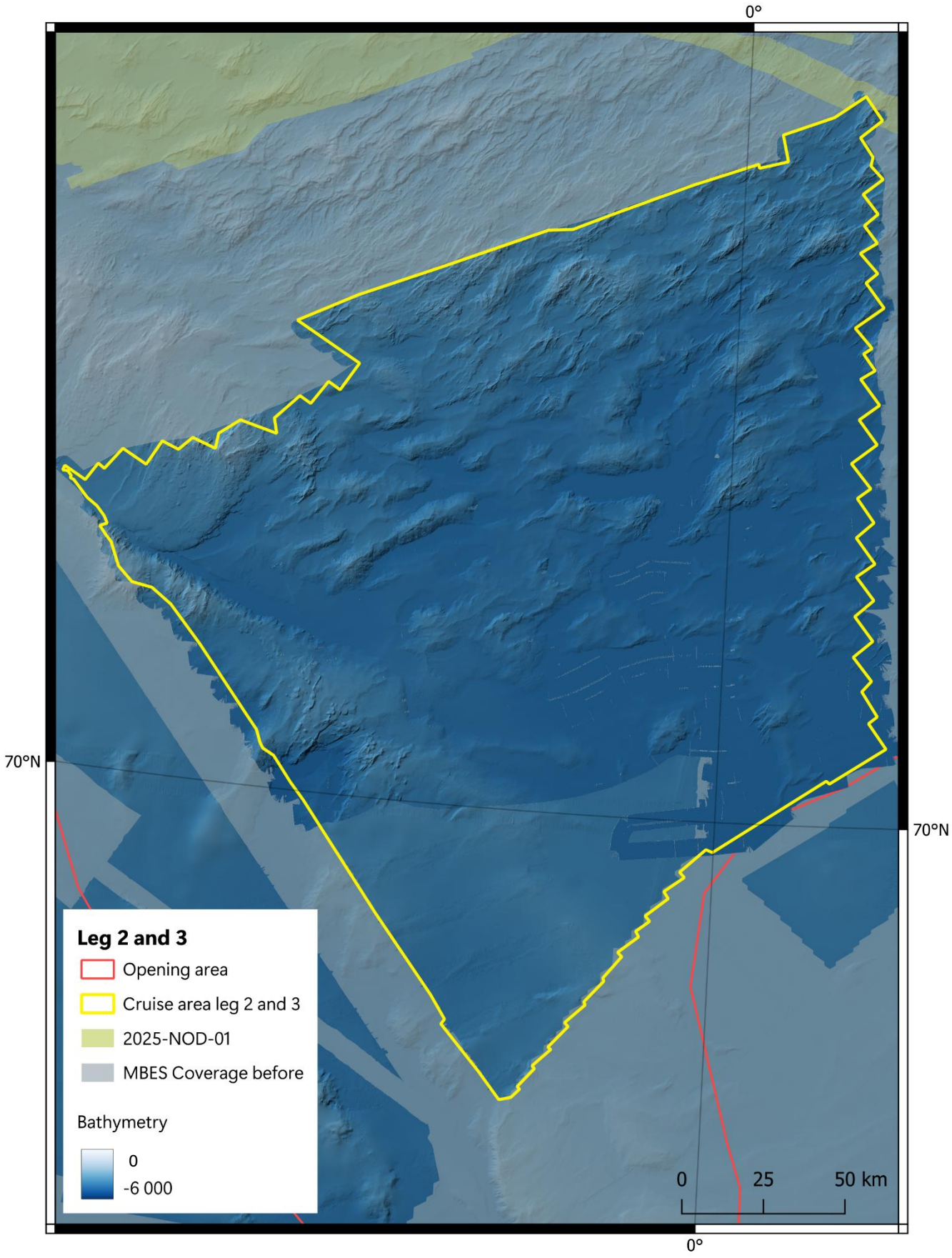


Figure 7: Map of the covered area at Leg 2 and 3 in the Lofoten Basin.

The data was processed onboard and cleaned using Geocap software and subsequently gridded to 25 m resolution. The total MB area covered during this cruise is approximately 40 193 km^2. The MB *.all files are used also for backscatter mosaicking.

The total count of MB lines and *.all files acquired while on site, are listed (Table x).

Table 1: Area coverage (in km^2) of the three different legs, and total.

Area	Area (km^2) before mapping	Area (km^2) covered with multibeam (inside polygon)	Total area (km^2) covered (including outside polygon)
Southern Knipovich (leg 1)	2 985	2 985	3 400
Lofoten Basin (leg 2)	41 303	27 302	28 717
Lofoten Basin (leg 3)	41 303	8 107	8 796
Total	44 288	38 394	40 193

*Table 1: Overview of the multibeam lines from the 3 legs. *Note that the multibeam files from the transit in and 'area' both start at 0000. Dates in the rest of the file name should be used to distinguish between the two.*

Part of cruise	Dates	Multibeam line	Transit in, area, transit out
Leg 1	29th of June -5th of July	0001-0214	0000-0035*, 0000-0158, 0159-0214
Leg 2	7th of July – 4th of Aug	0000-1307	0000-0067, 0068-1231, 1232-1307
Leg 3	5th – 15th of Aug	0000-0430	0000-0072, 0073-0362, 363-0430

Additional objectives

Rig pick-up UiT

A subsurface mooring was recovered from the South Cape of Spitsbergen (76°06.420' N, 15°58.020' E) on June 30th, 2025. The mooring was deployed on May 22nd, 2024 as part of the Norwegian node for the European Multidisciplinary Seafloor and water column Observatory (NorEMSO) project - an initiative aimed at filling a critical observational gap in the Nordic Seas within the broader EMSO ERIC infrastructure. The mooring was

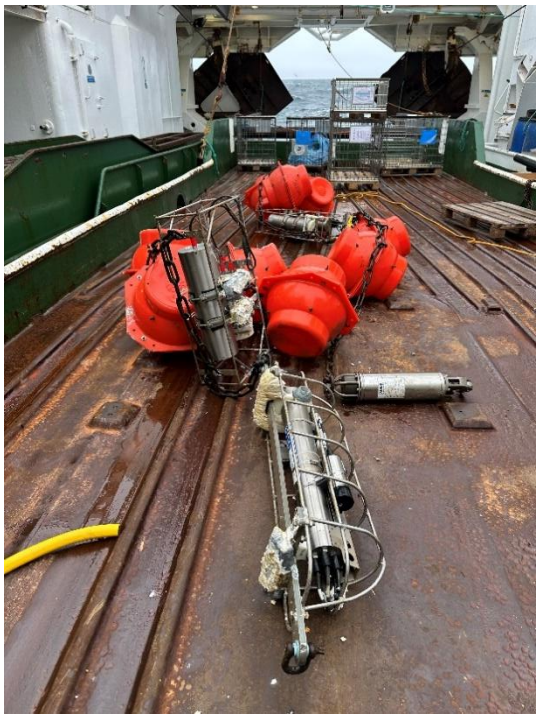
deployed in an area where previous hydroacoustic data and ROV observations have revealed active methane release from nearby pingo structures. With an instrument payload consisting of two 4H-Jena Contros HydroC CH_4 methane sensors (13 and 140 meters above the seafloor (mab)), two SeaBird CTDs (240 and 280 mab), one SeaBird SeaPhOx CTD (13 mab), and one upward-looking Teledyne RDI Sentinel ADCP (150 mab), the mooring was designed to monitor methane variability in relation to ambient environmental conditions. The recovery operation was conducted in three stages i) CTD cast and water sampling ii) Multibeam survey and iii) mooring retrieval.

The CTD cast was performed at the mooring recovery site on June 30th at 05:55 UTC. Water samples were collected at seven depths above the seafloor: 5, 10, 70, 140, 210, 280, and 350 meters. Two water samples were taken at each depth. Bottles were flushed and filled by overflow for a minimum of 10 seconds then treated with NaOH by replacing 1 mL of sample with 1 mL of NaOH solution (prepared as 40 g NaOH per 1000 g water) using a pipette. Treated samples were stored at 4^{o}C for preservation.

A multibeam echosounder survey (EM302 from Kongsberg) was conducted beginning at 06:57 UTC on June 30th. The survey included four lines traversing the mooring area (See Table) and was a repetition of a survey conducted during the deployment cruise. The aim of the previous and current multibeam surveys were to map the seafloor topography and identify potential gas releases and/or changes in observed seepage.

Line	Time start	Latitude Start	Longitude Start	Latitude End	Longitude End
1	06:57	76°06.765' N	16°05.023' E	76°05.016' N	15°54.685' E
2	07:36	76°05.133' N	15°53.075' E	76°07.606' N	16°07.920' E
3	08:23	76°07.629' N	16°05.936' E	76°05.440' N	15°52.338' E
4	09:08	76°05.829' N	15°52.007' E	76°07.599' N	16°03.341' E

The mooring was successfully recovered using the ship's starboard-side crane without any operational difficulties (see accompanying photos). Instruments were secured and will be disassembled for data extraction upon return to the laboratory.



Gas seep

Passing over a point at the seafloor where there has been observed a natural seepage of gas. This point was located on the transit from Knipovich to Tromsø –it was natural to pass over it on the way to land.

Seep 7017_08: 70°23.115’ N, 17°27.030’ E.

Diapir region in the Lofoten basin

On the transit from Tromsø to the study area in the Lofoten basin we sailed over an area where diapirs have been identified. The goal was to collect multibeam data just south of a previous multibeam line to confirm whether there were more diapirs south as well.

This region was passed on the transit in and out of the Lofoten basin mapping area at leg 2 and 3.

Data processing

Data products

The MB data products for bathymetry are distributed by the Norwegian Offshore Directorate (NOD) by the webpage www.sodir.no. Data products are projected to WGS84/ UTM31N (EPSG:32631).

Appendix

Line log and station log

Line log (leg 1, 2 and 3)

Location	Line name/ number	Date (UTC) START	Time (UTC) START	Latitude START	Longitude START	Time (UTC) STOP	Latitude STOP	Longitude STOP	MB Lines	Speed kn	Notes
Transit_west	x1	30.06	11:21	76 05.541 N	15 47.600 E	23:27	75 17.620 N	08 03.868 E	000-024	10	
Transit	x2	30.06	23:29	75 17.469 N	08 03.637 E	04:07	74 44.880 N	08 45.306 E	026-035	7,5	
Survey Area	1	01.07	06:10	74 44.184 N	08 40.753 E	12:00	74 44.262 N	05 59.380 E	001-012	7,5	New survey, 2025-NOD-02
Knipovich southwest	2	01.07	12:12	74 42.584 N	05 57.303 E	18:15	74 42.424 N	08 41.016 E	014-026	7,5	
Knipovich southwest	3	01.07	18:34	74 40.499 N	08 41.885 E	00:26	74 40.828 N	05 59.028 E	028-039	7,5	
Knipovich southwest	4	02.07	00:41	74 38.810 N	05 58.711 E	06:25	74 38.573 N	08 41.227 E	041-052	7,5	
Knipovich southwest	5	02.07	06:54	74 36.229 N	08 41.575 E	13:25	74 37.670 N	05 49.395 E	054-067	7,5	Wind from southwest, 4-6m high waves
Knipovich southwest	6	02.07	14:13	74 35.135 N	05 36.909 E	17:10	74 36.114 N	06 58.617 E	070-075	7,5	Wind from southwest, 4-6m high waves
Knipovich southwest	7	02.07	17:10	74 36.114 N	06 58.899 E	20:58	74 33.729 N	08 42.286 E	076-083	7,5	Wind from southwest, 4-6m high waves
Knipovich southwest	8	02.07	21:18	74 31.263 N	08 41.706 E	04:30	74 29.472 N	05 33.676 E	086-100	7,5	
Knipovich southwest	9	03.07	04:54	74 30.541 N	05 40.099 E	12:40	74 28.261 N	09 02.331 E	102-117	7,5	
Knipovich southwest	10	03.07	13:00	74 25.724 N	09 01.755 E	19:04	74 30.052 N	06 15.273 E	120-132	7,5	
Knipovich southwest	11	03.07	19:21	74 32.599 N	06 15.293 E	20:33	74 28.132 N	06 05.437 E	134-136	7,5	
Knipovich southwest	12	03.07.	20:39	74 28.083 N	06 08.048 E	03:13	74 25.831 N	08 25.283 E	138-152	7,5	
Transit	13	04.07	03:14	74 28.083 N	06 08.048 E	03:14	70 07.689 N	17 57.920 E	152-0215	10	

Lofoten basin	1	10.07	09:39	71 00.032 N	001 08.069 E	17:01	71 53.488 N	000 57.006 E	72	7,5	
Lofoten basin	2	10.07	17:08	71 53.819 N	000 54.851 E	17:56	71 57.609 N	001 09.538 E	89-90	7,5	
Lofoten basin	3	10.07	18:08	71 57.315 N	001 06.654 E	18:40	72 00.341 N	000 58.419 E	92-93	7,5	
Lofoten basin	4	10.07	18:55	71 59.274 N	000 59.754 E	20:54	71 52.653 N	000 18.050 E	95-98	7,5	
Lofoten basin	5	10.07	21:12	71 50.752 N	000 18.672 E	23:16	71 57.957 N	1 02.707 E	100-104	7,5	
Lofoten basin	6	11.07	00:00	71 54.098 N	000 59.662 E	13:13	71 16.152 N	003 46.851 W	107-133	7,5	Crossed the first line we went north at the end, for the magnetometer
Lofoten basin	7	11.07	13:31	71 15.179 N	003 41.706 W	02:32	71 51.832 N	000 58.822 E	135-161	7,5	
Lofoten basin	8	12.07	02:58	71 49.786 N	001 01.208 E	15:47	71 14.145 N	003 36.233 W	163-188	7,5	
Lofoten basin	9	12.07	16:11	71 13.571 N	003 29.045 W	04:52	71 48.611 N	001 04.993 E	190-215	7,5	
Lofoten basin	10	13.07	05:14	71 47.075 N	001 07.034 E	18:08	71 12.222 N	003 24.518 W	217-242	7,5	
Lofoten basin	11	13.07	18:24	71 11.507 N	003 19.432 W	06:49	71 44.157 N	001 06.504 E	244-268	7,5	
Lofoten basin	12	14.07	07:02	71 42.873 N	001 07.974 E	01:55	70 47.079 N	005 24.256 W	270-307	7,5	
Lofoten basin	13	15.07	02:42	70 48.275 N	005 35.523 W	03:24	70 45.362 N	005 22.729 W	310-311	7,5	
Lofoten basin	14	15.07	03:33	70 45.472 N	005 19.894 W	22:11	71 39.281 N	001 07.625 E	313-350	7,5	Crossed the first line we went north at the end, for the magnetometer
Lofoten basin	15	15.07	22:26	71 37.750 N	001 08.439 E	16:46	70 43.040 N	005 20.601 W	352-388	7,5	
Lofoten basin	16	16.07	17:05	70 41.748 N	005 16.150 W	11:32	71 35.608 N	001 06.100 E	390-427	7,5	
Lofoten basin	17	17.07	11:52	71 33.615 N	001 07.062 E	06:14	70 40.234 N	005 12.254 W	428-464	7,5	
Lofoten basin	18	18.07	06:35	70 38.221 N	005 11.066 W	01:03	71 31.099 N	001 07.487 E	466-503	7,5	
Lofoten basin	19	19.07	01:32	71 28.989 N	001 07.560 E	19:55	70 37.578 N	005 09.725 W	505-541	7,5	
Lofoten basin	20	19.07	20:02	70 36.956 N	005 09.237 W	14:32	71 27.055 N	001 12.834 E	543-579	7,5	Crossed the first line we went north at the end, for the magnetometer
Lofoten basin	21	20.07	15:07	71 24.569 N	001 09.190 E	09:23	70 36.152 N	005 08.743 W	583-620	7,5	Crossed the first line we went north at the end, for the magnetometer
Lofoten basin	22	21.07	09:29	70 35.575 N	005 08.093 W	03:43	71 21.674 N	001 06.877 E	622-659	7,5	
Lofoten basin	23	22.07	04:15	71 19.065 N	001 04.394 E	21:53	70 34.495 N	005 03.998 W	662-697	7,5	
Lofoten basin	24	22.07	22:07	70 33.423 N	005 03.283 W	15:37	71 16.282 N	001 03.892 E	699-734	7,5	

Lofoten basin	25	23.07	16:07	71 13.824 N	001 06.480 E	09:36	70 32.469 N	005 00.382 W	737-772	7,5	
Lofoten basin	26	24.07	09:47	70 31.489 N	004 59.807 W	03:20	71 11.799 N	001 09.962 E	774-811	7,5	Crossed the first line we went north at the end, for the magnetometer
Lofoten basin	27	25.07	03:50	71 09.247 N	001 09.005 E	20:47	70 29.736 N	004 47.559 W	813-846	7,5	
Lofoten basin	28	25.07	21:11	70 28.217 N	004 41.166 W	13:59	71 06.749 N	001 10.894 E	848 - 881	7,5	Crossed the first line we went north at the end, for the magnetometer
Lofoten basin	29	26.07	14:33	71 03.585 N	001 07.141 E	06:54	70 27.205 N	004 33.853 W	884 -918	7,5	
Lofoten basin	30	27.07	07:06	70 26.560 N	004 31.289 W	23:14	71 00.879 N	001 07.517 E	920 - 953	7,5	
Lofoten basin	31	27.07	23:46	70 58.262 N	001 11.925 E	15:53	70 25.638 N	004 27.498 W	956 - 988	7,5	
Lofoten basin	32	28.07	16:18	70 23.742 N	004 23.924 W	08:15	70 55.765 N	001 12.908 E	990 -1025	7,5	
Lofoten basin	33	29.07	08:39	70 53.240 N	001 12.539 E	00:17	70 21.123 N	004 17.693 W	1027-1059	7,5	
Lofoten basin	34	30.07	00:42	70 18.723 N	004 15.016 W	16:19	70 50.745 N	001 15.152 E	1061 - 1092	7,5	
Lofoten basin	35	30.07	16:46	70 48.049 N	001 14.434 E	08:21	70 16.507 N	004 04.619 W	1094 -1125	7,5	
Lofoten basin	36	31.07	08:44	70 14.474 N	004 01.202 W	23:40	70 45.428 N	001 13.047 E	1127 - 1157	7,5	
Lofoten basin	37	01.08	00:08	70 43.378 N	001 17.976 E	15:02	70 12.417 N	003 54.166 W	1159 - 1191	7,5	
Lofoten basin	38	01.08	15:28	70 09.649 N	003 51.708 W	06:06	70 40.116 N	001 14.394 E	1193 - 1224	7,5	
Lofoten basin	39	02.08	06:34	70 37.679 N	001 17.698 E	08:01	70 36.114 N	000 45.586 E	1126-1128	7,5	
Lofoten basin	40	02.08	08:23	70 33.920 N	000 47.707 E	09:23	70 35.153 N	001 09.070 E	1130-1131	7,5	picked up magnetometer also
		03.08	02:47	70 47.980 N	009 05.750 E	06:02	70 38.195 N	010 17.473 E	1268	8	Multibeam start 8 knop 2
		06.08	09:03	70 14.922 N	010 22.636 E	12:16	70 20.974 N	009 08.687 E	28-34	8	Multibeam start 8 knop 3
Lofoten basin	41	07.08	07:05	70 36.245 N	000 46.523 E	20:25	70 08.438 N	003 45.430 W	73-99	7,5	Magnetometer in ocean 06:50, Linecount 82-3 error:no contact with sonar
Lofoten basin	42	07.08	20:46	70 07.237 N	003 43.127 W	10:04	70 33.916 N	000 48.464 E	101-127	7,5	
Lofoten basin	43	08.08	11:14	70 32.570 N	001 11.460 E	01:36	70 05.474 N	003 42.757 W	131-160	7,5	

Lofoten basin	44	09.08	02:06	70 03.947 N	003 36.139 W	16:05	70 30.253 N	001 15.167 E	162 -189	7,5	
Lofoten basin	45	09.08	16:35	70 27.336 N	001 15.771 E	06:40	70 01.417 N	003 32.344 W	192 -220	7,5	
Lofoten basin	46	10.08	07:02	69 59.453 N	003 27.034 W	20:46	70 24.631 N	001 17.255 E	222 -249	7,5	
Lofoten basin	47	10.08	21:17	70 21.850 N	001 13.467 E	10:22	69 57.762 N	003 18.747 W	252 -278	7,5	
Lofoten basin	48	11.08	10:47	69 55.095 N	002 15.772 W	00:13	70 19.599 N	001 18.293 E	280 - 306	7,5	
Lofoten basin	49	12.08	00:45	70 16.878 N	001 18.096 E	04:39	70 09.4226 N	000 02.017 E	308 - 315	7,5	
Lofoten basin	50	12.08	05:06	70 06.719 N	000 02.569 E	09:15	70 14.468 N	001 22.059 E	317 -325	7,5	Logging started a bit late. Data is in line count 326.
Lofoten basin	51	12.08	09:40	70 11.844 N	001 21.591 E	14:01	70 03.949 N	000 03.820 E	327-335	7,5	
Lofoten basin	52	12.08	14:46	69 58.770 N	000 03.485 W	16:37	70 02.482 N	000 34.275 E	338 - 341	7,5	
Lofoten basin	53	12.08	17:55	69 56.913 N	000 14.219 E	20:44	69 54.438 N	000 45.389 W	345-350	7,5	
Lofoten basin	54	12.08	21:30	69 59.304 N	000 40 755 W	02:21	70 08.295 N	001 02.723 E	353- 362	7,5	Magnetometer crosses line, magnetometer taken out of the water 02:45 utc
	Multibeam Start, 8 Knop 4	13.08	20:39	70 08.433 N	009 07.860 E	23:46	70 05.081 N	010 15.892 E	400- 406	8	

Station log

Station type	Date	Time	Loc.St.no	Latitude	Longitude	Depth	Heading	Speed	Water temp	Wind	Wind dir.	Air temp	Air pressure	Humidity
CTD m/u vann START	01.07	04:13:59	695	7444.904627 N	00845.245738 E	2847.03	21.43	0.4	6.1	7.3	147.4	7.0	1005.8	98.4
CTD m/u vann STOPP	01.07	05:25:38	695	7445.362007 N	00842.885649 E	2875.62	32.33	1.5	6.0	9.2	155.5	7.0	1005.4	98.5
CTD m/u vann START	10.07	06:28:20	699	7103.179665 N	00112.087164 E	3090.57	207.69	0.5	8.8	5.5	200.7	8.6	1004.1	98.6
CTD m/u vann STOPP	10.07	06:31:45	699	7104.054197 N	00112.364225 E	3077.23	133.91	0.5	8.7	4.8	206.9	8.4	1004.6	98.5

CTD m/u vann START	07.08	03:50:46	703	7037.665520 N	00120.423583 E	3146.27	168.27	0.4	12.0	3.9	178.7	11.4	986.5	99.4
CTD m/u vann STOPP	07.08	05:25:44	703	7038.126661 N	00120.125767 E	3144.39	139.06	0.6	12.4	0.9	206.6	11.1	986.6	99.5