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CAGE_JM
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Cruise Report
FF Helmer Hanssen

Arctic Ocean

Longyearbyen – Tromsø
08 October 2013 – 25 October 2013


Chief Scientist: Jürgen Mienert
Master: Jon Almestad

With contributions by Andreia Plaza Faverola, Joel Johnson, Peter Franek, Peter Urban, Giacomo Osti, Steinar Iversen, Anoop Nair, Bjørn-Runar Olsen

RV Helmer Hanssen, 25.10.2013

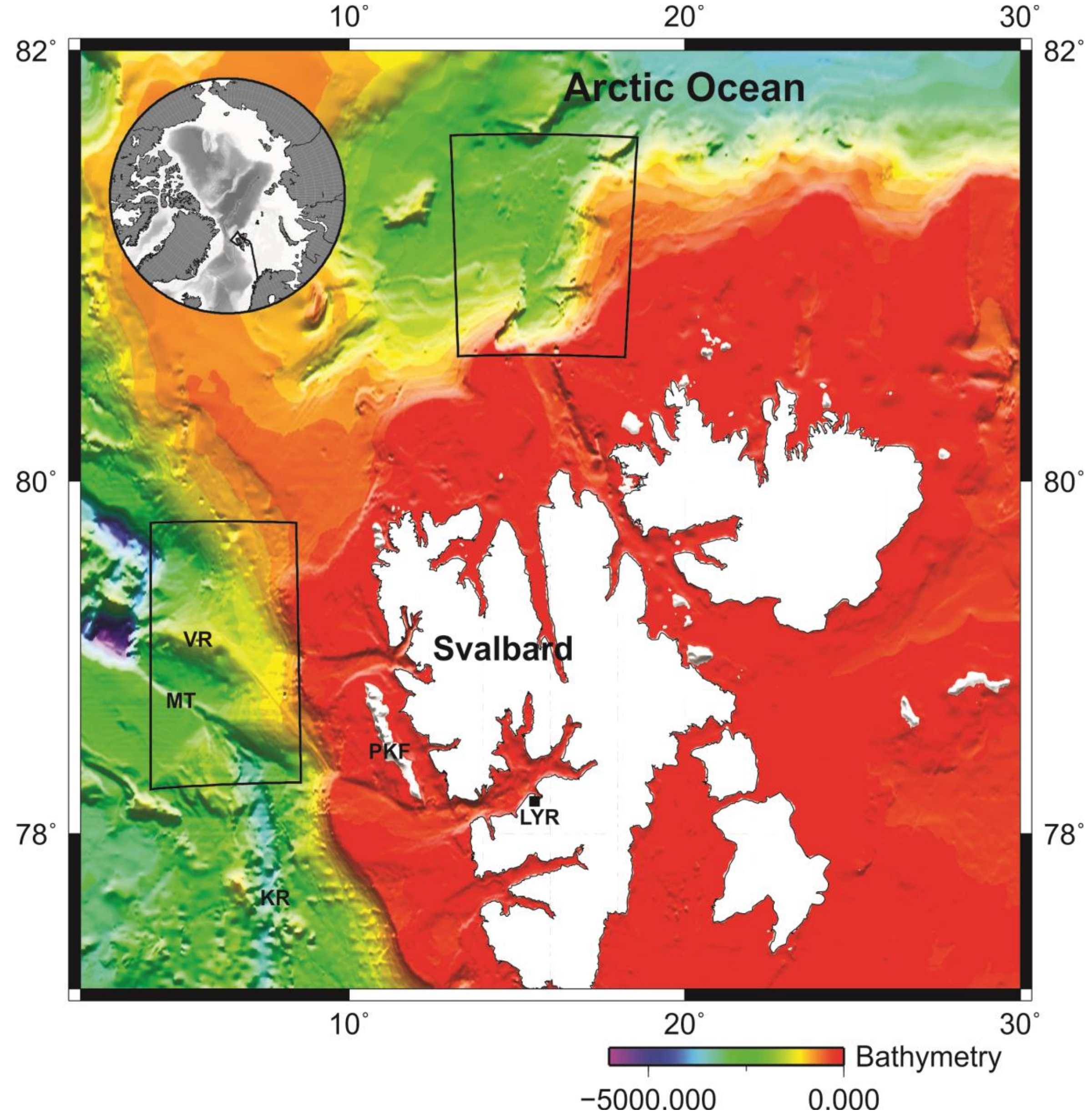

Figure 1: Overview map showing the working area off NW and N Svalbard (squares). Cruise CAGE_JM-2013 started from Longyearbyen (LYR), Svalbard on 08-10-2013 and finished in Tromsø on 25-10-2013. The work concentrated on the gas flares at the shelf off Prins Karls Forland (PKF), the gas hydrates at Vestnesa Ridge (VR), the Knipovich Ridge (KR) and Molloy transform (MT), and gas hydrates and submarine slides off NW Svalbard and the giant Hinlopen submarine slide at the Arctic continental margin. The Knipovich Ridge is the slowly- and obliquely-spreading northernmost extension of the Mid-Atlantic Ridge system (Thiede and Myhre, 1996).

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1 Summary

The overall aim of the CAGE_JM cruise was to study the gas release activity from gas hydrated sub-seabed environments at the continental margin off Svalbard towards the Norwegian-Greenland Sea and Arctic Ocean (Fig. 1). Acoustic measurements in the water column, water sampling for gas analyses, seismic profiling, bathymetry mapping, and sediment coring allowed to reach this aim. Generally, the water column above gas flares may be rich in methane but methanotrophic microorganisms might hinder an escape of methane from the water to the atmosphere. At the Molloy transform and the Vestnesa ridge we collected seismic data and sediment cores for sampling gas hydrates (Fig. 3a). We also took sediment cores from a submarine slide complex at the continental margin of NW Svalbard. The age of this slide is of interest because it sits on gas hydrated sediments as indicated by a BSR. The timing of the slope failure is unknown. At the massive Hinlopen slide area we surveyed the eastern sidewall (Fig. 3b), the toe of the slope and a block within the major slide debris flow area to understand better a potential coupling between slide processes and gas hydrates. Seismic profiles show bottom simulating reflectors that are indicative for gas hydrate underneath the southeastern headwall of this slide complex.

2 Participants and Affiliations

2.1 Participants

1.	Jürgen Mienert	Chief scientist	UiT_CAGE
2.	Joel Johnson	Sediment geochemistry	UNH&UiT_CAGE
3.	Andreia Plaza Faverola	Seismics	UiT_CAGE
4.	Peter Franek	Seismics	UiT_CAGE
5.	Peter Urban	Bubble Acoustics	GEOMAR
6.	Giacomo Osti	Sedimentology	UiT_CAGE
7.	Steinar Iversen	Seismic Engineer	UiT
8.	Annop Nair	Seismic Engineer	UiT_CAGE
9.	Bjørn-Runar Olsen	Seismic Engineer	UiT_CAGE

2.2 Affiliations

UiT	UiT The Arctic University of Norway, Tromsø Department of Geology, Dramsveien 201, 9037 Tromsø, Norway
UiT_CAGE	UiT The Arctic University of Norway, CAGE - Centre of Arctic Gas Hydrate, Environment and Climate, Tromsø
UNH	University of New Hampshire, Dept. of Earth Sciences 56 College Rd. Durham, NH USA
GEOMAR	GEOMAR | Helmholtz Centre for Ocean Research Kiel Marine Geodynamics, Wischhofstr. 1-3, 24148 Kiel, Germany

3 Research program

3.1 Introduction

Gas hydrates form ice-like crystals occurring in continental margins at high pressure and low temperature. Gas hydrates consists mainly of methane and water and therefore it is often called methane hydrate. Methane hydrates can also form in the enormous pan-arctic permafrost areas (Sloan Jr., 1998). The stability of both hydrates in continental margins and permafrost is mainly governed by temperature variations. Hence, hydrate stability will be strongly affected by warming of the Earth's ocean and land masses.

Large uncertainties exist when estimating the total amount of carbon stored in gas hydrates and the free gas reservoirs beneath it. Values for gas hydrates range from 500 to 5000 Gt of carbon (e.g. Buffett and Archer, 2004; Milkov, 2004; Kvenvolden & Rogers, 2005) but free gas reservoirs may add approximately 1800 Gt of organic carbon (Buffett and Archer, 2004). The total carbon reservoirs are enormous and comprise almost half of the Earth's organic carbon. It could enter the atmosphere affecting climate leading to a greenhouse world.

The dynamics concerning the stability of this carbon reservoir needs to be better understood. One could envision a rapid release of methane that would have recognisable effects on climate as most of this methane (as carbon) is a 25-35% more effective greenhouse gas than CO_2 (Harvey and Huang, 1995; Shindell et al., 2009). A change in ocean temperature of 3°C would for example release globally ~4000 Gt of carbon into the ocean and atmosphere, but again large uncertainties from 500 (Biastoch et al., 2011) – 4000 Gt (Archer and Buffett, 2005) exists regarding such predictions.

Climate models do not include the dynamical behaviour of carbon flux rates from the seafloor to the atmosphere but assume that the present amounts of released carbon are small. The assumption is based on that carbon does not reach the atmosphere as methane gets oxidised in the water column. However, evidence accumulates that even at present time there are significant amounts of methane venting from the seabed of the large Arctic shelf regions (Shakova et al.; Portnov et al. 2013). Evidence exists also in deep water areas from which methane may reach the atmosphere (Dimitrov, 2002; Kennett et al., 2003; Kastner et al., 2005).

Triggering of submarine landslides on glaciated continental margins have been speculated about to be at least partly related to dissociation of gas hydrate and migrating fluids leading to overpressure build up (e.g. Mienert et al., 2005; Maslin et al., Mienert, 2009). The part of the gas hydrate system that is most strongly affected by bottom-water warming is the zone where the base of the gas hydrate stability zone (BGHSZ) intersects the seabed at the most upper continental margin (Jung and Vogt, 2004; Mienert et al., 2005). In the Arctic this zone is approximately at 350 m water depth. Because most if not all of the investigated submarine slides are retrogressive (Solheim et al., 2005; Vanneste et al., 2006; Hogan et al., 2013) the instability starts at the toe and not at the top of the slope. This makes it difficult to explain the gas hydrate dissociation as a trigger for sliding because of ocean warming causing gas hydrate dissociation. This would start at the top of the slope leading to a progressive and not a retrogressive slope failure.

The Centre of Excellence CAGE – Centre for Arctic Gas Hydrate, Environment and Climate aims to understand how the gas hydrate reservoirs will react to future increases in bottom-water temperature, and if future bottom-water warming might trigger a sudden release of large amounts of methane leading to changes in the ocean environment and climate.

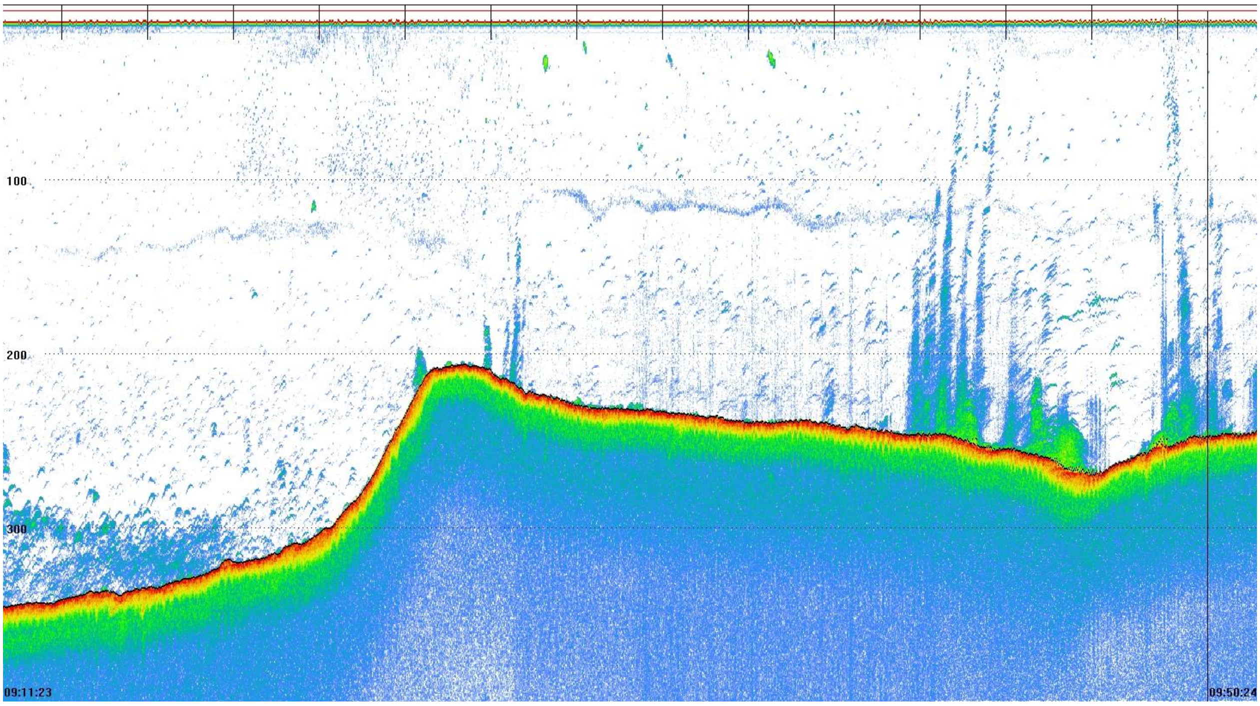

Fig. 2: Seepage offshore W-Spitsbergen evidenced by numerous flares. Gas flares off Prins Karls Forland in water depth from 200 – 300 m.

3.2 Cruise objectives

The main objectives of the cruise are:

- Acoustic imaging of gas bubble release from seep sites using 18 and 38 kHz single echo sounder. The multi-frequency echosounder allows flare imaging in order to identify active seeps and variations in their activity. Additionally, we deploy CTD measurements for water sampling and gas chemistry analysis at seep locations.

- In addition to water mass sampling, we use gravity and box corer to study deeper parts of the sediment with respect to microbiology and geochemistry along transect laid across venting sites at Vestnesa Ridge. Up to 6 m long sediment cores may provide information about paleo-seep activity for the ~last 20.000 yrs.

- Dating of sediments from the active and inactive Vestnesa vent sites. Dating of carbonaceous sediments from venting sites will reveal periodicities in their activity and age of active/inactivity.

- Areal extension of the GHSZ based on mapping of the seismic indicator for gas hydrates (BSR) towards the Knipovich Ridge and Molløy deep.

- Areal extension of the GHSZ based on mapping of the seismic indicator for gas hydrates (BSR) towards the NW Kongsfjorden slide complex.

- Dating of sediments from the Hinlopen and Kongsfjorden slide complex

- Identification of plow-marks created by the mega blocks during the Hinlopen slide event

3.3 Deviations from the intended cruise schedule

The cruise followed the intended cruise schedule as planned.

3.4 Compliance with the regulations for responsible marine research

We complied with the regulations for responsible marine research. The cruise activities were outside of the Svalbard National Park boundaries. During the cruise the ship was operated in clean ship mode except for disposal of sediments after sampling.

3.5. Water mass and pore-water sampling

CTD Water Mass Analyzes

We took 108 water samples (120ml bottles) from nine CTD-stations throughout the cruise (Fig. 3). The water samples will be analyzed for dissolved methane at the “GEOMAR Helmholtz-Zentrum für Ozeanforschung” in Kiel, Germany. To stop bacterial activity that would distort the measurements, the water samples are poisoned immediately after sampling. Because the use of mercury-chloride is prohibited on Norwegian research vessels, this was done using 50ml saturated salt water solution. We took 12 water samples at different depth per CTD station. One Sample was always taken at 10m depth below sea surface and one 10m above seabed. The remaining 10 samples were taken at different depth intervals in-between. The vertical distance between the samples was smaller closer to the see bottom, because we expect more changes in dissolved methane concentration here.

CTD Number	Station Number	Number of Bottles
CTD_CAGE_JM_1	476	12
CTD_CAGE_JM_2	477	12
CTD_CAGE_JM_3	478	12
CTD_CAGE_JM_4	479	12
CTD_CAGE_JM_5	482	12
CTD_CAGE_JM_6	483	11
CTD_CAGE_JM_7	484	12
CTD_CAGE_JM_8	486	11
CTD_CAGE_JM_9	489	10

CTD Number and corresponding station numbers. See Figure 3 and appendix 2 for CTD measurements and CTD locations.

Pore-water analyzes from gravity cores

Five gravity cores were sampled for methane analyzes. 3ml of porewater rich sediment were taken every meter (right after cutting the core in meter sections). The sediment was added into 50ml vials that where prepared with 1.5 grams of natrium chloride and 9ml of saturated saltwater solution. For porosity analyzes we took another 3 ml of sediment in pre-weighted tubs. Additionally we took two samples of methane gas hydrates from gravity core station 204 to analyze the gas composition. All together we took 28 sediment samples from six cores. All samples were stored in a ~ + 3.6 degrees Celcius and dark room. They will be sent to the “GEOMAR Helmholtz-Zentrum für Ozeanforschung” in Kiel, Germany for further analyzes.

Core-Number	Station-Number	Number of Samples
CAGE-GC1	195	4
CAGE-GC2	196	4
CAGE-GC4	198	6
CAGE-GC7	201	3
CAGE-GC10	204	6
CAGE-GC19	214	5

Core number and corresponding station numbers. See Figure 3 and appendix 3 for core locations

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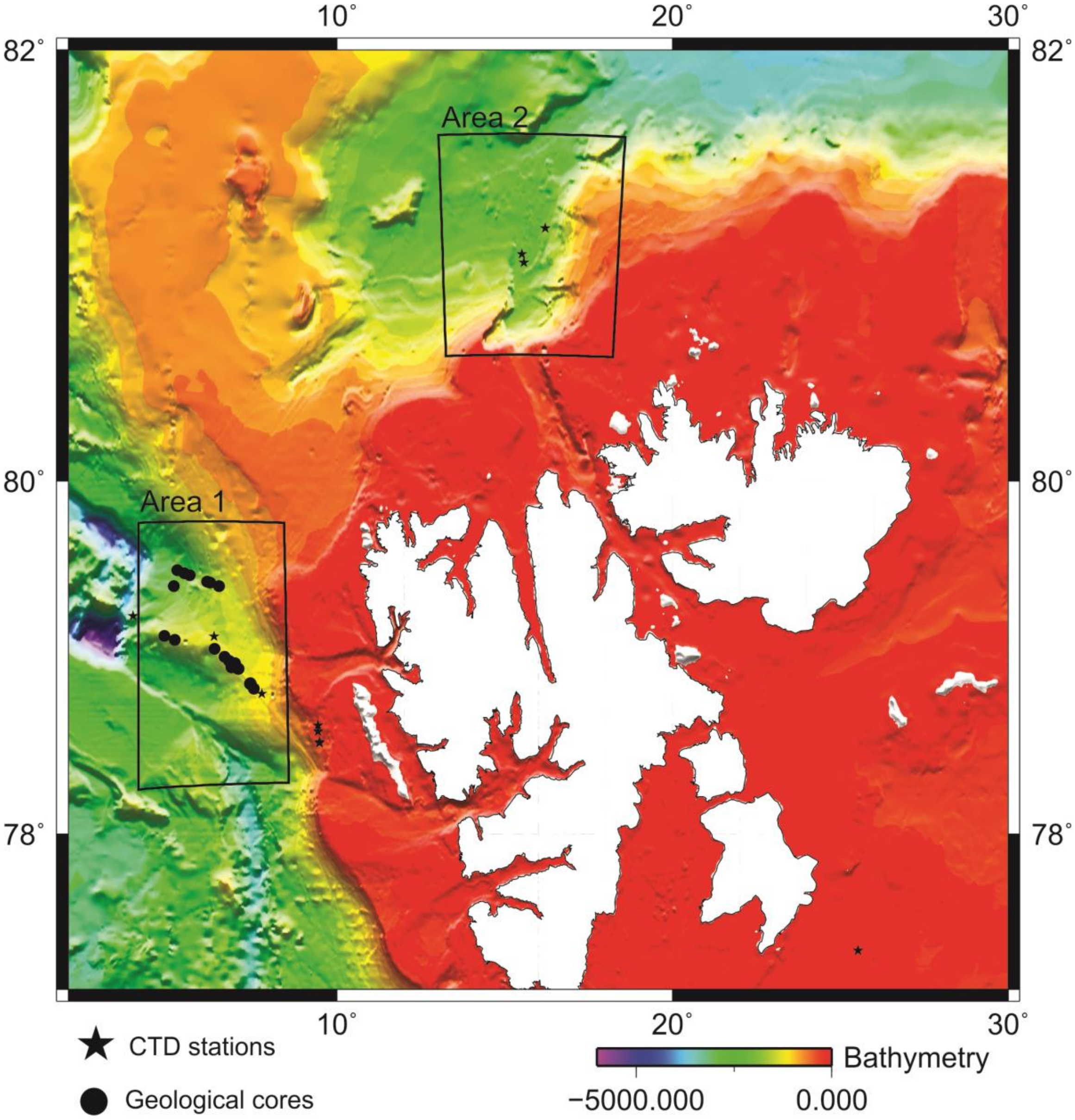

Figure 3: Sediment core and CTD locations with samples for gas analysis.

Single Beam Survey over seep area west of Prins Karls Foreland

The seep area west of Prins Karls Foreland (Fig. 2) has been subject of repetitive single beam surveys by the University of Tromso during the last years. Due to the high change in acoustic impedance, hydro acoustic systems are very sensitive to gas bubbles in the water column. This makes single beam echo sounders an effective tool to investigate gas bubble releases in the water column. Data gained, allows the imaging of methane bubble flares in the area and can further be used for methane flux estimations.

During this survey a calibrated Kongsberg EK60 multi-frequency echo sounder was used. The system can operate parallel in three different frequencies (18 kHz, 38 kHz and 120 kHz), but due to technical difficulties only the 18 kHz and the 38 kHz signal were used.

The investigated seep area is divided into two areas. One deeper area between 400m and 350m- and a shallower one in about 250m water depth. For a complete mapping of the area the footprint of the single beam system at the different water depth has to be considered and the survey lines must be planned accordingly. During this cruise we repeated the survey of the last investigation of the seep area from 2012. For high quality imaging and later flux estimations a high spatial resolution (ship along track) is important. To archive this, the maximum ping rate available was used and the ships speed was reduced to 5 knots during the survey. A speed of only 3 knots or less would have been even more optimal, but was not possible due to the limited time planned for this survey.

The data was loaded into FMMidwater tools for quick analyzes of the flares positions. Later post processing analyzes will allow estimations of the gas flux in the seep area that can be compared to the data of previous Helmer Hanssen surveys of UiT The Arctic University of Norway.

4 Cruise narrative

Tuesday 08.10.2013
On 08.10.2013 we left Longyearbyen at 16:00 GMT heading northwest towards Prins Karls Forland. We reached the survey area at 01:00 GMT on Wednesday morning.

Wednesday 09.10.2013
We surveyed the gas flares off Prins Karls Forland with 6 single echosounder profiles (38 and 18 kHz) in deep water and 16 in shallow water. Then we started 4 CTD stations (stnr 476-479) including water mass sampling with 12 bottles at prescribed intervals for gas analysis.

Thursday 10.10.2013
MB data collection and seabed mapping continued throughout the night and during the day. We continued MB mapping because the wind picked up and the sea stage would not allow for collecting high-quality seismic data.

Friday 11.10.2013
We started seismic surveying (Line 05) along the Vestnesa Ridge in good weather conditions and the recording was of good quality for both the old delph streamer and the new digital streamer system. For the digital system we used 4 streamer sections each with 8 channels within a length of 25 metres, comprising an active streamer length of 100 m and 32 channels. Two airguns (45/45 and 45/105) fired at an interval of 10 sec rate and a pressure of 150 bar. After collecting the seismic, EM 300 multibeam, chirp and the 38 and 18 kHz data we started selecting sediment gravity, box core and CTD stations along the ridge from ~2400 (northern end) to ~1140 m water depth (southern end). The acoustic surveying allowed mapping the bubble release activity on the ridge as indicated by flares in the 38 kHz profile. The ship speed was 4,5 knt.

Saturday 12.10.2013
Gravity coring started at ~noon time and continued until the weather conditions deteriorated rapidly with winds of force 7. It took us about 30 minutes to take one gravity core and in total about 1,5 hours to cut the core into 1 m sections and store the sediments. In total we took 4 gravity cores each with a 6 m long steal pipe and a plastic liner inside. A core catcher hinders that the sediments slip out the liner. We

reached full penetration and a appreciable core recovery between min 3,3 m and max. 5,15 m (core 195 3,3m; 196 3,94 m; 197 5,15 m; 198 4,11 m; core 197 was frozen for geochemical studies, the sediments were smelly of H_2S and core 197 showed carbonate crusts at the cc). Increasing wind and waves forced us to stop the coring operation. We started to survey the big acoustic flares across along the crest of the Vestnesa Ridge. They reach from the seabed up to a height of more than 1000 metres coming close to the sea surface. Inspection of their variability and their activity allows to document changes in the supply rate of gas, in this case only between Friday and Saturday. Therefore, we steamed back and forth along the ridge over a time period of two days.

Sunday 13.10.2013

We arrived at the southernmost big flare and took a CTD (stnr 482) for water mass properties and gas composition. Afterwards we continued coring but now during calm weather conditions. We returned to our last station (198) to take a gravity core (station 199; recovery 4,5 m) for reference outside the active pockmark field in the southern area of Vestnesa Ridge. We sailed back to the big flare site (CTD station 482) that we had discovered during the multibeam and echosounder profiling and retrieved two gravity cores (stations 200 and 201; recovery 200: 2,7 m; recovery 201: 1,94 m) that only penetrated 3,5 m. Core 201 recovered authigenic carbonate in the core catcher. We speculated about that the limited penetration may be due to a hard ground caused by extensive carbonate or gas hydrate layers. For the surface sampling we used a box corer (station 000). The first box core station sampled sediments from inside the pockmark but outside the plume. The core smelled not of H_2S but showed high concentrations of drop stones in the surface layer and some pogonophora (tube worms). While the second box core (station 001) that was taken between pockmarks showed no indications of pogonophora the third box core did not smell of H_2S (station 002), though it was retrieved from within the pockmark. Gravity core station (202, recovery 4,83 m) located between pockmarks did not smell of H_2S.

Gravity cores from within pockmarks (station 203 and 204, 203 was frozen for pore water and has a recovery of 3,0 m; 204 recovery: 5,95 with gas expansion) smelled of H_2S. Gravity core (station 204) recovered gas hydrate concentrated in the sample from the core catcher and within the bottom of the liner. We finished the coring activity with a CTD station (483) at 16:05 (UTC) and started a seismic line crossing station 204. The location also shows a large, up to 1000 m high flare in the water column above the pockmark. A 2 hrs seismic transect line (station 205 is seismic line 06) across the Vestnesa Ridge revealed a BSR, a large vertical flare at the top of the crest, and a fault on the western flank. The same flare site was identified on the seismic profile along the ridge. At 08:00 we started collecting two gravity cores from each flank (one frozen from each side) of the ridge to investigate the SMT zone development towards the ridge crest. Gravity core stations (206-207, recovery 4,8 and 4,9 m) and (208-209, recovery 4,94 and 4,25 m) did not smell of H_2S which is in strong contrast to cores from the crest of the ridge. Gravity core 207 and 209 were frozen for pore water chemistry analysis.

Monday 14.10.2013

Coring continued and station 209 was successfully finished. Aftwards we steamed north to the ridge crest. Station 210 (recovery 4,93m, between 17 and 18) was a reference site between pockmarks, station 211 (recovery 4,98 m smelled H_2S) a pockmark station without a flare and station 212 (5,16 m) again (between 15 and 16) a reference site between pockmarks. Station 213 (5,2 m), water depth 1217 m, was taken within a pockmark showing a large flare and sediments that smelled of H_2S. The next active pockmark lies at station 214 (recovery 4,64 m; 012), water depth 1212 m and showed a large flare which we reached at 07:06 UTC. The pockmark itself did not have a distinct morphological expression on the seabed but the flare was significant. Afterwards, a CTD station (484) allowed taking water mass samples for gas analysis from within the flare. During northward steaming we crossed a pockmark (010) with a depth of 20 m and a diameter of a few hundred metres. Core station 215 (recovery 5,29 m), water depth 1229 m sampled sediments from within a pockmark without flare. The chirp record showed a strong reflector within the pockmark. Core stations 216 (recovery 5,95 m) and 217 (recovery 5,95 m) located at the northern Vestnesa ridge recovered sediments from within pockmarks without flares. Why the northern area of Vestnesa shows no flare activity, the southern area does. This observation remains to be explained during the upcoming studies. At the end of the Vestnesa coring we took another CTD before we started multibeam mapping. The data were of poor quality because of heigh wave heights and rough seas (wind speed 20 m/s).

Tuesday 15.10.2013
From midnight onwards the sea got less rough so that the MB data quality improved. We stopped the MB mapping at 08:50 UTC and sailed to the start of seismic line (SOL) at the toe of the NW-Svalbard slide. The seismic line HH13-CAGE-NWSV2D-07 starts at 10:26 (79 36.052 N; 07.756 E), water depth 4044m and ends at 1300 m water depth (79 26.1042 N; 06 35.976 E).

Wednesday 16.10.2013
Note, the ship log name for the seismic line is station 218. After finishing the seismic transect along the slide nine core sites were selected based on the chirp sonar and bathymetry information: one core (st219-GC: recovery:5,29 m; 79 26.540 N, 06 29.840E) off the headwall within the undisturbed area, 6 cores (st220-GC to st225-GC: recovery 4,97m; 5,09m; 5,66 m; 4,52m; 4,73 m; 3,84 m) within the slide area and 2 cores (st226-GC and st227-GC; recovery: 2,62m and 2,14 m) within a channel. The channel appears to be crossed and thus eroded/buried by the slide. From the last core station, at 09:00 UTC we steamed south completing the seismic line across the Molly transform, an area partly covered by the Vestnesa Ridge. We reached the SOL (line 08) at 12:00, started the line at 13:16 and ended the line at 20:31. The next line (09) crossed an previously unknown sediment drift south of Molløy Transform starting at 21.50 and ending on Thursday.

Thursday 17.10.2013
We reached the EOL (line 09) at the eastern part of the drift at 00:57. One inactive pockmark on the ridge crest showed no signs of activity. Pockmarks along the crest were also inactive but a BSR was evident at 200 ms across the ridge. Bottom simulating reflectors, i.e. gas hydrate indications exists here above young oceanic crust! After finishing the survey of the drift segment west of the Knipovich Ridge we sailed north to continue mapping the NW-Svalbard slide complex. After we reached the toe of the slide complex we started multibeam mapping including chirp and echosounder profiling. Bad weather limited data quality but Multibeam showed only a few data gaps.

Friday 18.10.2013
Multibeam mapping and echolot profiling continued in bad weather conditions (wind speed 17-20 m/s). The mapping of the NWSV slide finished at 16:56 UTC (79 51.873 W; 04 43.59 E). From NW Svalbard we sailed to the Hinlopen slide with the aim to investigate one of the large slide block materials using 3D seismic.

Saturday 19.10.2013
We arrived at 06:30 in the study area and used at first a CTD station for the MB mapping. Afterwards, at 08:00 UTC we started deploying the 3D P-Cable seismic system to investigate the block that lies in 2207 m water depth within the slide debris of the Sophia basin at 81°10.7824 N; 15°51.0486E. Problems with the batteries for the GPS are solved by exchanging the batteries and all three GPS antenna (one on the gun float and one on each of the doors on the backboard and starboard side) worked well. We deployed the complete P-Cable system using 14 streamers (8 channels per streamer, channel spacing 3,125 m). At 13:00 we finished the deployment but realized a leakage. The whole system was brought on board, streamer after streamer in order to detect the failure. After we found the leakage and replaced the whole section we redeployed the seismic equipment finishing at 18:00 UTC. After ten hours of deployment including failure searches the survey started again but this time the software did not work. The error message said: “”Incomplete data on file 71 missing sections 2, 1…1” All trials including bypassing the signal cable with a tow cable for data transfer were unsuccessful.

Sunday 20.10.2013
We tried until 04:00 UTC finding the malfunctioned soft- or hardware. We did not succeed but we believe that there is a software problem in the data management system. GEOMETRIX is to be approached to find soon a solution to all the many failures of the P-Cable system starting from leakage to software malfunctions.
During this 3D seismic work all teams worked well together in very cold (- 9°C) weather conditions. All of us got worn out after so many hours of work concerning failure and trial. At 07:00 the 3D system got back on deck and we assembled the 2D digital streamer system. Data were recorded with a GeoEel digital streamer.
The alternative 2D seismic survey of the large slide block within Hinlopen started at 11:26 UTC (st 229, profile 10) and ended at 02:16 UTC (st 229, profile 18; 81 07.945; 15 51.583).

Monday 21.10.2013
A CTD station (487) allowed to take water samples for methane measurements at the end of the line 18. After finishing the seismic survey across one of the large blocks in the Sophia basin we started a new line investigating BSRs in sediment drifts upslope. Line 19 showed stacking of sediment drifts and a BSR at the undisturbed area towards Hinlopen Strait. The profile ended at 10:38 in 220 m reading ~220 m water depth on the Hinlopen shelf. Profile 20 started at 11:06 in 204 m water depth on the shelf and we were heading straight north (360 degrees) downslope. At 81 07.099 N the air temperature dropped from - 6 to -12 °C while the sea temperature stayed at + 4.5 °C. At 81 09.8629 the air temperature dropped from – 12 to 12.7 °C and the water temperature reached 2.2 °C. At 81 11.3737 N (heading 326) the air temperature was – 12.9 °C and the water temperature reached 2.0 °C. At 81 16.331 N (heading 326) the air temperature was – 13.8 °C and the water temperature reached 2.0 °C. Giant iceberg ploughmarks extends in water depth between 400 and 600 m. They are up to 20 m deep and less than less than 1 km wide showing a NE-SW trend parallel to the

slope. At 81 16.331 N (heading 326) the air temperature was – 13.8 °C and the water temperature reached 2.0 °C.

At ~650 m water depth the sediment drape across the plough mark filed disappears and the seabed reflectivity becomes stronger indicating increased bottom current activity. At approx. the same water depth wavy beds show up beneath the seabed suggesting contourite or drifts sediment deposits at ~81 23,902 N; 18 15,396 E at 799 m water depth. At 81 32.957 N (heading 358) the air temperature was – 15,0 °C and the water temperature reached 3.0 °C.

At 81 36,779; 18 13.745 E we reached the sea ice; air temperature dropped to -15.8 °C, water temperature 3.8 °C !

Profile 21 started at 19:31 just in front of the sea ice, we are south of the sea ice heading 233 degrees. We reached sea ice at 20:53 (81 34.257N; 17 41.366E) and abandoned the course; the new heading is 101 degrees. We discovered a new major sediment drift at 1362 m water depth at the northern outlet of the Hinlopen slide to the Nansen Basin but were unfortunately forced by sea ice to survey more southward. Heading was therefore concentrating further south away from the sea ice. We surveyed one slide at the eastern Hinlopen side wall showing clearly several events in the MB and seismic data at 2102 m water depth.

Profile line 22 was abandoned because of the sea ice.

A new CTD station (488) allowed to recalibrate the MB water column for the speed of sound, which improved the MB data quality.

Tuesday 22.10.2013
After finishing a CTD station we sailed southward heading 180 degrees. Two more long seismic lines across the eastern Hinlopen side wall area suggest where BSRs are prominent. At 81 13.963 N; 16 16.513 E (07:26 UTC) and 2106 m water depth we reached the major debris flow area of the eastern side wall. The debris flow lies on top of the massive Hinlopen slide. The massive block is presumably coming from the southern headwall while the debris flows comes from the eastern sidewall.

Profile 23 started at 00:34 (81 19.550 N; 17 27.101 E) mapping a characteristic submarine slide at the eastern Hinlopen sidewall and ended at the base of the slope at 03:01 UTC (81 2.885 N; 16 34.225 E). Heading is 303 degrees and downslope.

Profile 24 started at 09:05 (81 07.5150 N; 16 13.562 E) and ended at 12:06 (81 07.481 N; 17 40.221E). Heading is 92 degrees and upslope.

Profile 25 started at 12:15 (81 07.131 N; 17 42.421 E) and ended at 13:30 UTC (81 01.745 N; 17 40.371 E). Heading is 180 degrees and parallel to the slope.

At 16:43 we stopped recording data and sailed via Hinlopen Straight and Barents Sea back to Tromsø.

The crew on the bridge sighted 5 (white nose) dolphins that jumped out of the water near to the bow of the ship. Windspeed reached ~13 m/s and air temperature 5 °C, water temperature 3.9 °C.

Wednesday 23.10.2012
Writing of reports and seismic and MB data processing continues on our transit to Tromsø

Thursday 24.10.2013
Writing of reports and seismic and MB data processing continues on our transit to Tromsø

Friday 25.10.2013
FF Helmer Hanssen arrives in Tromsø at……UTC.

5. MB and seismic mapping

Fig. 3a and b: Location of seismic profiles, core and CTD stations at the northern termination of the Knipovich Ridge and Vestnesa Ridge, of the NW Svalbard margin area at the newly discovered landslide.

Fig 4: Enlargement for the northern study area showing the headwalls of the newly discovered landslide.

Fig 5. Location of seismic profiles and CTD stations at the eastern side of the massive Hinlopen submarine slide.

6. Acknowledgements

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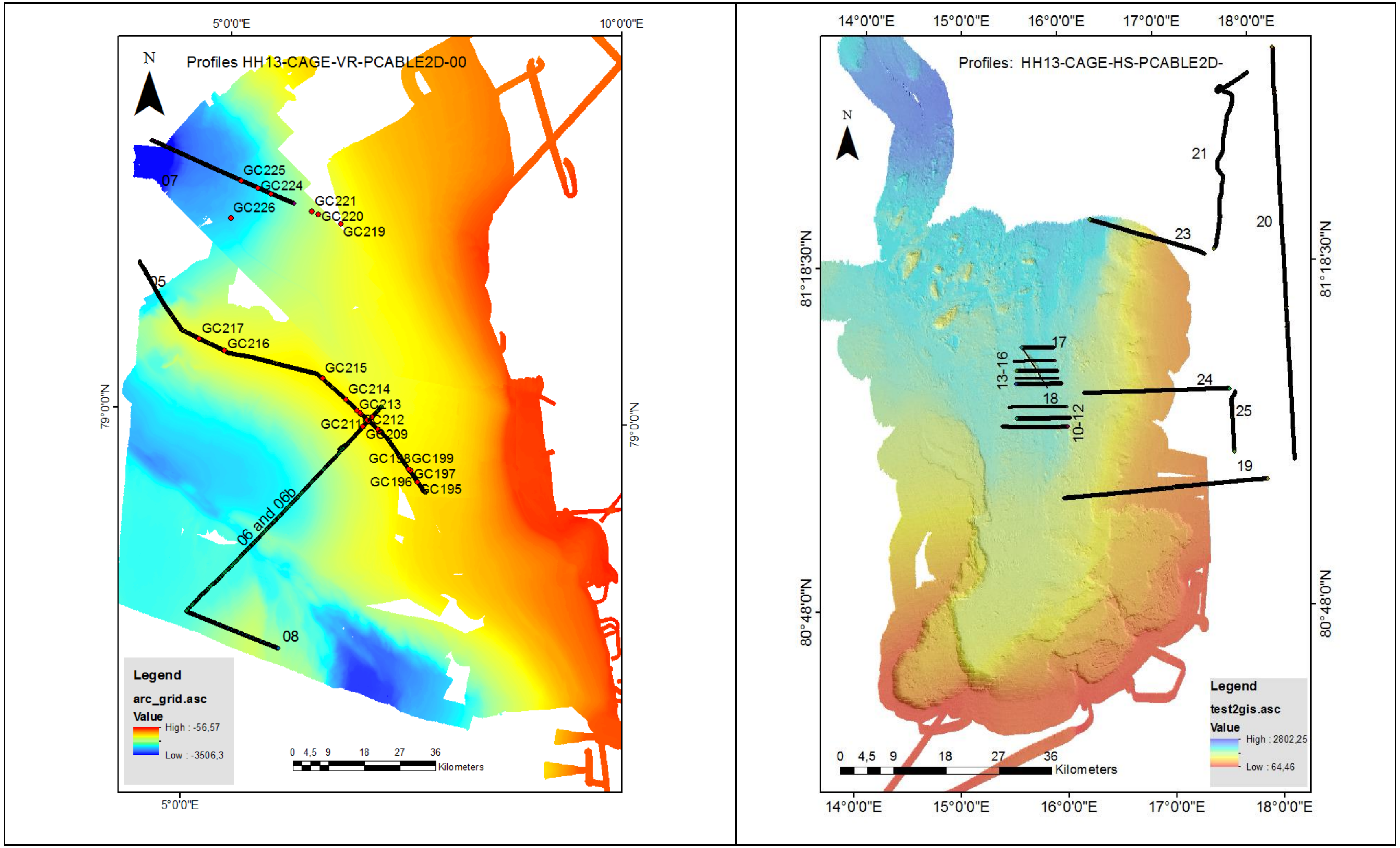
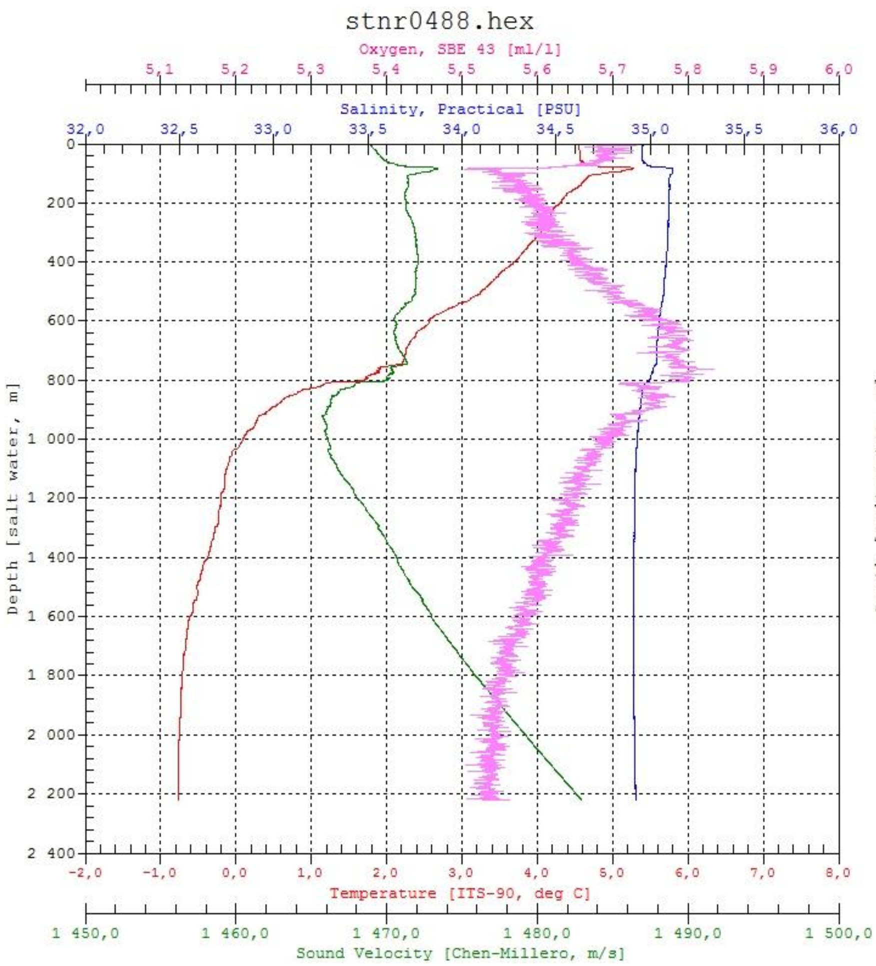
7 Appendices



Appendix 1: Location of Multibeam and seismic profiles, core stations at the northern termination of the Knipovich and Vestnesa Ridge, off the NW Svalbard margin. At the Kongsfjorden margin we mapped and cored a submarine landslide. At the Arctic Ocean margin the eastern sidewall of the giant Hinlopen submarine slide shows numerous slope failures, a sediment drift and BSRs.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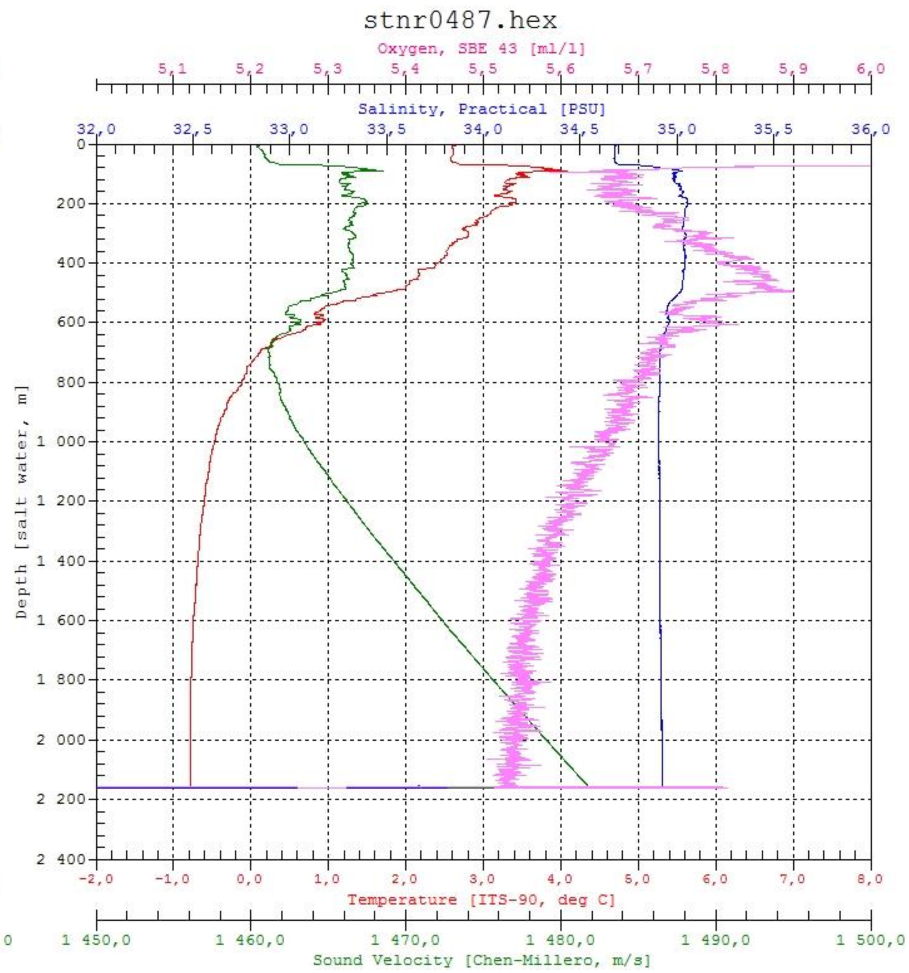
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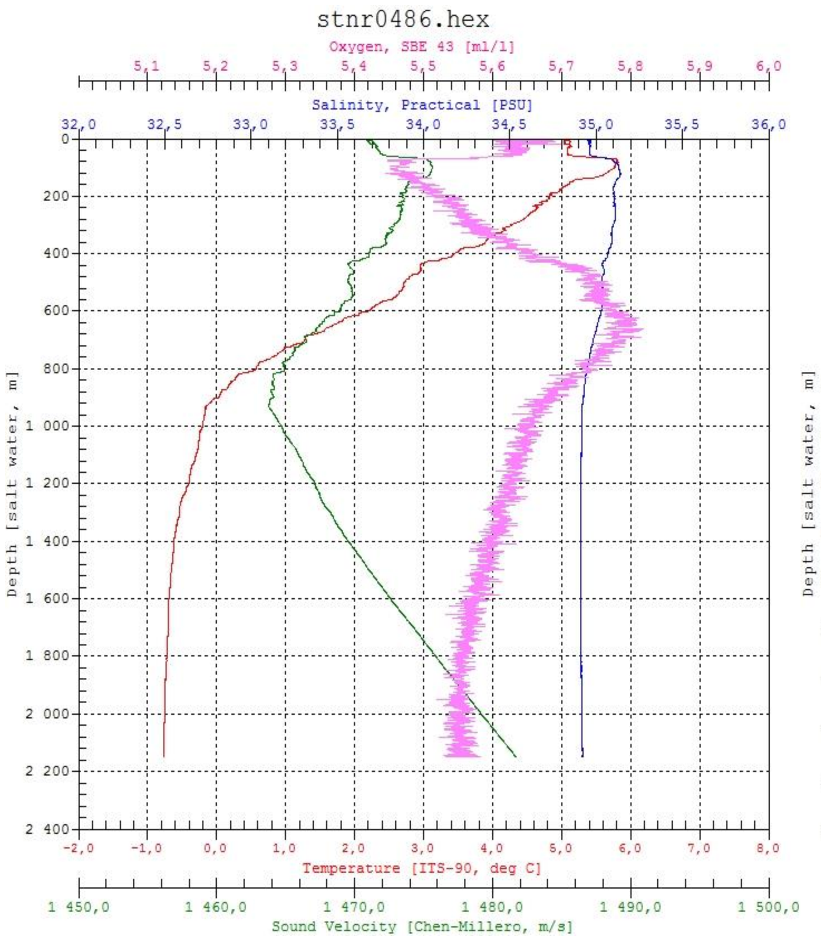
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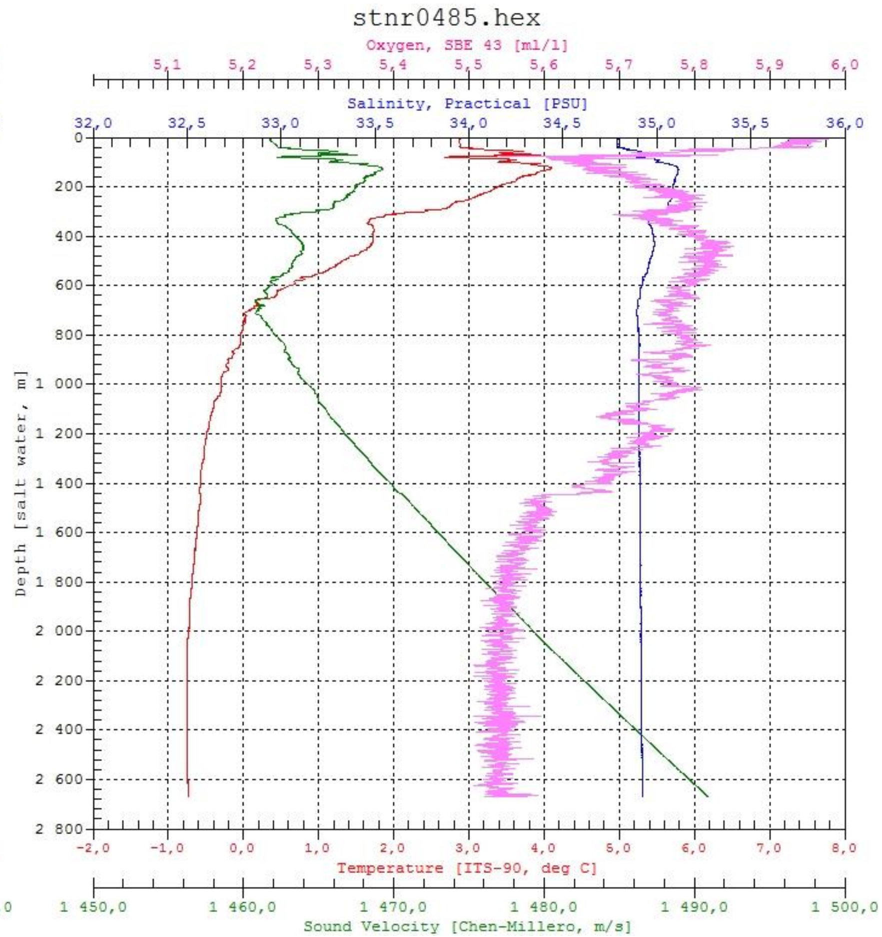
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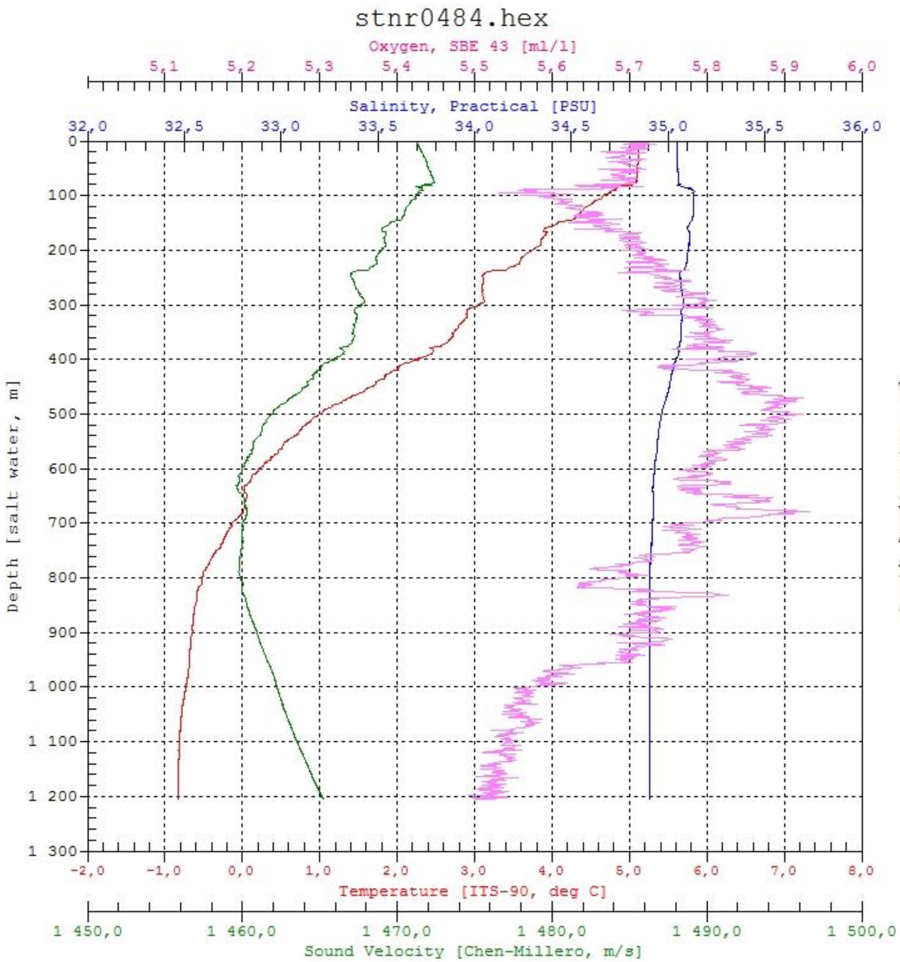
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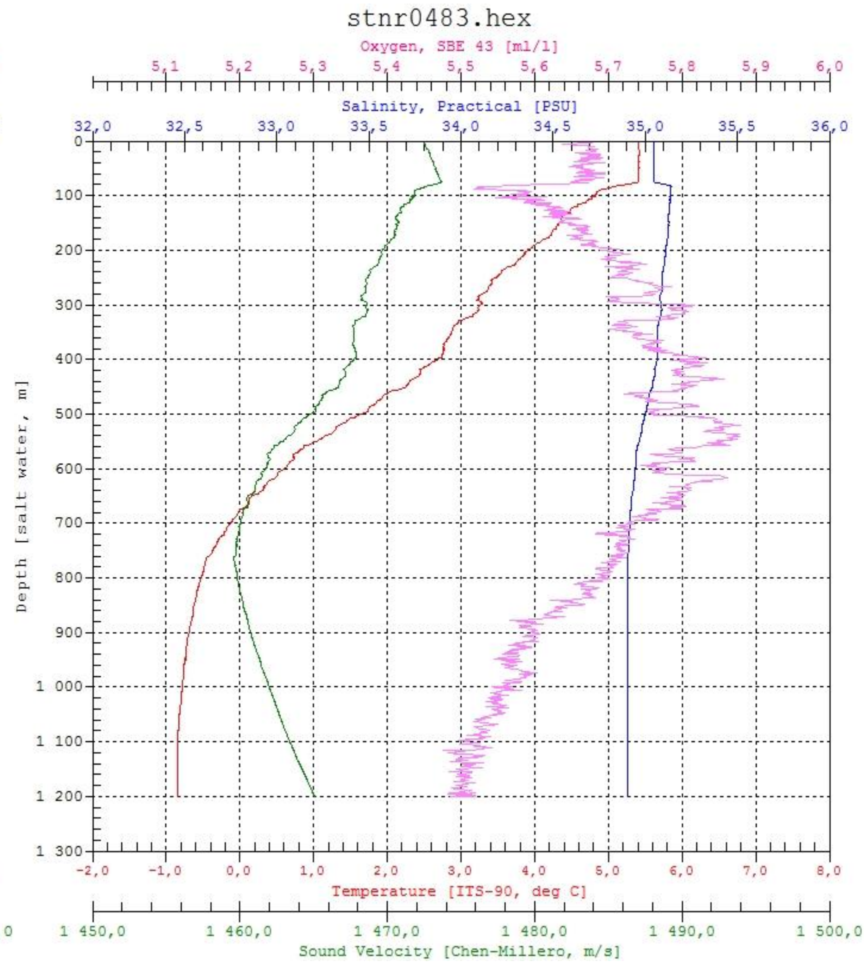
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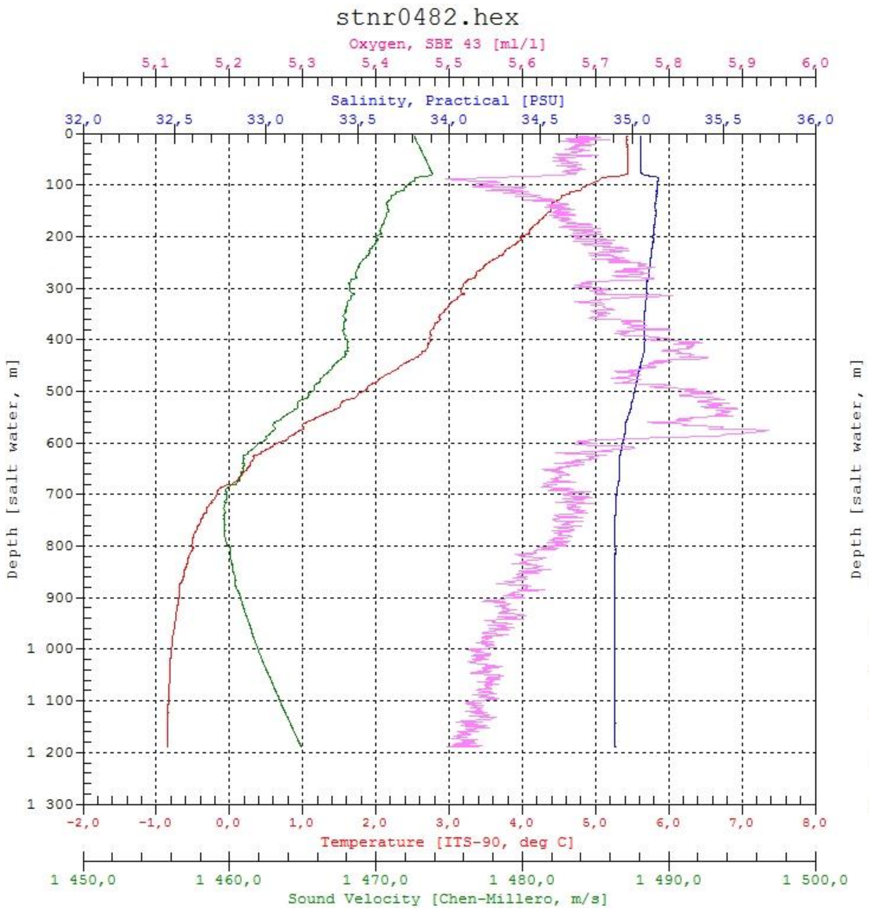
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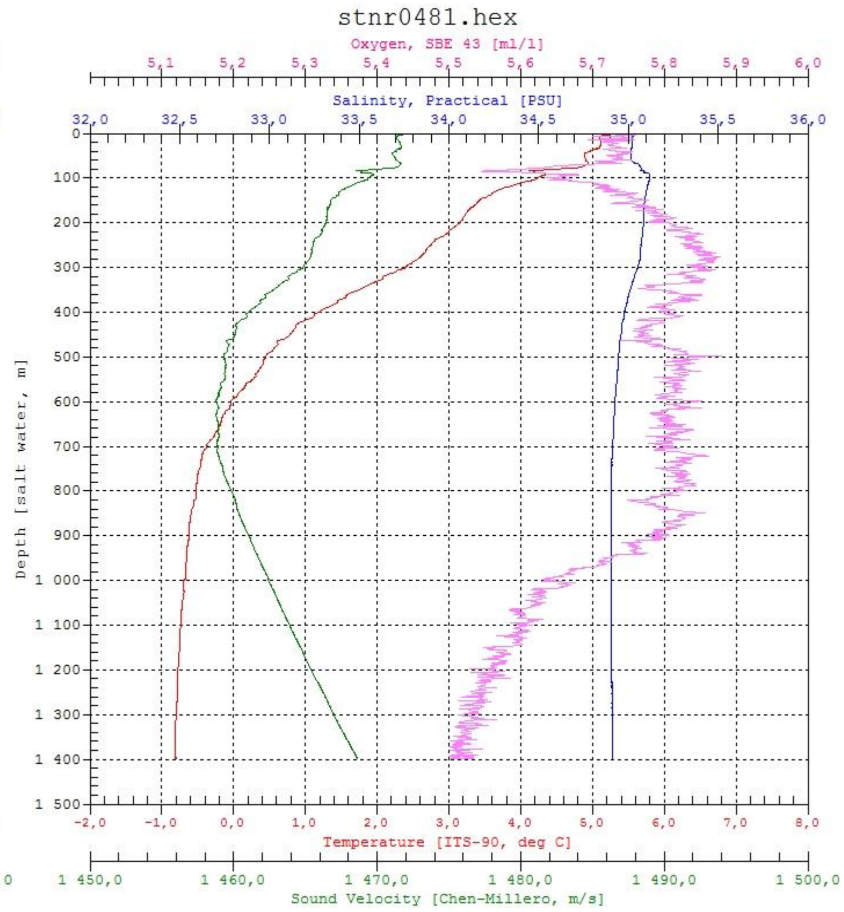
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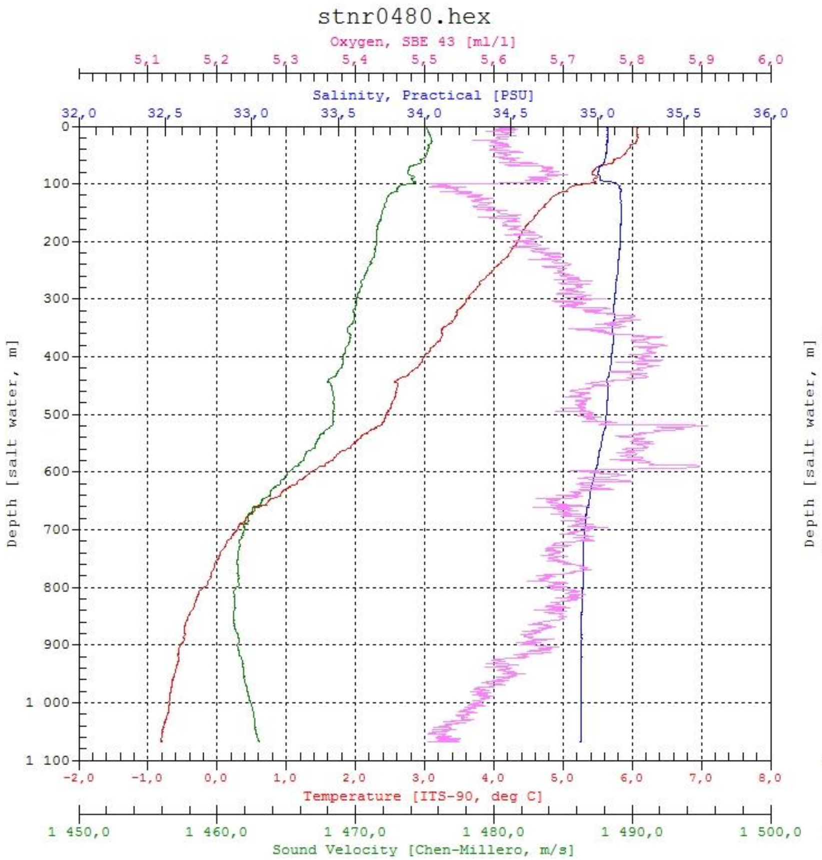
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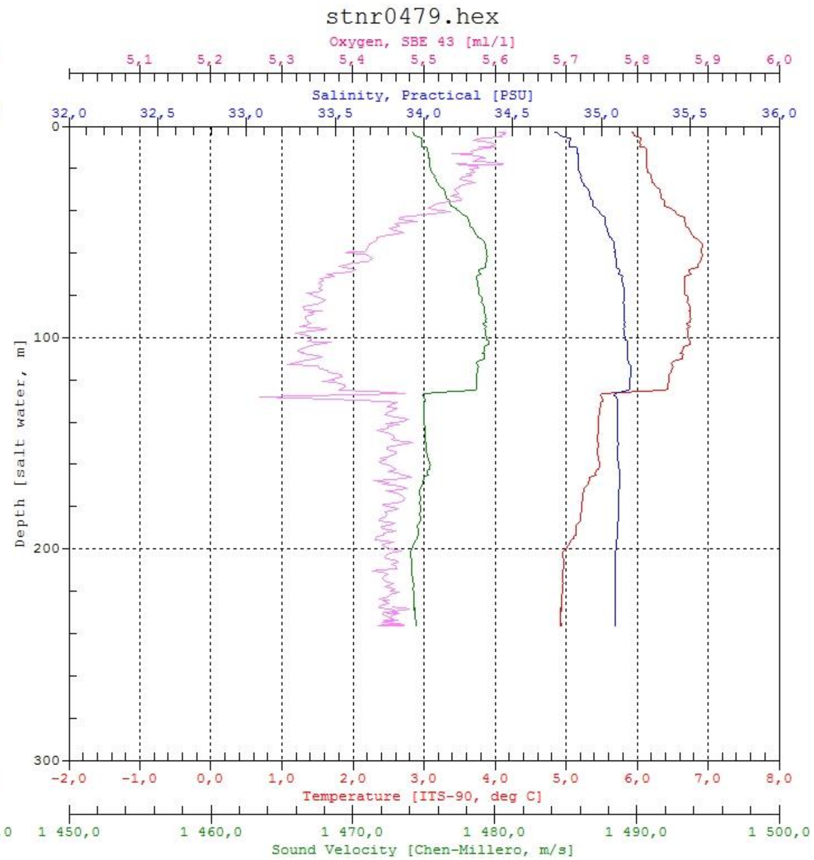
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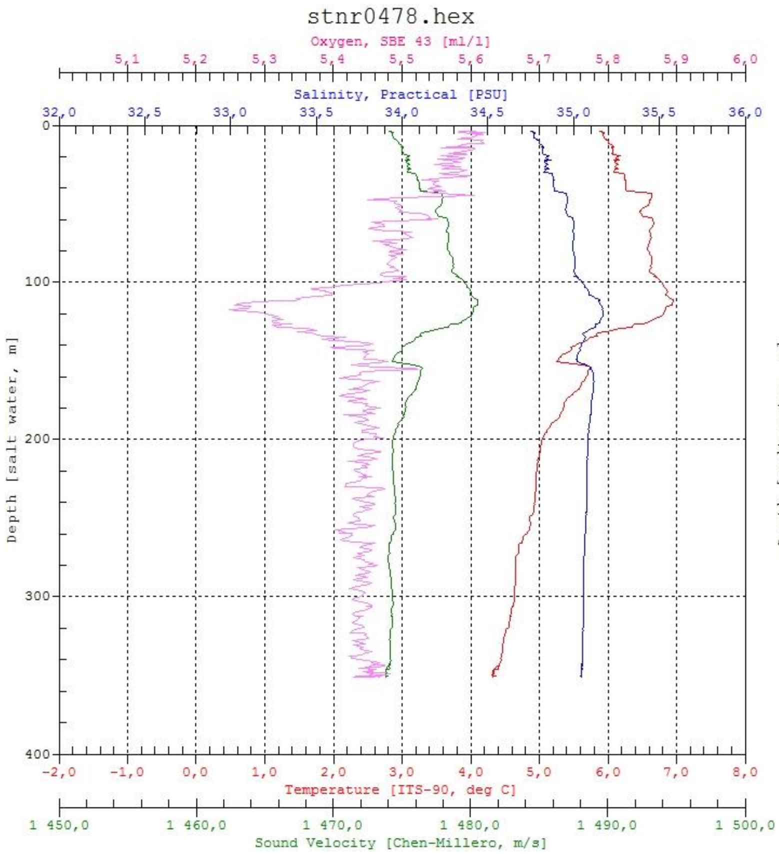
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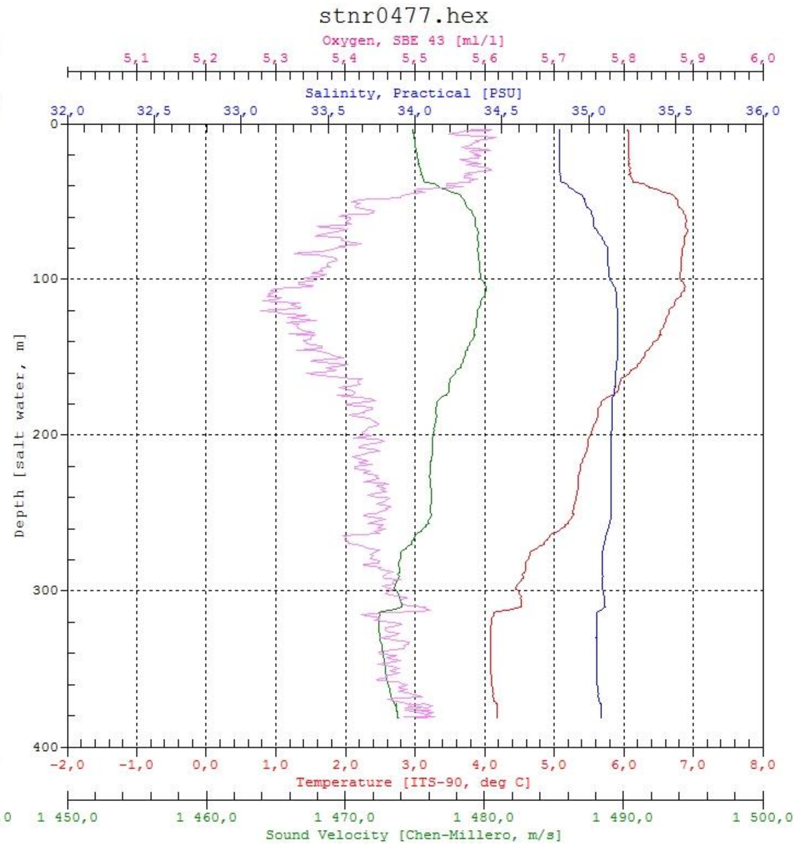
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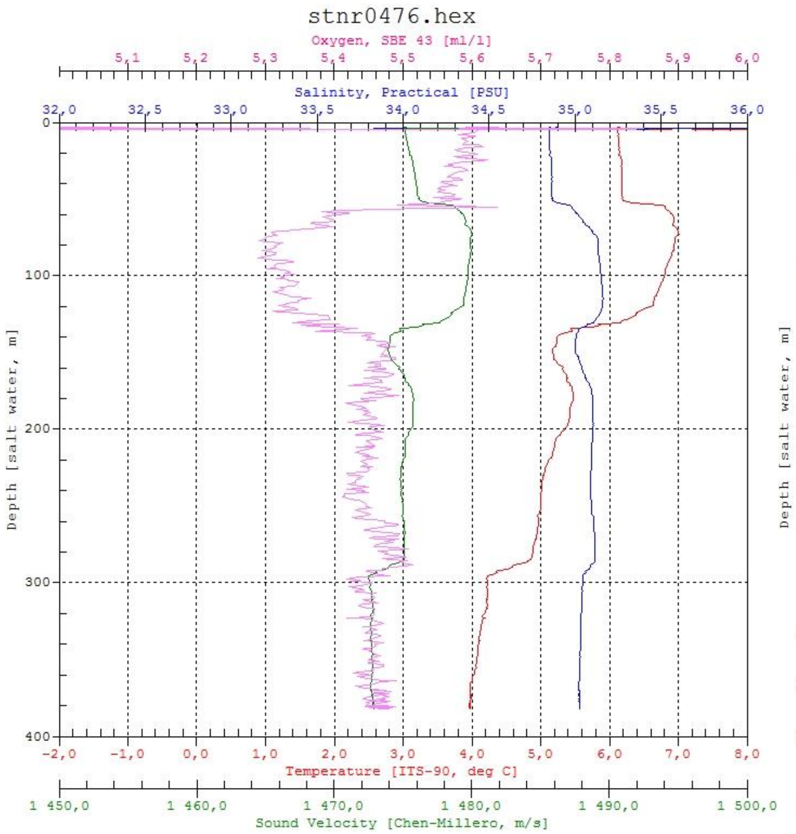
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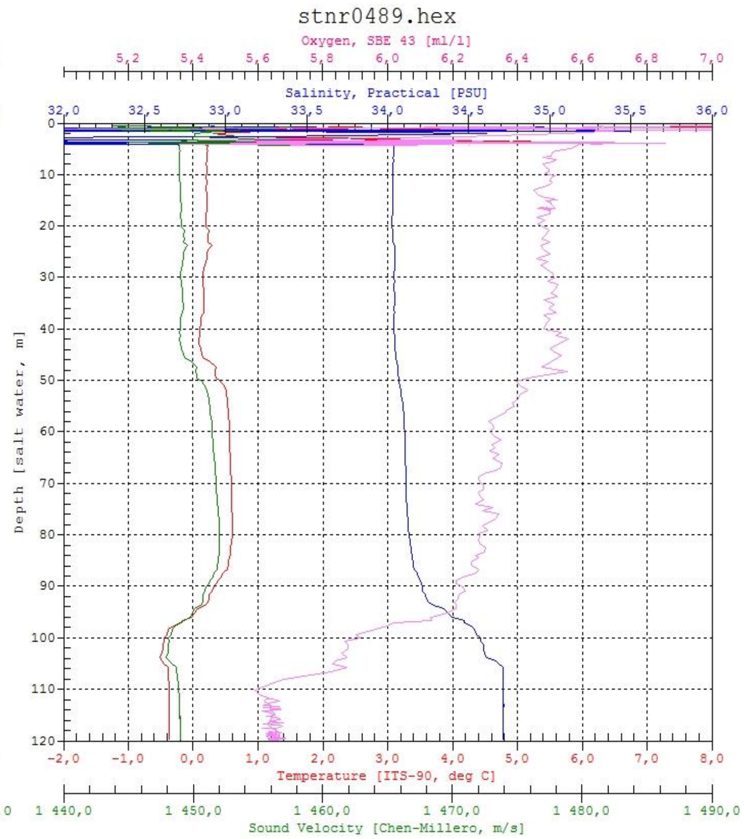
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Salinity, Practical [PSU]
Depth [salt water, m]
Temperature [ITS-90, deg C]
Sound Velocity [Chen-Millero, m/s]

Name	LatN	LonE
CTD 476	78°33.350815'	009°28.601165'
CTD 477	78°33.153977'	009°29.338760'
CTD 478	78°37.051063	009°26.166692'
CTD 479	78°39.285730'	009°26.078185'
CTD 480	78°50.299193'	007°46.258092'
CTD 481	79°09.772263'	006°20.320291'
CTD 482	78°58.842986'	007°03.508501'
CTD 483	79°00.164882'	006°55.641961'
CTD 484	79°02.934411'	006°38.162570'
CTD 485	79°16.682559'	003°55.235116'
CTD 486	81°10.331992'	015°50.455372'
CTD 487	81°06.890879'	015°57.108442'
CTD 488	77°25.607042'	016°20.806780'
CTD 489	81°22.698330'	025°52.195853'

Appendix 2: CTD stations (red: water samples for gas analysis at GEOMAR)

VESTNESA RIDGE

STATION NUMBER	DATE	TIME UTC	CORE #	PENETRATION (CM)	RECOVERY (CM)	COMMENTS
195	12.10.2013	-	GC-01	530	330	sediment methane sampled (Geomar)
196	12.10.2013	-	GC-02	630	394	sediment methane sampled (Geomar)
197	12.10.2013	-	GC-03	659	515	H2S smell strong, carbonates in core catcher-frozen for porewaters
198	12.10.2013	-	GC-04	740	411	sediment methane sampled (Geomar)
199	13.10.2013	-	GC-05	760	450	frozen for porewaters
200	13.10.2013	-	GC-06	450	270	H2S smell strong-frozen for porewaters
201	13.10.2013	-	GC-07	450	194	H2S smell strong, carbonates in core catcher, sediment methane sampled (Geomar)
0	13.10.2013	-	BC-01	full	full	benthic worm tubes at surface-photos taken, 2 tubes of sed. collected, one frozen for pore waters, topmost sediment sampled and frozen
1	13.10.2013	-	BC-02	full	full	no benthic worm tubes-photos taken, 2 tubes of sed. collected, one frozen for pore waters, topmost sediment sampled and frozen
202	13.10.2013	-	GC-08	630	483	no H2S smell
203	13.10.2013	-	GC-09	360	300	H2S smell strong-frozen for porewaters
204	13.10.2013	-	GC-10	630	594	gas hydrates vein chips in core catcher-photos taken, hydrate sample taken for methane measurement, sediment methane sampled (Geoma
2	13.10.2013	-	BC-03	overpenetrated	full	disturbed top, after overpenetration topmost mud fell back into the box-2 tubes of sed. collected, one frozen for pore waters, topmost sedi
206	13.10.2013	-	GC-11	762	480	no H2S smell
207	13.10.2013	22:38	GC-12	775	490	no H2S smell, stiff at the bottom-frozen for porewaters
208	13.10.2013	23:38	GC-13	760	494	no H2S smell, stiff at the bottom
209	14.10.2013	00:43	GC-14	766	425	no H2S smell, stiff at the bottom-frozen for porewaters
210	14.10.2013	03:05	GC-15	787	493	no H2S smell
211	14.10.2013	04:02	GC-16	768	498	H2S smell
212	14.10.2013	05:12	GC-17	756	516	no H2S smell
213	14.10.2013	06:00	GC-18	600	520	H2S smell
214	14.10.2013	07:40	GC-19	630	464	no H2S smell, sediment methane sampled (Geomar)
215	14.10.2013	10:30	GC-20	630	529	no H2S smell
216	14.10.2013	12:15	GC-21	674	595	no H2S smell

217	14.10.2013	13:37	GC-22	590	595	no H2S smell

NOTE: station number 205 was assigned to a seismic line
NOTE: frozen cores marked in red above will be sent to Jochen Knies at NGU for pore water analyses and (bold red underlined are pore water samples analyzed by Jens Greinert, GEOMAR)

NW Svalbard Slide

STATION NUMBER	DATE	TIME UTC	CORE #	PENETRATION (CM)	RECOVERY (CM)	COMMENTS
219	15.10.2013	19:00	GC-23	762	529	
220	15.10.2013	20:17	GC-24	602	497	shale lithic fragment found in core catcher
221	15.10.2013	22:00	GC-25	493	509	
222	15.10.2013	23:10	GC-26	608	566	
223	16.10.2013	01:13	GC-27	742	452	
224	16.10.2013	02:57	GC-28	747	473	no core catcher recovery, only nose cone piece
225	16.10.2013	04:44	GC-29	750	384	no nose cone recovery
226	16.10.2013	06:52	GC-30	430	262	no nose cone or core catcher recovery
227	16.10.2013	08:29	GC-31	400	214	no nose cone or core catcher recovery

Name	LatN	LonE	
GC195	78°52.122854’	007°31.209957’	4143
GC196	78°53.558463’	007°25.815334’	
GC197	78°53.631417’	007°26.462102’	
GC198	78°53.838792’	007°24.858031’	
GC199	78°53.875934’	007°25.033750’	3990
GC200	78°58.848623’	007°03.636811’	
GC201	78°58.805524’	007°03.647216’	
BC000	78°58.833107’	007°03.738971’	

BC001	78°59.094579’	007°02.272631’	
GC202	78°59.077682’	007°02.265784’	3396
GC203	79°00.143977’	006°55.683059’	
GC204	79°00.156195’	006°55.760490’	
BC002	79°00.167326’	006°55.732832’	
GC206	79°00.750371’	006°58.127430’	
GC207	79°00.702323’	006°58.048735’	
GC208	78°59.398097’	006°51.949861’	3348
GC209	78°59.352930’	006°51.793659’	3340
GC210	79°00.275853’	006°54.723779’	3240
GC211	79°01.086696’	006°49.850833’	3139
GC212	79°01.214249’	006°48.935230’	3121
GC213	79°01.523798’	006°46.941976’	3082
GC214	79°02.941629’	006°38.747334’	2901
GC215	79°05.620114’	006°21.462443’	2561
GC216	79°08.616630’	005°10.214328’	1455
GC217	79°09.990241’	004°51.382136’	
GC219	79°26.509599’	006°29.771299’	
GC220	79°27.668785’	006°13.161782’	
GC221	79°28.006185’	006°08.043128’	
GC223	79°30.113672’	005°37.353897’	
GC224	79°30.766960’	005°27.438998’	
GC225	79°31.632152’	005°14.365221’	
GC226	79°26.554089’	005°08.488853’	

Appendix 3: Vestnesa and NW Svalbard gravity and box core stations (red bold underlined stations are sampled for gas analyses by Jens Greinert, GEOMAR, red indicate double coring where one core is frozen for gas analysis by Jochen Knies at NGU)

Name	LatN	LonE
004_noflare	79°10.030'	4°51.567'
004_noflare	79°08.774'	5°08.198'
005_noflare	79°08.618'	5°10.208'
006_noflare	79°08.472'	5°12.139'
007_noflare	79°07.791'	5°35.177'
008_noflare	79°06.628'	6°06.399'
	79°06.297'	6°15.163'
009_noflare	79°05.594'	6°21.496'
between9_10	79°05.245'	6°23.812'
010_flare	79°04.179'	6°30.708'
between10_11	79°03.627'	6°34.387'
011_noflare	79°03.275'	6°36.714'
012_bigFlare	79°02.918'	6°38.939'
between12_13	79°02.543'	6°41.180'
013_flare	79°02.172'	6°43.432'
between13_14	79°01.914'	6°45.000'
014_noflare	79°01.752'	6°45.959'
015_flare	79°01.513'	6°47.434'
016_noflare	79°01.051'	6°50.233'
017_bigFlare	79°00.478'	6°53.695'
018_bigFlare	79°00.160'	6°55.627'
bkg_between18_20	78°59.848'	6°57.532'
019_noflare	78°59.508'	6°59.584'
close20	78°59.089'	7°02.105'
020_bigFlare	78°58.832'	7°03.668'

021_flare	78°58.149’	7°07.798’
between17_18	79°00.287’	6°54.818’
between16_17	79°00.708’	6°52.325’
between15_16	79°01.173’	6°49.560’
22_noflare	78°55.008’	7°20.456’
23_noflare	78°53.622’	7°25.783’
between22_23	78°53.913’	7°24.692’
bkg_wipeout	78°52.180’	7°31.327’
big_flare	78°58.850’	7°03.507’
big_flare_2	79°00.203’	6°55.310’
big_flare_3	79°00.480’	6°53.650’
big_flare_4	79°01.505’	6°47.454’
passed_big_flare_5	79°02.351’	6°42.291’
big_flare_6	79°02.842’	6°39.282’
large_flare	79°04.086’	6°31.412’

Appendix 4: Vestnesa flare locations, see also seismic line 2D_05.

Appendix 5: Helmer Hanssen October 2013 Survey: HH13-CAGE-VR2D 11.10. – 22.10.2013

2D line number:	Date: Start - end	Time (UTC): Start - end	Shot point number First - last	Shot point number when crossing planned start and end of line	Comments (sailing direction, ship speed, depth sensor, wind speed, air temperature downtime, etc.)
05	11.10. – 12.10.	20:56 – 08:55	24 – 4266	1463.4	Wind speed ~ 10 m/s Shooting rate – 1/10 sec Ship speed ~ 4.5 kn Streamer length Geoeel:100m, 90 meters behind ship. Number of channels:32 Channel spacing: 3,125m Streamer length Fjord: 6m Guns: Gun1: 45/45, Gun2:45/105 Air pressure: 150bars Shooting rate 10 sec Airgun depth 4 meters, 55 meters behind ship Sampling rate: 0.5sec Record length:5 sec
					3776 missing channels2,3,4,
06	13.10-13.10	17:27 – 17:42 17:42 – 19:29	1 – 86 87 – 724		Wind speed ~ 3-4 m/s Shooting rate – 1/10 sec Ship speed ~ 4.5 kn Streamer length Geoeel: 100m, 90 meters behind ship. Number of channels:32 Channel spacing: 3,125m Streamer length Fjord: 6m Guns: Gun1: 45/45, Gun2:45/105 Air pressure: 150bars Shooting rate 10 sec

2D line number:	Date: Start - end	Time (UTC): Start - end	Shot point number First - last	Shot point number when crossing planned start and end of line	Comments (sailing direction, ship speed, depth sensor, wind speed, air temperature downtime, etc.)
					Airgun depth 4 meters, 55 meters behind ship Sampling rate: 0.25sec Record length:4 sec Proper logging begins from shot number 87
(St 218) Line HH13-CAGE-NWSV2D 07	15.10. – 15.10.	10:16 – 17:11	01 – 1746		Wind speed ~ 9-10 m/s Shooting rate – 7/10 sec Ship speed ~ 4.5 kn Streamer length Geoeel: 100m, 90 meters behind ship. Number of channels:32 Channel spacing: 3,125m Streamer length Fjord: 6m Guns: Gun1: 15/15, Gun2:15/15 Air pressure: 150bars Airgun depth 4 meters, 55 meters behind ship Sampling rate: 0.5msec Record length:7 sec Proper logging begins from shot number 01 (UTC 10:20) Water depth 4044 m
(St 228) Line HH13-CAGE-VR_MD-2D 08	16.10 – 16.10.	13:16 – 20:31	01 – 2375		Wind speed ~ 12-13 m/s Shooting rate – 1/11 sec Ship speed ~ 4.5 kn Streamer length Geoeel: 100m, 95 meters behind ship. Number of channels:32 Channel spacing: 3,125m Streamer length Fjord: 6m Guns: Gun1: 45/45, Gun2:105105 Air pressure: 150bars Shooting rate 11 sec Airgun depth 4 meters, 51 meters behind ship Sampling rate: 0.5msec Record length:7 sec Proper logging begins from shot number 87

2D line number:	Date: Start - end	Time (UTC): Start - end	Shot point number First - last	Shot point number when crossing planned start and end of line	Comments (sailing direction, ship speed, depth sensor, wind speed, air temperature downtime, etc.)
					13:40- checking streamer for tangling with airguns
Line HH13-CAGE-VR_MD-2D 09	16.10 – 17.10.	21:50 – 00:57	01 – 1018		Wind speed ~ 11-13 m/s Shooting rate – 1/11 sec Ship speed ~ 4.5 kn Streamer length Geoeel: 100m, 95 meters behind ship. Number of channels:32 Channel spacing: 3,125m Streamer length Fjord: 6m Guns: Gun1: 45/45, Gun2:105105 Air pressure: 150bars Shooting rate 11 sec Airgun depth 4 meters, 51 meters behind ship Sampling rate: 0.5 msec Record length:7 sec Proper logging begins from shot number 01
(ST 229) Line HH13-CAGE-HINL_2D 10	20.10. – 20.10.	11:26-12:53	01-515		Wind speed ~ 8,5 m/s Shooting rate 10 sec Ship speed ~ 4.0 kn Streamer length Geoeel: 100m, 95 meters behind ship. Number of streamers: 4. Number of channels:32 (8 channels/streamer) Channel spacing: 3,125m Streamer length Fjord: 6m Guns: Gun1: 45/45, Gun2:45/105 Air pressure: 160bars Shooting rate 10 sec Airgun depth 4 meters, 47 meters behind ship Sampling rate: 0.5msec Record length: 6 sec Proper logging begins from shot number 01 Start at 81 04.6167; 15 26.2500; Heading 90 degrees

2D line number:	Date: Start - end	Time (UTC): Start - end	Shot point number First - last	Shot point number when crossing planned start and end of line	Comments (sailing direction, ship speed, depth sensor, wind speed, air temperature downtime, etc.)
					End at 81 04.5065; 16 04.294
(ST 229) Line HH13-CAGE-HINL_2D 11	20.10. – 20.10	Delph 13.38: Geoeel:13:55- 15:01	1-recording the turns 1- 404		Wind speed ~ 13,5 m/s Shooting rate 10 sec Ship speed ~ 4.0 kn Same parameters as line 10 (st 229) We run individual lines for Geoeel but only one line for delph which includes the turns!! Note, turns are not recorded by Geoeel only SOL and EOL. Start at 81 05,3106; 16 02.4470; Heading 270
(ST 229) Line HH13-CAGE-HINL_2D 12	20.10. – 20.10	Geoeel:15:34- 16:45	1- 426		Wind speed ~ 13,5 m/s Shooting rate 10 sec Ship speed ~ 4.0 kn Same parameters as line 10 (st 229) We run individual lines for Geoeel but only one line for delph which includes the turns!! Note, turns are not recorded by Geoeel only SOL and EOL. Start at 81 06,3400; 15 29.966; Heading 90 End 81 06.3068; 16 04.5624
Line HH13-CAGE-HINL_2D 13	20.10. – 20.10	Geoeel:17:38- 18:35	1-343		Wind speed ~ 10,5 m/s Shooting rate 10 sec Ship speed ~ 4.0 kn Same parameters as line 10 (st 229) We run individual lines for Geoeel but only one line for delph which includes the turns!! Note, turns are not recorded by Geoeel only SOL and EOL. Start at 81 08.371; 15 59.954; Heading 245 End at 81 08.364; 15 31.774

Line HH13-CAGE-HINL_2D 14	20.10. – 20.10.	Geoeel:19:23-20:17	1-325		Wind speed ~ 6,2 m/s Shooting rate 10 sec Ship speed ~ 4.0 kn Same parameters as line 10 (st 229) We run individual lines for Geoeel but only one line for delph which includes the turns!! Note, turns are not recorded by Geoeel only SOL and EOL. Start at 81 08.882: 15 32.750; Heading 90 End at 81 08.867 ; 15 58.120
Line HH13-CAGE-HINL_2D 15	20.10. – 20.10.	Geoeel: 20:49-21:39	1-298		Wind speed ~ 6,6 m/s Shooting rate 10 sec Ship speed ~ 4.0 kn Same parameters as line 10 (st 229) We run individual lines for Geoeel but only one line for delph which includes the turns!! Note, turns are not recorded by Geoeel only SOL and EOL. Start at 81 09.515: 15 56.422; Heading 260 End at 81 09.521 ; 15 32.439
Line HH13-CAGE-HINL_2D 16	20.10. – 20.10.	Geoeel: 22:17-23:07	1-298		Wind speed ~ 13,03 m/s Shooting rate 10 sec Ship speed ~ 4.5 kn Same parameters as line 10 (st 229) We run individual lines for Geoeel but only one line for delph which includes the turns!! Note, turns are not recorded by Geoeel only SOL and EOL. Start at 81 10.409; 15 31.919; Heading 89 End at 81 10.414 ; 15 56.292
Line HH13-CAGE-HINL_2D 17	20.10. – 21.10.	Geoeel: 23:38-00:18	1-241		Wind speed ~ 12,41 m/s Shooting rate 10 sec Ship speed ~ 4.5 kn Same parameters as line 10 (st 229) We run individual lines for Geoeel but only one line for delph which includes the turns!! Note, turns are not recorded by Geoeel only SOL and EOL. Start at 81 10.588; 15 54.729; Heading 268 End at 81 11.616 ; 15 35.669

Line HH13- CAGE-HINL_2D 18	21.10. – 21.10.	Geoeel: 01:17-02:16	1-355		Wind speed ~ 10,85 m/s Shooting rate 10 sec Ship speed ~ 4.6 kn Same parameters as line 10 (st 229) We run individual lines for Geoeel but only one line for delph which includes the turns!! Note, turns are not recorded by Geoeel only SOL and EOL. Start at 81 11.595; 15 35.975; Heading 131 End at 81 07.945 ; 15 51.583
(st230) CAGE-HINL_2D 19	21.10. – 21.10.	Geoeel: 06:06-10:38	1-1627		Wind speed ~ 7m/s Shooting rate 10 sec Ship speed ~ 4.6 kn Same parameters as line 10 (st 229) We run individual lines for Geoeel but a continuous line for delph Start at 80 58.213N 016 00.357Heading 082 End at 80 59.352 N; 18 04.729
(st231) CAGE-HINL_2D 20	21.10. – 21.10	Geoeel:11:06 – 19:26	1 - 2999		Wind speed ~ 7m/s Shooting rate 10 sec Ship speed ~ 4.6 kn Same parameters as line 10 (st 229) We run individual lines for Geoeel but a continuous line for delph Start at 81 00.0820 N; 18 5.543 E; heading 359 End at 81 36.694 N; 18 12.20 E

CAGE-HINL_2D 21	21.10.-22.10.	Geoeel:19:31 – 00:20	1-1735		Wind speed ~ 7m/s Shooting rate 10 sec Ship speed ~ 4.6 kn Same parameters as line 10 (st 229) We run individual lines for Geoeel but a continuous line for delph Start at 81 036.565 N; 18 11.139 E; heading 235 Abandoned course because of sea ice at 81 34.257 N; 17 41.366 E, new heading 101; At 20:57 (81 33.960; 17 42.975) new heading150 degrees, we are trying to pass the ice on the eastern side. Water depth 1325 meters. At 21:10 (8131.9725; 1746.25) heading 210, still avoiding sea ice, water depth 1339 meters. At 22:42 (8126.89; 1738.27) heading 150, still avoiding sea ice, water depth 960. At 22:10 (8121.16; 1736.15) heading 195, still avoiding sea ice, water depth 773. coming up on SOL for Line 23. End at 81 19.885 N; 17 32.937 E
CAGE-HINL_2D 22	N/A	N/A	N/A		Due to sea ice line 22 was not accessible; line 21 has data following the ice as close to line 22 as possible.

CAGE-HINL_2D 23	22.10. – 22.10.	Geoeel: 00:34 – 03:01	1 – 884		Wind speed ~ 10 m/s Shooting rate 10 sec Ship speed ~ 4.3 kn Same parameters as line 10 (st 229) We run individual lines for Geoeel but a continuous line for delph Start at 81 19.550 N; 17 27.101 E; Heading 303 Start of line not matched due to avoiding of ice End at 81 22.885 N; 16 18.080 E Note slides at eastern Hinlopen sidewall, one was mapped by MB and seismic and shows up clearly at 2102 m water depth at 81 22.154 N; 16 34.225 E.
(st 230) CAGE-HINL_2D 24	22.10. – 22.10	Geoeel: 09:05 – 12:06	1 – 1084		Wind speed ~ 12,5 m/s Shooting rate 10 sec Ship speed ~ 4,5 kn Same parameters as line 10 (st 229) We run individual lines for Geoeel but a continuous line for delph Start at 81 07.5150 N; 16 13.562 E; Heading 92 End at 81 07.481N; 17 40.221 E
(st 230) CAGE-HINL_2D 25	22.10. – 22.10.	Geoeel: 12:15 – 13:30	1 – 448		Wind speed ~ 10,5 m/s Shooting rate 10 sec Ship speed ~ 4,5 kn Same parameters as line 10 (st 229) We run individual lines for Geoeel but a continuous line for delph Start at 81 07.131 N; 17 42.421 E; Heading 180 End at 81 01.745 N; 17 40.371 E END OF LINE and RESEARCH CRUISE: Sailing via Hinlopen Straight back to Tromsø. Stopped recording data at 16:43!

Stasjonslapper på HELMER HANSSEN (Logg fra 23.juni 2003) [Aktiv katalog: e:\felles\rls\log]

CruiseNr	Date (UTC)	Time (UTC)	StNr	StationType	Comment	Logg (nm)	Latitude	Longitude	Depth (m)	Sea temp (°C)	Air Temp (°C)	Wind Speed (m/s)	Wind dir (deg)	Humidity (%)	Air Pressure (hPa)	Weather	Clouds	Sea	Ice	Heading COG (deg)	Speed SOG (kn)
2013009	09.10.2013	142547	**476**	CTD-stasjon med vannhenter.start		8242,511	7833.350815 N	00928.601165 E	387,41	6,2	2,2	6,37	33	70	1004,4	2	8	5	0	127,09	0,5
2013009	09.10.2013	144752	**476**	CTD-stasjon med vannhenter.stopp		8242,619	7833.384280 N	00928.746577 E	388,66	6,3	2,1	4,94	40	70	1004,1	2	8	5	0	105,2	0,4
2013009	09.10.2013	164756	**477**	CTD-stasjon med vannhenter.start		8243,626	7833.153977 N	00929.338760 E	390,88	6,2	2,5	4,94	59	71	1003,4	2	8	2	0	104,59	0,5
2013009	09.10.2013	170210	**477**	CTD-stasjon med vannhenter.stopp		8243,69	7833.183532 N	00929.419346 E	390,26	6,3	2,6	4,1	55	71	1003,4	2	8	2	0	110,99	0,1
2013009	09.10.2013	184014	**478**	CTD-stasjon med vannhenter.start		8248,546	7837.051063 N	00926.166692 E	358,49	6,1	2,7	2,96	84	71	1003,1	2	8	2	0	98,93	1,8
2013009	09.10.2013	185815	**478**	CTD-stasjon med vannhenter.stopp		8248,677	7837.133752 N	00925.948947 E	360,34	6,4	2,7	1,99	59	71	1003	2	8	2	0	38,08	0,7
2013009	09.10.2013	204236	**479**	CTD-stasjon med vannhenter.start		8252,736	7839.285730 N	00926.078185 E	241,75	5,3	2,6	2,1	42	69	1002,5	2	8	2	0	358,79	3,3
2013009	09.10.2013	210134	**479**	CTD-stasjon med vannhenter.stopp		8253,018	7839.535453 N	00925.644375 E	244,8	6	2,6	2,47	4	68	1002,3	2	8	2	0	118,48	0,7
2013009	10.10.2013	55309	**480**	CTD-stasjon med vannhenter.start		8341,72	7850.299193 N	00746.258092 E	815,36	6,3	2,2	3,64	14	81	998,4	2	8	2	0	74,03	4,5
2013009	10.10.2013	64510	**480**	CTD-stasjon med vannhenter.stopp		8342,263	7850.770035 N	00746.630365 E	1079,49	6,3	2,6	4,29	8	79	998,2	2	8	2	0	244,4	1,1
2013009	10.10.2013	143321	**481**	CTD-stasjon. start		8405,996	7909.772263 N	00620.320291 E	1413,01	5	-2,9	12,96	347	82	998,5	2	8	5	0	325,16	1,1
2013009	10.10.2013	151651	**481**	CTD-stasjon.stopp		8406,444	7909.709711 N	00619.511819 E	1403,99	5,3	-2,8	12,46	347	81	998,6	2	8	5	0	332,23	1

2013009	11.10.2013	213658	**194**	Annen stasjon	seismikklinjer	8618,407	7917.480060 N	00412.597068 E	2444,29	5,2	-9,5	8,13	256	60	1013,7	2	8	5	0	150,33	4,2
2013009	12.10.2013	101101	**195**	Annen stasjon	GC	8673,188	7852.122854 N	00731.209957 E	1126,82	5,6	-7,3	7,56	8	79	1013,9	2	8	5	0	334,03	0,9
2013009	12.10.2013	111304	**196**	Annen stasjon	gc	8675,277	7853.558463 N	00725.815334 E	1151,69	5,5	-4,9	16,03	351	69	1014,6	2	8	5	0	0,19	0,3
2013009	12.10.2013	123953	**197**	Annen stasjon	gc	8676,434	7853.631417 N	00726.462102 E	1156,87	5,6	-5,5	12,59	332	81	1016,1	2	8	5	0	342,37	0,5
2013009	12.10.2013	134747	**198**	Annen stasjon	gc	8677,723	7853.838792 N	00724.858031 E	1144,15	5,4	-4,8	13,71	320	73	1017	2	8	5	0	337,15	1,1
2013009	13.10.2013	30511	**482**	CTD-stasjon med vannhenter.start		8732,148	7858.842986 N	00703.508501 E	1201,17	5,6	-1	6,42	327	66	1025,9	2	8	4	0	296,54	0,3
2013009	13.10.2013	34706	**482**	CTD-stasjon med vannhenter.stopp		8732,621	7858.418842 N	00703.293049 E	1200,07	5,5	-1	7,36	343	67	1026	2	8	4	0	270,79	0,6
2013009	13.10.2013	44954	**199**	Annen stasjon	gc	8739,471	7853.875934 N	00725.033750 E	1143,9	5,4	-0,9	6,98	334	65	1024,9	2	8	4	0	309,44	0,4
2013009	13.10.2013	62118	**200**	Annen stasjon	gc	8746,182	7858.848623 N	00703.636811 E	1204,75	5,5	-1,3	4,94	303	65	1024,5	2	8	4	0	13,71	0,8
2013009	13.10.2013	72434	**201**	Annen stasjon	gc	8747,334	7858.805524 N	00703.647216 E	1204,89	5,6	-1,4	3,43	282	64	1024,3	2	8	4	0	342,53	0,4
2013009	13.10.2013	84210	**0**	Box core (BC)		8748,67	7858.833107 N	00703.738971 E	1206,92	5,6	-1,8	2,01	1	72	1023,8	2	8	4	0	257,6	0,4
2013009	13.10.2013	94919	**1**	Box core (BC)		8749,567	7859.094579 N	00702.272631 E	1198,25	5,6	-1,7	2,67	324	72	1023,3	2	8	4	0	234,63	0,2
2013009	13.10.2013	110342	**202**	Annen stasjon	gc	8750,484	7859.077682 N	00702.265784 E	1197,84	5,6	-1,5	5,02	302	63	1022,5	2	8	4	0	317,72	0,6
2013009	13.10.2013	121334	**203**	Annen stasjon	gc	8752,761	7900.143977 N	00655.683059 E	1210,47	5,5	-1,4	1,61	343	64	1021,7	2	8	3	0	190,77	0,3
2013009	13.10.2013	130310	**204**	Annen stasjon	gc	8753,072	7900.156195 N	00655.760490 E	1211,55	5,6	-1,4	1,91	337	63	1021,3	2	8	3	0	340,06	0,4
2013009	13.10.2013	141051	**2**	Box core (BC)		8753,746	7900.167326 N	00655.732832 E	1210,62	5,6	-1,2	1,8	297	59	1020,6	2	8	3	0	317,21	0,2
2013009	13.10.2013	150002	**483**	CTD-stasjon med vannhenter.start		8754,079	7900.164882 N	00655.641961 E	1209,67	5,7	-1,6	1,96	327	64	1020	2	8	3	0	174,98	0,2
2013009	13.10.2013	154948	**483**	CTD-stasjon med vannhenter.stopp		8754,261	7900.145551 N	00655.636438 E	1210,74	5,7	-1,7	2,33	331	72	1019,4	2	8	3	0	352,37	0,5
2013009	13.10.2013	173340	**205**	Annen stasjon	seismikk	8763,404	7856.286098 N	00636.442310 E	1561,94	5,3	-1,8	1,85	79	72	1018,2	2	8	3	0	56,16	1,9

2013 009	13.10. 2013	205 336	**20** **6**	Annen stasjon	gc	8777 ,206	7900.75 0371 N	00658.12 7430 E	123 5,24	5,5	- 0,8	2,8 8	13 6	63	1016, 5	2	8	3	0	42,6	0,3
2013 009	13.10. 2013	220 349	**20** **7**	Annen stasjon	gc	8778 ,771	7900.70 2323 N	00658.04 8735 E	123 2,49	5,5	- 0,4	3,7 1	83	65	1015, 6	2	8	3	0	35,8 6	0,6
2013 009	13.10. 2013	230 835	**20** **8**	Annen stasjon	gc	8781 ,426	7859.39 8097 N	00651.94 9861 E	123 9,62	5,6	- 0,1	5,3 7	11 5	66	1014, 7	2	8	3	0	246, 51	1
2013 009	14.10. 2013	182 5	**20** **9**	Annen stasjon	gc	8781 ,996	7859.35 2930 N	00651.79 3659 E	124 1,77	5,7	0,2	6,3 2	10 0	64	1013, 6	2	8	3	0	139, 21	0,5
2013 009	14.10. 2013	234 16	**21** **0**	Annen stasjon	gc	8784 ,194	7900.27 5853 N	00654.72 3779 E	119 9,18	5,7	0,2	11, 22	10 9	71	1011, 2	2	8	3	0	122, 43	0,4
2013 009	14.10. 2013	331 20	**21** **1**	Annen stasjon	gc	8786 ,263	7901.08 6696 N	00649.85 0833 E	120 2,11	5,6	0,3	11, 48	10 0	70	1010, 3	2	8	3	0	154, 59	0,7
2013 009	14.10. 2013	444 43	**21** **2**	Annen stasjon	gc	8787 ,424	7901.21 4249 N	00648.93 5230 E	120 1,89	5,7	0,3	12, 8	11 5	69	1009, 2	2	8	4	0	109, 84	0,2
2013 009	14.10. 2013	538 04	**21** **3**	Annen stasjon	gc	8788 ,786	7901.52 3798 N	00646.94 1976 E	120 3,15	5,5	- 0,1	14, 17	10 6	75	1008, 3	2	8	5	0	135, 89	0,5
2013 009	14.10. 2013	708 12	**21** **4**	Annen stasjon	gc	8792 ,401	7902.94 1629 N	00638.74 7334 E	121 1,04	5,3	- 1,1	12, 52	10 1	86	1007, 9	2	8	5	0	110, 39	0,5
2013 009	14.10. 2013	739 28	**48** **4**	CTD-stasjon med vannhenter.start		8792 ,717	7902.93 4411 N	00638.16 2570 E	120 8,83	5,3	- 0,8	11, 71	81	87	1007, 6	2	8	5	0	126, 19	1,5
2013 009	14.10. 2013	854 38	**48** **4**	CTD-stasjon med vannhenter.stopp		8793 ,64	7903.00 7076 N	00638.91 0030 E	121 1,19	5,4	0,2	15, 88	65	77	1007, 7	2	8	5	0	79,3 8	0,9
2013 009	14.10. 2013	934 05	**21** **5**	Annen stasjon	gc	8798 ,298	7905.62 0114 N	00621.46 2443 E	123 0,96	4,8	- 0,5	16, 75	61	81	1008	2	8	5	0	94,4 6	0,2
2013 009	14.10. 2013	113 939	**21** **6**	Annen stasjon	gc	8813	7908.61 6630 N	00510.21 4328 E	134 5,32	5,4	0,5	14, 4	41	69	1009	2	8	5	0	65,3 8	0,7
2013 009	14.10. 2013	130 229	**21** **7**	Annen stasjon	gc	8817 ,392	7909.99 0241 N	00451.38 2136 E	141 2,91	5,3	0,8	11, 37	22	61	1009, 8	2	8	5	0	47,3 5	0,5
2013 009	14.10. 2013	150 950	**48** **5**	CTD-stasjon. start		8830 ,324	7916.68 2559 N	00355.23 5116 E	264 9,74	3,2	0,1	11, 68	5	71	1011, 2	2	8	5	0	7,52	0,9
2013 009	14.10. 2013	163 418	**48** **5**	CTD-stasjon.stopp		8831 ,39	7917.14 4650 N	00353.74 7333 E	273 3,06	3,3	1	12, 26	42	59	1012, 4	2	8	5	0	24,0 4	0,1
2013 009	15.10. 2013	102 217	**21** **8**	Annen stasjon	seismik klinje	8889 ,122	7936.11 9435 N	00406.29 8101 E	407 5,71	4,9	-3	9,5 8	27	90	1021, 8	7	9	4	0	108, 71	3,5
2013 009	15.10. 2013	181 835	**21** **9**	Annen stasjon	gc	8922 ,98	7926.50 9599 N	00629.77 1299 E	143 1,96	5,5	- 2,7	8,1 4	30 6	78	1021, 3	7	9	4	0	353, 73	0,9
2013 009	15.10. 2013	192 948	**22** **0**	Annen stasjon	gc	8926 ,614	7927.66 8785 N	00613.16 1782 E	168 6,57	5,7	-3	8,4 1	31 3	78	1021, 1	7	9	4	0	346, 69	0

2013009	15.10.2013	210755	**221**	Annen stasjon	gc	8928,572	7928.006185 N	00608.043128 E	1766,97	5,6	-3,6	8,48	310	71	1021	7	9	4	0	346,65	0,7
2013009	15.10.2013	222349	**222**	Annen stasjon		8930,825	7928.529213 N	00601.265595 E	1862,75	5,4	-4,4	9,82	298	69	1020,5	7	9	4	0	344,04	0,9
2013009	16.10.2013	1515	**223**	Annen stasjon	gc	8936,306	7930.113672 N	00537.353897 E	2294,11	5,2	-5,7	11,73	298	72	1020,3	7	9	4	0	300,63	0,7
2013009	16.10.2013	15709	**224**	Annen stasjon	gc	8938,798	7930.766960 N	00527.438998 E	2468,48	5,1	-5,9	9,68	295	76	1019,8	7	9	4	0	330,9	0,3
2013009	16.10.2013	33627	**225**	Annen stasjon	gc	8941,888	7931.632152 N	00514.365221 E	2639,47	5,1	-5,8	13,36	315	80	1019,2	7	9	4	0	318,89	0,6
2013009	16.10.2013	54420	**226**	Annen stasjon	gc	8947,866	7926.554089 N	00508.488853 E	2519,5	5,1	-5,6	12,18	309	85	1018,7	7	9	4	0	325,01	0,2
2013009	16.10.2013	74642	**227**	Annen stasjon		8949,552	7926.467824 N	00507.987890 E	2522,77	4,9	-6,3	13,4	322	78	1018,3	7	9	4	0	345,9	0,5
2013009	16.10.2013	131730	**228**	Annen stasjon	seismikk	8991,548	7857.029010 N	00641.709022 E	1457,57	4,4	-6,6	5,68	331	78	1017,1	7	9	4	0	215,93	3,8
2013009	19.10.2013	65024	**486**	CTD-stasjon med vannhenter.start		9096,951	8110.780549 N	01551.538841 E	2200,24	4,3					1011,5	2	3	3	0	0,81	1,9
2013009	19.10.2013	84108	**486**	CTD-stasjon med vannhenter.stopp		9096,951	8110.331925 N	01550.455372 E	2211,69	4,3					1011,5	2	3	3	0	261,33	0,4
2013009	20.10.2013	113622	**229**	Annen stasjon	seismikk linjer		8104.586231 N	01527.905351 E	2138,43	4,3					1011,5	2	3	3	0	102,51	4,5
2013009	21.10.2013	25813	**487**	CTD-stasjon med vannhenter.start			8106.890879 N	01557.108442 E	2170,4	4,3					1011,5	2	8	4	0	318,46	0,5
2013009	21.10.2013	53647	**230**	Annen stasjon	seismikk		8058.595102 N	01549.927858 E	2013,44	4,3					1011,5	2	8	4	0	188,22	2,6
2013009	22.10.2013	35345	**488**	CTD-stasjon. start			8122.610443 N	01620.636877 E	2316,69	4,3					1011,5	8	7	4	0	277,35	0,3
2013009	22.10.2013	45321	**488**	CTD-stasjon.stopp			8122.607042 N	01620.806780 E	2317,36	4,3					1011,5	8	7	4	0	290,67	0,4
2013009	23.10.2013	141742	**489**	CTD-stasjon med vannhenter.start			7725.713476 N	02552.245277 E	120,7	4,3					1011,5	2	7	3	0	228,3	0,5
2013009	23.10.2013	142916	**489**	CTD-stasjon med vannhenter.stopp			7725.698330 N	02552.195853 E	120,5	4,3					1011,5	2	7	3	0	310,63	0,3