CAGE - Centre for Arctic Gas Hydrate Environment and Climate Report Series, Volume 6 (2018)

To be cited as: Ferré, B. (2022). Cruise report CAGE 18-2: LoVe site – exploration around node 7. *CAGE - Centre for Arctic Gas Hydrate Environment and Climate Report Series, Volume 6*. https://doi.org/10.7557/cage.6770
Additional info at: https://septentrio.uit.no/index.php/cage/database

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

Version 0: 18 November 2022
Version 1: 28 November 2022 –publication date in cover page has been corrected

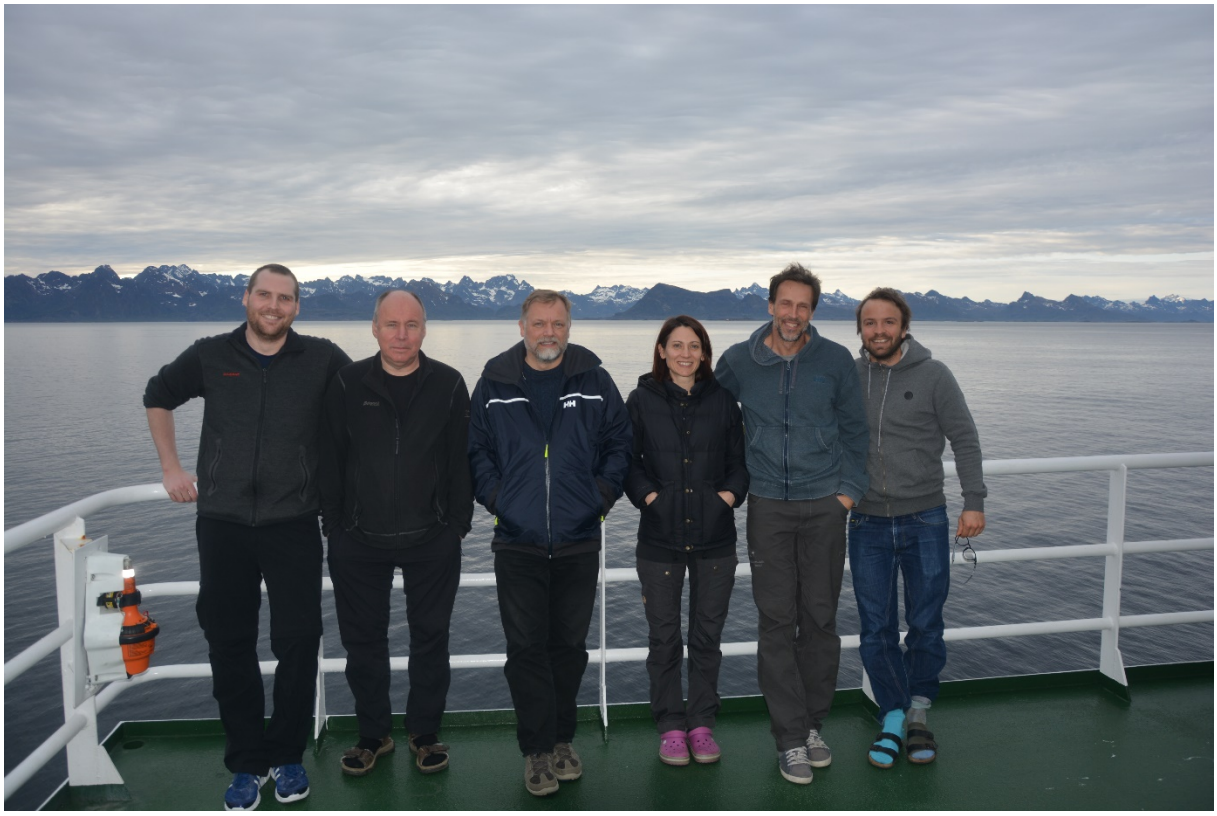
Cruise report CAGE 18-2

LoVe site – exploration around node 7

Tromsø – Tromsø 20-05-18 to 27-05-18

Bénédicte Ferré (chief scientist)

Participants: Knut Ola Dølven, Manuel Moser, Pär Jansson, Bjørn Runar Olsen and Steinar Iversen



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Contents

1. INTRODUCTION AND OBJECTIVES

The cruise was conducted from May 20th to 27th 2018 as part of the Centre of Excellence for Arctic Gas Hydrate, Environment and Climate (CAGE) at UiT – The Arctic University of Norway.

The main goal of the cruise was to explore the area around Node 7 as part of the LoVe (Lofoten-Vesterålen) observatory. The first phase of the LoVe project was founded by Statoil in was first launched in 2013 to observe a cold coral reef. This area is known to be an oceanographic hotspot because the shelf is very narrow and northern drift of warm Atlantic water is concentrated and very dynamic in this area. It is also a biological hotspot because the large oceanic fish stocks are passing through or spawn in the area. It is finally an economic hotspot because the area is expected to hold large oil and gas resources but exploitation of these resources is controversial because of the importance for fish and fishermen in this region. The observatory has 12 sensors on the platform today including a camera looking at the coral reef and echosounders to study the biology.

The second phase of LoVe was granted by the Research Council of Norway in 2015 through the Infrastructure programme, with a network of nodes crossing the main oceanographic and biological processes. The various nodes of the planned transect have specific objectives, and in particular, node 7 is located on top of methane seepages which CAGE is in charge.

The present cruise aimed at performing echosounder and multibeam surveys as well as performing water samples and CTD casts around node 7 and known seepage area. The addressed scientific topics include quantification of methane concentration in the water column, temperature and salinity (via CTD casts), echosounder and multibeam signals and current (amplitude and direction).

2. PARTICIPANT LIST

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3. STUDY AREA

The continental shelf offshore the Vesterålen Islands (Figure 2) is relatively narrow and characterized by numerous banks separated by over-deepened cross-shelf troughs, formed during the last glaciations (Bøe et al., 2009; Godø et al., 2012). The Hola trough is ca. 12 km wide with water depths reaching 270 m at the deepest point and confined by the banks Vesterålsgrunnen to the NE and Eggagrunnen to the SW. Several sand wave fields and cold water coral mounds cover the sea and active seepage and gas flares were first reported by Chand et al. (2008).

The water masses in the area are dominated by Norwegian Coastal Water (NCW) brought by the Norwegian Coastal Current (NCC) flowing along the coast from the southwest and the Norwegian Atlantic Water transported by the Norwegian Atlantic Current (NAC) which follows the continental slope from the southwest. The NAW is colder (2 to 6°C) and fresher (average of 34.5 PSU) than NAW due to water coming from the brackish Baltic Sea as well as the Norwegian fjords and rivers (Sætre, 1999). Norwegian Sea Arctic Intermediate Water (NSAIW) flows below NAW and reaches down to 1000 m, with temperatures from -0.5 to 0.5°C and salinity between 34.87 and 34.90 PSU (Hansen and

Østerhus, 2000). The annual mean bottom water temperature is around 7°C on the shelf, but decreases fast down the slope (Albretsen et al., 2011).

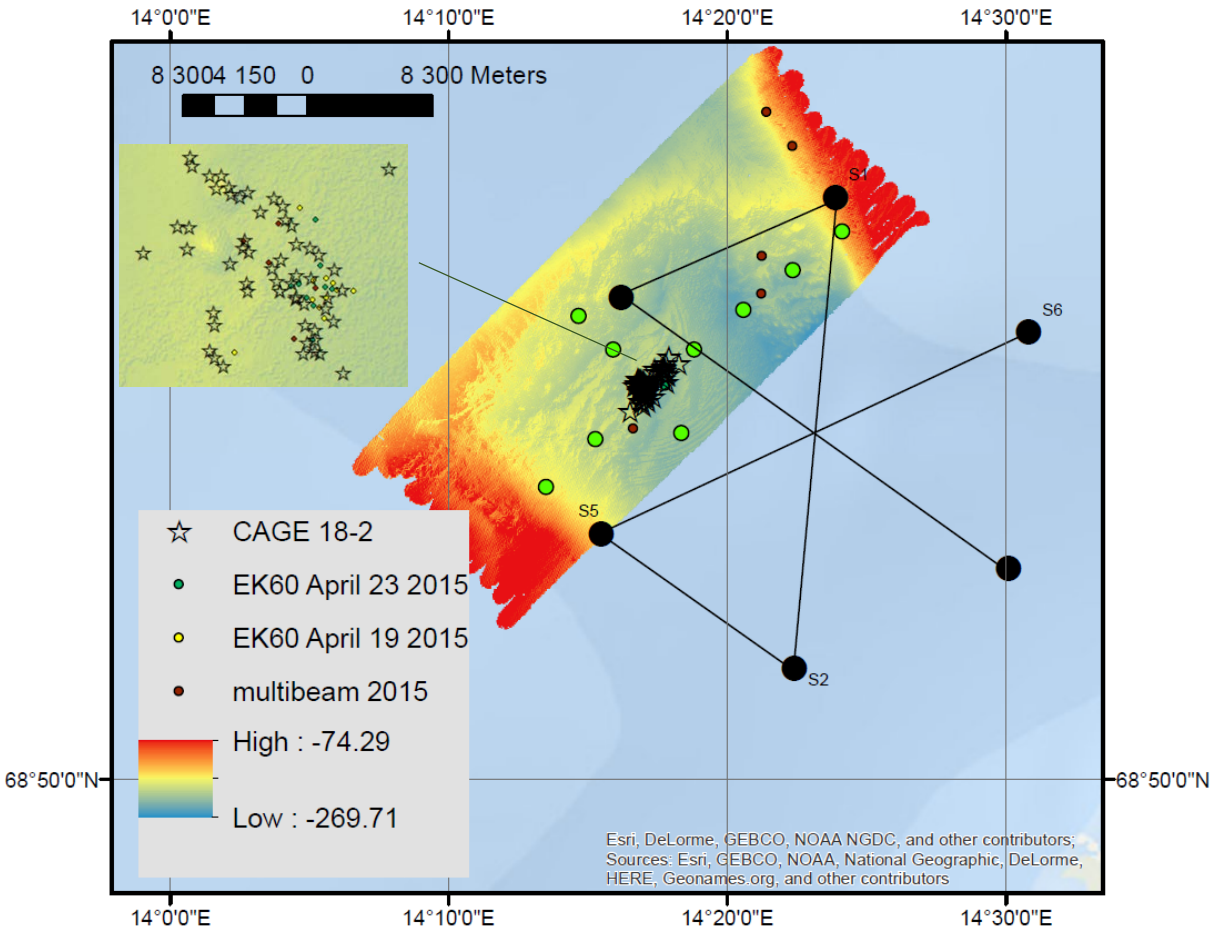

Figure 1. Maps of the main working area, showing previously located flares (circles) and flares located during the present cruise (stars). The transects S* show the echosounder lines performed upon IMR request; CTD stations are shown in green dots. The bathymetry was obtained during this present cruise.

4. METHODS AND PRELIMINARY RESULTS

➢ ECHOSOUNDER EK60 AND MULTIBEAM FOR FLARE OBSERVATION

Single beam echo sounders are common among all types of ships with the main purpose of detecting fish. Here, the Simrad EK60 scientific echosounder system was used at 18 KHz, 38 KHz and 120 KHz to identify active seeps. 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. The multibeam was used with a 30° angle at a speed of 3kn during the small surveys (one and three), and with a 60° angle at a speed of 6kn for the larger area.

The echosounder and multibeam were on during the entire cruise. The new data is used to identify active flares, expand the flares data set and compare with previous flares activity. (cf figure 1 and 2)

A short multibeam survey was performed for water column in the Lofoten canyon area for Jochen Knies (not post-processed yet).

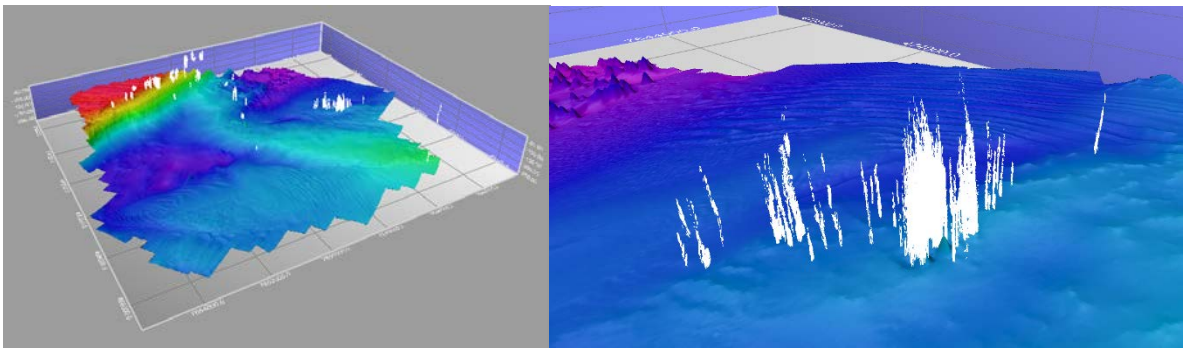

Figure 2. Detected flares in the entire covered area. Right: close up of the most concentrated flares

➢ ADCP

The ship is equipped with a traditional “Ocean Surveyor” Acoustic Doppler Current Profiler (ADCP) from Teledyne RD, operating at 75 kHz. The setup consists of an ADCP transducer / receiver mounted on the lowered keel, 7 meters below the sea surface, a deck unit, communicating with the device and a standard PC in the Instrument room. The ADCP provides current amplitude and direction, as well as backscatter information.

➢ 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 can measure or calculate salinity of seawater, density, P-wave velocity, turbidity, fluorescence/chlorophyll, and oxygen content.

R/V Helmer Hanssen uses SBE 911plus CTD to produce vertical profiles of seawater properties. A winch is used to lower the CTD system into the water at 1 m/s. The CTD sensors record data at a rate of 24 samples per second.

A total of 12 × 5-liters Niskin bottles are attached to the CTD instrument set up to collect water samples from chosen depth. A single conductor cable supplies power to the system and transmits data from and to the CTD system in real time.

We collected CTD data and water sampling at 11 stations in the LoVe area and water samples from 12 discrete depths for methane concentration. Additional three stations were performed without water sampling to characterize water masses. We also performed four CTD casts with water sampling at 5, 10, 15, 20 and 25m above the seafloor in the Lofoten Canyon for Jochen Knies.

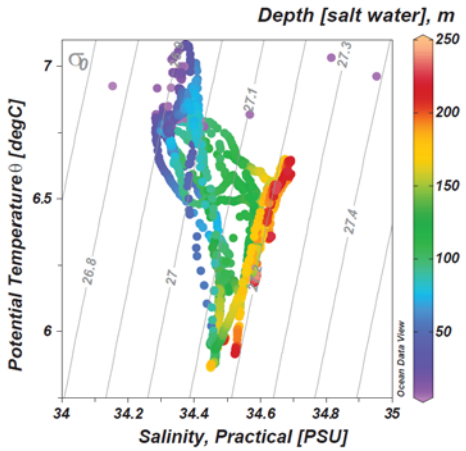

Figure 3. Temperature –Salinity diagram colored by the depth

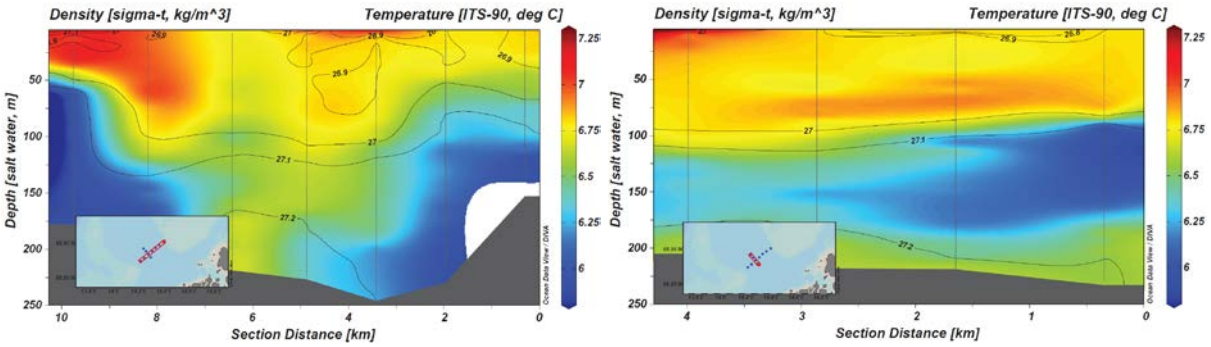

Figure 4. CTD transect along and across the intense flare area

Water masses are dominated by MCW around node 7. NAW flows further towards the open ocean above NSAIW.

➢ WATER SAMPLING FOR METHANE AT CTD LOCATION

To prepare water samples for measurements of methane concentrations we applied the conventional headspace gas extraction technique. Water samples were collected bubble free into 120 mL crimp seal bottles, and poisoned with 1 mL NaOH solution. We injected 5 ml of nitrogen through the rubber septa into with simultaneous removal of 5 mL of sample. By shaking the bottle for two minutes the headspace nitrogen equilibrated with the in situ water sample gas. Bottles were kept in the fridge (5 degrees C) until analysis back in Tromsø with the GC.

5. CRUISE NARRATIVE

Date	*Time (TOS)*	
20.05.2018	21:05	Departure from Tromsø
21.05.2018	14:50	CTD start
21.05.2018	21:00	end of CTD, direction S1
21.05.2018	21:40	beginning of line EK60 S1
21.05.2018	23:30	beginning of multibeam survey
23.05.2018	05:30	end of multibeam survey
23.05.2018	06:00	beginning of echosounder survey

23.05.2018	15:45	end of echosounder survey - go towards canyon area for Jochen's sampling
24.05.2018	06:00	beginning of CTD stations for Jochen
24.05.2018	08:00	end of CTD stations
24.05.2018	08:30	beginning of multibeam survey for Jochen
24.05.2018	10:00	end of multibeam survey, heading back to Tromsø
25.05.2018	08:00	Back to Tromsø

ACKNOWLEDGEMENTS

We thank the engineers (Bjørn Runar Ølsen and Steinar Iversen), the captain and his crew of R/V Helmer Hanssen of the University of Tromsø for their excellent support before and during the oceanographic survey and the deployment of the landers. This part of the cruise was conducted under the framework of the Centre of Excellence on Gas Hydrates, Environment and Climate (CAGE) (Norwegian Research Council (NFR) project number 223259/F5 at the University of Tromsø.

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APPENDIX: STASJONSLAPPER

CruiseNr	Date (UTC)	Time (UTC)	Logg (nm)	Stasjonstype	StNr	Speed	Latitude	Longitude	Depth (m)	Air Temp (°C)	Water Temp (°C)	Wind Speed (m/s)	Humidity (%)	Wind dir (deg)	Sea	Weather	Clouds	Scanmar DP1
05052018	22.05.2018	01:01:10	6515.51	Multibeam survey-STOPP	--	6.6	6852.324196 N	01412.960956 E	85.82	7.0	7.0	8.79	80	202	4	2	8	
05052018	23.05.2018	02:54:45	6672.82	Multibeam survey-STOPP	--	7.1	6859.143487 N	01420.820492 E	188.84	5.7	6.8	8.48	63	283	4	2	8	
05052018	21.05.2018	12:52:08	6458.95	CTD med vannhenter START	770	1.5	6856.583877 N	01422.385684 E	226.73	7.4	7.0	11.33	87	213	4	2	8	
05052018	21.05.2018	13:08:17	6459.22	CTD med vannhenter STOPP	770	0.8	6856.782085 N	01422.573313 E	219.42	7.2	7.0	8.41	87	215	4	2	8	589.44
05052018	21.05.2018	13:25:04	6460.16	CTD med vannhenter START	771	1.5	6857.097394 N	01424.351934 E	139.85	7.1	6.9	10.80	88	213	4	2	8	1183.19
05052018	21.05.2018	13:34:31	6460.33	CTD med vannhenter STOPP	771	0.7	6857.230037 N	01424.389885 E	128.98	7.2	7.0	11.35	88	216	4	2	8	1181.44
05052018	21.05.2018	13:58:11	6462.19	CTD med vannhenter START	772	1.1	6856.101179 N	01420.604271 E	246.40	7.4	7.0	10.64	87	212	4	2	8	1.88
05052018	21.05.2018	14:17:45	6462.43	CTD med vannhenter STOPP	772	0.7	6856.218407 N	01420.832388 E	240.68	7.2	7.0	9.67	88	213	4	2	8	
05052018	21.05.2018	14:33:30	6463.44	CTD med vannhenter START	773	0.3	6855.540855 N	01418.886169 E	226.85	7.2	7.0	8.87	88	213	4	2	8	
05052018	21.05.2018	14:51:54	6463.62	CTD med vannhenter STOPP	773	1.0	6855.588257 N	01419.082319 E	228.27	7.1	7.1	8.78	88	213	4	2	8	1177.50
05052018	21.05.2018	15:19:26	6464.91	CTD med vannhenter START	774	2.4	6855.071541 N	01417.134518 E	218.97	7.2	6.9	10.39	88	212	4	2	8	
05052018	21.05.2018	15:36:14	6465.16	CTD med vannhenter STOPP	774	1.4	6855.162581 N	01417.305192 E	221.13	7.4	7.0	11.81	86	213	4	2	8	1174.13
05052018	21.05.2018	15:57:25	6466.49	CTD med vannhenter START	775	1.2	6854.399440 N	01415.211128 E	210.00	7.3	7.1	11.14	85	213	4	2	8	
05052018	21.05.2018	16:25:53	6467.49	CTD med vannhenter STOPP	775	0.7	6853.856310 N	01413.418122 E	178.72	7.2	7.2	10.81	86	219	4	2	8	857.56
05052018	21.05.2018	16:25:56	6467.49	CTD med vannhenter START	776	0.7	6853.856427 N	01413.418777 E	179.10	7.3	7.2	10.52	86	215	4	2	8	857.56
05052018	21.05.2018	16:38:26	6467.67	CTD med vannhenter STOPP	776	1.3	6853.912868 N	01413.760690 E	186.90	7.1	7.1	9.45	86	219	4	2	8	1176.81
05052018	21.05.2018	17:07:07	6470.11	CTD med vannhenter START	777	1.6	6855.996371 N	01414.826709 E	202.98	7.1	7.1	10.54	87	214	4	2	8	1175.44

05052018	21.05.2018	17:21:41	6470.25	CTD med vannhenter STOPP	777	0.5	6855.992949 N	01414.644922 E	201.89	7.1	7.1	9.61	87	218	4	2	8	216.38
05052018	21.05.2018	17:34:07	6470.94	CTD med vannhenter START	778	2.3	6855.540086 N	01416.021854 E	217.97	7.0	7.0	10.50	88	227	4	2	8	1175.25
05052018	21.05.2018	17:51:57	6471.22	CTD med vannhenter STOPP	778	0.5	6855.555015 N	01416.107896 E	217.85	7.1	7.1	9.55	88	218	4	2	8	2.19
05052018	21.05.2018	18:02:57	6471.85	CTD med vannhenter START	779	0.5	6855.051566 N	01417.030994 E	215.68	6.9	7.0	10.32	89	218	4	2	8	2.69
05052018	21.05.2018	18:27:17	6472.14	CTD med vannhenter STOPP	779	0.9	6855.098094 N	01417.053254 E	215.99	7.0	6.9	9.50	88	210	4	2	8	1175.63
05052018	21.05.2018	18:43:03	6473.13	CTD med vannhenter START	780	1.5	6854.494203 N	01418.305033 E	230.83	7.1	6.9	10.17	89	222	4	2	8	
05052018	21.05.2018	18:59:35	6473.29	CTD med vannhenter STOPP	780	1.1	6854.503361 N	01418.289938 E	228.62	7.1	7.0	11.47	88	214	4	2	8	1175.06
05052018	21.05.2018	19:40:06	6478.35	Multibeam survey-START	781	6.4	6857.538869 N	01423.850643 E	132.99	7.1	7.0	11.07	88	220	4	2	8	
05052018	21.05.2018	20:34:09	6484.47	Multibeam survey-STOPP	781	6.5	6851.448784 N	01422.432199 E	187.11	7.1	7.0	10.05	79	217	4	2	8	
05052018	21.05.2018	22:28:47	6497.79	Multibeam survey-START	782	7.4	6853.116341 N	01415.196012 E	159.10	6.9	7.1	10.42	79	207	4	2	8	
05052018	21.05.2018	23:18:05	6503.94	Multibeam survey-STOPP	782	7.3	6855.727180 N	01430.553742 E	74.77	6.9	6.6	8.72	78	204	4	2	8	
05052018	21.05.2018	23:45:59	6507.38	Multibeam survey-START	783	5.7	6857.159134 N	01426.407393 E	81.35	6.9	6.8	10.91	80	203	4	2	8	
05052018	22.05.2018	01:11:19	6516.51	Multibeam survey-START	784	5.0	6852.401435 N	01412.669478 E	84.00	6.9	7.1	6.52	80	209	4	2	8	
05052018	22.05.2018	01:01:00	6515.49	Multibeam survey-STOPP	784	7.0	6852.337407 N	01412.998997 E	86.23	7.0	7.0	9.72	80	200	4	2	8	
05052018	22.05.2018	02:13:37	6523.30	Multibeam survey-START	785	7.0	6857.172527 N	01425.938126 E	80.99	6.8	7.0	6.96	82	201	4	2	8	
05052018	22.05.2018	02:20:53	6523.96	Multibeam survey-START	786	6.5	6857.351349 N	01425.924120 E	82.94	6.7	6.8	8.07	83	205	4	2	8	
05052018	23.05.2018	03:50:55	6678.70	Multibeam survey-START	786	6.0	6854.868163 N	01415.616336 E	214.32	5.5	6.9	7.29	66	285	4	2	8	
05052018	23.05.2018	02:54:39	6672.81	Multibeam survey-STOPP	786	6.6	6859.134432 N	01420.795324 E	190.67	5.7	6.8	7.62	63	280	4	2	8	
05052018	23.05.2018	13:46:29	6725.73	Multibeam survey-STOPP	786	7.4	6855.186399 N	01418.038236 E	228.20	7.1	7.1	5.80	62	228	4	2	8	

05052018	23.05.2018	14:33:04	6732.05	CTD uten vann START	787	7.2	6859.789024 N	01408.251999 E	210.50	6.4	7.2	7.50	64	225	4	2	8	1176.25
05052018	23.05.2018	14:51:29	6732.57	CTD uten vann STOPP	787	0.2	6900.068785 N	01408.026571 E	207.84	6.8	7.4	7.23	65	225	4	2	8	2.88
05052018	23.05.2018	15:28:14	6737.49	CTD uten vann START	789	0.9	6904.051779 N	01400.235632 E	480.14	6.0	6.8	7.97	67	221	4	2	8	
20052018	23.05.2018	16:29:01	6743.43	CTD uten vann START	790	2.8	6908.834564 N	01352.383433 E	0.00	6.3	7.5	6.04	71	189	4	2	8	
20052018	23.05.2018	17:14:44	6744.21	CTD uten vann STOPP	790	1.1	6909.238885 N	01353.867542 E	1300.19	6.3	7.5	5.45	73	228	4	2	8	
20052018	24.05.2018	03:38:43	6841.72	CTD med vannhenter START	791	1.1	6809.502344 N	01027.645212 E	758.03	7.6	8.0	9.72	79	229	4	2	8	
20052018	24.05.2018	04:14:06	6841.95	CTD med vannhenter STOPP	791	0.6	6809.498693 N	01027.744482 E	755.08	7.6	8.0	8.24	79	211	4	2	8	
20052018	24.05.2018	04:21:50	6842.05	CTD med vannhenter START	792	1.3	6809.489387 N	01027.904927 E	740.45	7.4	8.0	10.07	79	221	4	2	8	1269.88
20052018	24.05.2018	04:55:22	6842.29	CTD med vannhenter STOPP	792	0.7	6809.486910 N	01028.072494 E	745.42	7.6	8.1	10.24	79	218	4	2	8	
20052018	24.05.2018	05:06:17	6842.70	CTD med vannhenter START	793	0.5	6809.494403 N	01027.223443 E	787.50	7.6	8.1	9.63	80	220	4	2	8	
20052018	24.05.2018	05:43:28	6842.92	CTD med vannhenter STOPP	793	0.5	6809.496879 N	01027.401637 E	775.38	7.7	8.1	11.56	80	216	4	2	8	
20052018	24.05.2018	06:00:57	6843.86	CTD med vannhenter START	794	0.4	6809.993320 N	01028.210348 E	741.15	7.6	8.0	9.74	81	213	4	2	8	
20052018	24.05.2018	06:31:17	6844.20	CTD med vannhenter STOPP	794	0.6	6810.168228 N	01028.561182 E	726.35	7.6	8.0	9.76	80	202	4	2	8	