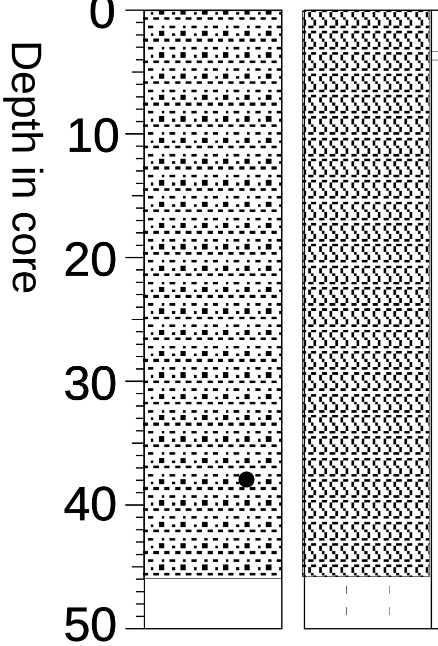
PS93/006-2 (GKG) Western Svalbard margin

Recovery: 0.46 m 79°12.20'N, 4°40.08'E Water depth: 1605 m

Lithology	Texture	Color	Description
Surface:	Even surface, dark grayish brown (2.5Y4/2) sandy silty clay, abundant elongated arenaceaous benthic foraminifers, rare small dropstones (1-5 mm)		



Color: 5Y4/1

0-3.5 cm: Dark grayish brown (2.5Y4/2) to very dark grayish brown (2.5Y3/2) sandy silty clay, homogeneous, darker at base, one small bivalve (2 mm) at 1 cm

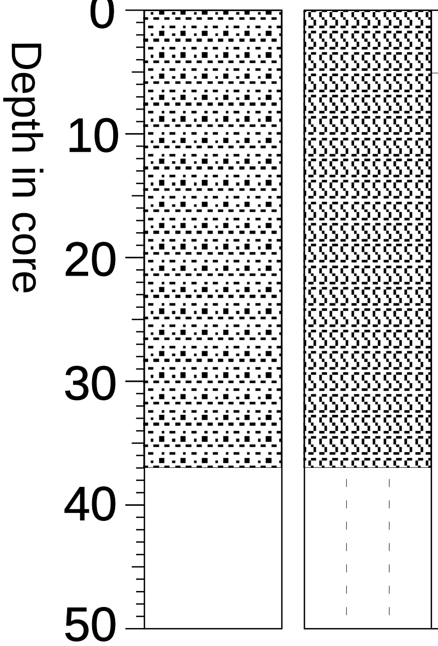
3.5-4.0 cm: Olive brown (2.5Y4/4) sandy silty clay

4-46 cm: Dark gray sandy silty clay, homogeneous, rare benthic foraminifera, small dropstone (5 mm) at 38 cm

PS93/012-1 (GKG) NE Greenland shelf

Recovery: 0.37 m 80°27.88'N, 8°26.33'W Water depth: 295 m

Lithology	Texture	Color	Description
Surface:	Even surface with abundant fine channel-like structures, dark grayish brown (2.5Y4/2) slightly sandy silty clay, common small mudballs, rare thin worm tubes		

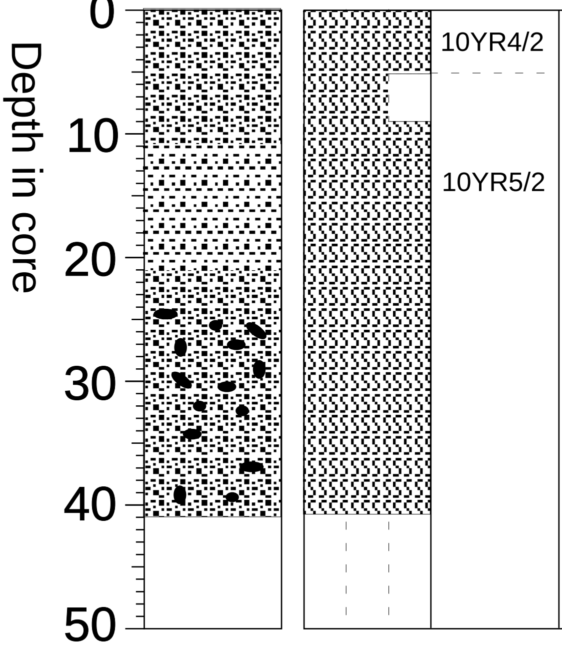


Color	Description
2.5Y4/2	0-5 cm: Dark grayish brown slightly sandy silty clay, homogeneous
5Y4/1	5-37 cm: Dark gray slightly sandy silty clay, homogeneous

PS93/016-4 (GKG) NE Greenland continental margin

Recovery: 0.41 m 81°13.02'N, 7°20.44'W Water depth: 1550 m

Lithology	Texture	Color	Description
Surface:			Uneven surface (relief 0-5 cm) with 3 crater-like structures (5-7 cm), dark grayish brown (10YR4/2) sandy clayey silt, abundant elongated arenaceous benthic foraminifera, abundant dropstones (up to 3 cm), common small mudballs



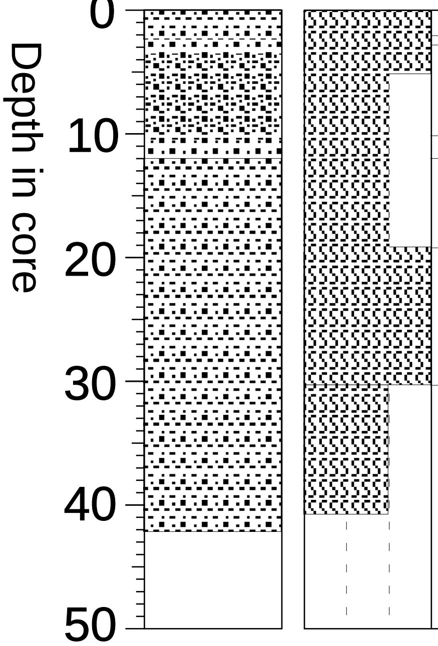
0-5 cm: Dark grayish brown sandy clayey silt, homogeneous

5-41 cm: Grayish brown sandy clayey silt
- Dark grayish brown burrows at 5-9 cm
- Sandy silty clay at 11-21 cm
- Abundant dropstones (0.5-2 cm) at 24-33 cm
- Common dropstones at 33-41 cm
- Slightly reddish in lower part

PS93/017-4 (GKG) NE Greenland continental margin

Recovery: 0.41 m 81°35.69'N, 6°35.17'W Water depth: 3351 m

Lithology	Texture	Color	Description
Surface:			Even surface, brown (10YR4/3) slightly sandy silty clay, abundant small mudballs, rare small bivalves (<1 cm)



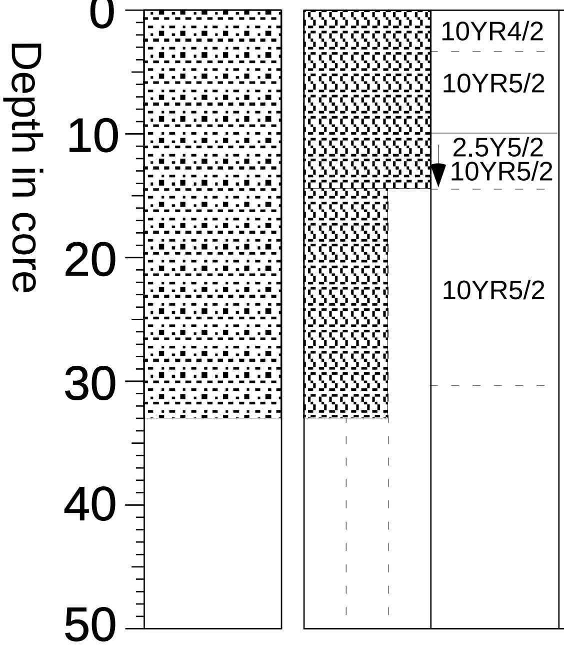
Color	Description
10YR4/3	0-2.5 cm: Brown slightly sandy clayey silt, homogeneous
10YR4/2	2.5-3.5 cm: Dark grayish brown (10YR4/2) silty sand, homog. 3.5-10.5 cm: Dark grayish brown sandy clayey silt, slightly reddish at base
10YR4/2	10.5-12.0 cm: Dark grayish brown silty sand, homogeneous
10YR4/3	12-19 cm: brown sandy silty clay with irregular grayish horizontal streaks
10YR4/2	19-30.5 cm:Dark grayish brown sandy silty clay, homogeneous
10YR4/3	30.5-42 cm: Brown sandy silty clay with 0.5 cm thick silty sand layers and 0.5-1.5 cm thick greenish horizontal streaks

PS93/018-3 (GKG) NE Greenland continental margin

Recovery: 0.33 m — 81°44.15'N, 8°08.53'W — Water depth: 2475 m

Lithology	Texture	Color	Description

Surface: Even surface with one crater-like structure (7 cm), dark grayish brown (10YR4/2) sandy silty clay, common elongated arenaceous benthic foraminifera, abundant calcareous benthic foraminifera (*Pyrgo* and other), common dropstones and mudballs (<2 cm)



0-3.5 cm: Dark grayish brown sandy silty clay, common *Pyrgo*

3.5-10 cm: Grayish brown slightly sandy silty clay with brown burrows, rare calcareous benthic foraminifers

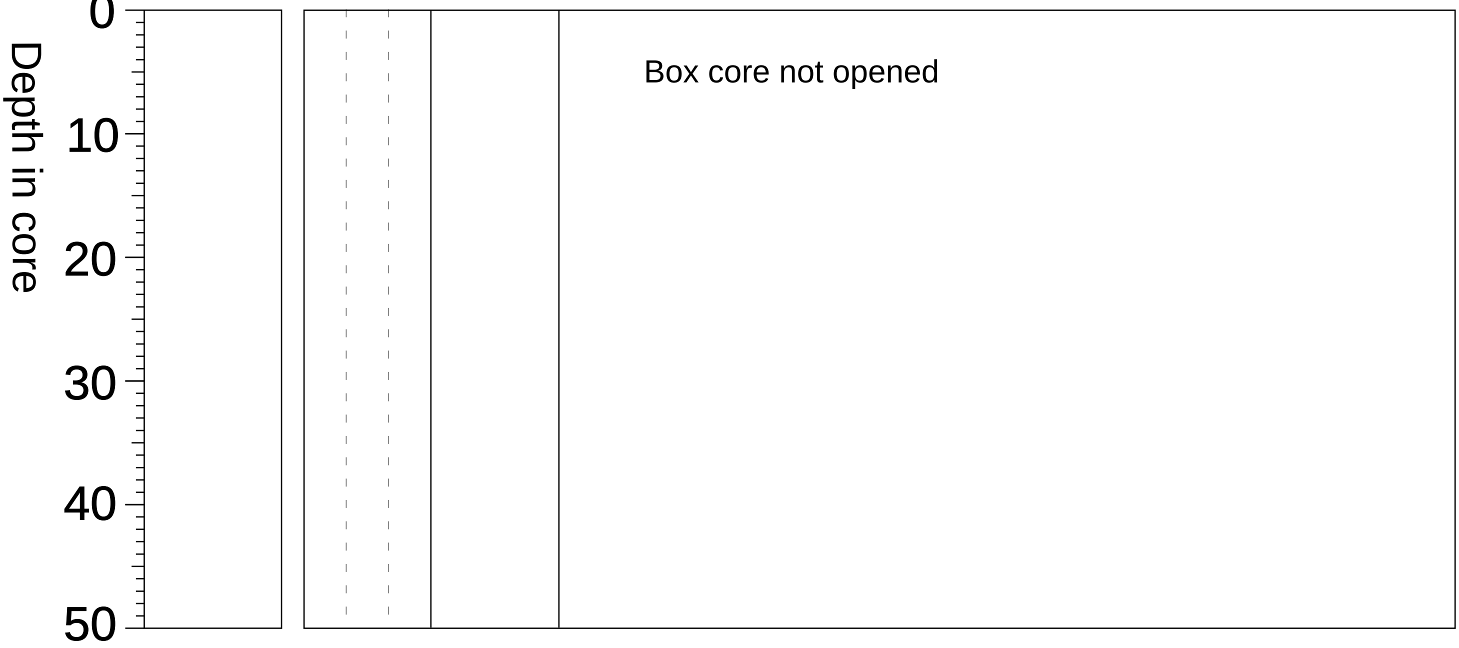
10-14.5 cm: Grayish brown slightly sandy silty clay, fine (2 mm) greenish layer at top, brownish burrows, rare benthic foraminifers

14.5-33.0 cm: slightly sandy silty clay with darker brownish burrows (abundant at top), rare benthic foraminifers

PS93/019-3 (GKG) NE Greenland continental margin

Recovery: 0.20 m 81°45.08'N, 8°08.45'W Water depth: 2033 m

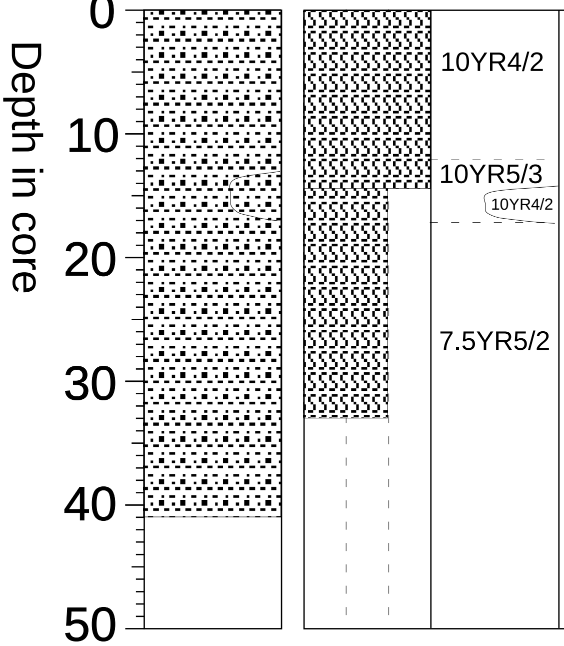
Lithology	Texture	Color	Description
Surface:	Surface tilted (45°), even surface, coarse-grained sediment with very abundant gravel (mostly black), common large benthic foraminifers, common worms		



PS93/023-3 (GKG) NE Greenland continental margin

Recovery: 0.41 m 81°15.43'N, 7°11.37'W Water depth: 1505 m

Lithology	Texture	Color	Description
Surface:			Even surface with abundant large sponges (4-8 cm), dark grayish brown (10YR4/2) sandy silty clay, common bivalves and arenaceaous foraminifers, common dropstones (<2 cm), common small mudballs (<1 cm), common gastropods (<1 cm)



0-12.5 cm: Dark grayish brown sandy silty clay, abundant sponge spicules

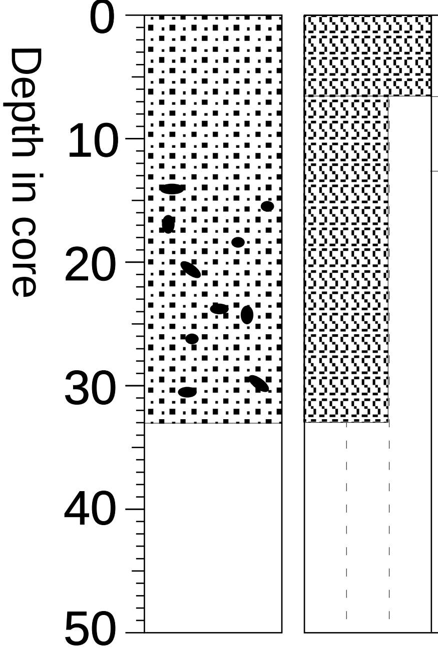
12.5-17.5 cm: Brown (slightly reddish) sandy silty clay with dark grayish brown parts in which sponge spicules are abundant

17.5-41 cm: Brown (slightly reddish) sandy silty clay, lighter at 35-41 cm, darker grayish spots in upper part

PS93/024-4 (GKG) NE Greenland continental margin

Recovery: 0.33 m   80°54.62'N, 6°23.43'W   **Water depth:** 1307 m

Surface: Uneven surface with common large sponges (3-8 cm), dark grayish brown (10YR4/2) sandy silt, common bivalves (<1 cm), common elongated arenac. foraminifers, abundant dropstones (<1 cm), common small mudballs (<1 cm), rare gastropods (1-3 cm)



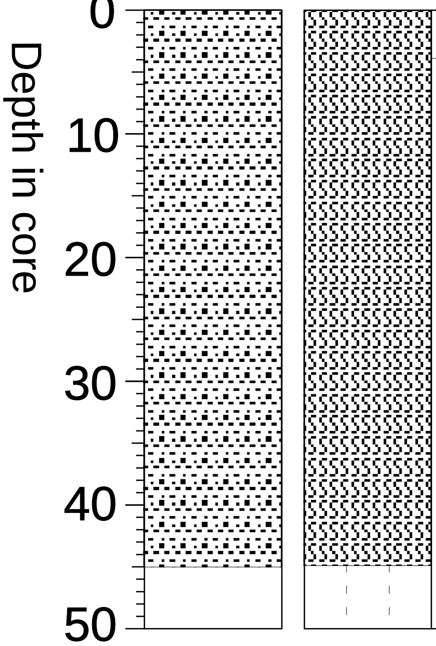
Color	Description
10YR4/2	0-6 cm: Dark grayish brown sandy silt, abundant sponge spicules
10YR4/2	6-12.5 cm: Dark grayish brown sandy silt with abundant irregular grayish horizontal streaks
10YR5/2	12.5-33 cm: Grayish brown sandy silt with common dropstones and abundant irregular grayish horizontal streaks

PS93/025-1 (GKG) NE Greenland shelf

Recovery: 0.45 m 80°28.84'N, 8°29.24'W **Water depth:** 291 m

Lithology	Texture	Color	Description

Surface: Soft even surface, dark grayish brown (2.5Y4/2) slightly sandy silty clay, common large calcareous benthic foraminifers, rare small mudballs and worm tubes

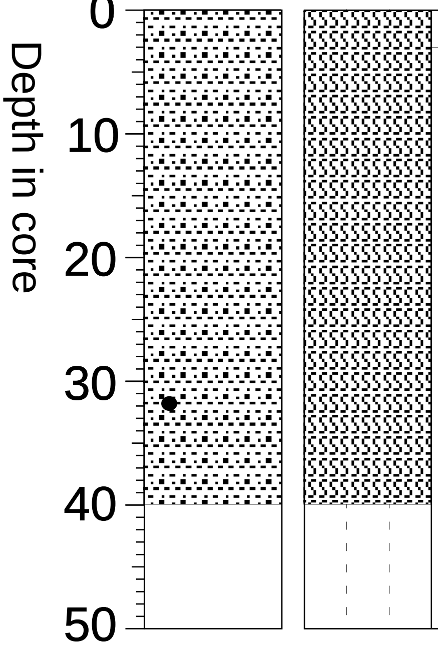


Color	Description
2.5Y4/2	0-4 cm: Dark grayish brown slightly sandy silty clay, homogeneous
5Y4/1	4-45 cm: Dark gray slightly sandy silty clay, homogeneous

PS93/029-2 (GKG) NE Greenland shelf

Recovery: 0.40 m 80°22.19'N, 9°58.54'W **Water depth:** 318 m

Lithology	Texture	Color	Description
Surface:	Soft even surface, dark grayish brown (2.5Y4/2) slightly sandy silty clay, common large calcareous benthic foraminifers, rare small mudballs and worm tubes		



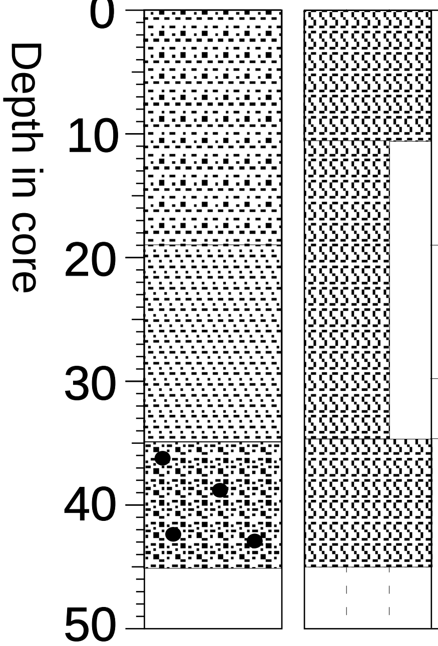
Color	Description
2.5Y4/2	0-3 cm: Dark grayish brown sandy silty clay, homogeneous
5Y4/1	3-40 cm: Dark gray slightly sandy silty clay, homogeneous, common small dark spots in lower part at 11 cm: Brownish olive burrow at 32 cm: small dropstone (2 mm)

PS93/030-5 (GKG) NE Greenland continental margin

Recovery: 0.45 m 79°33.83'N, 4°49.36'W **Water depth:** 1294 m

Lithology	Texture	Color	Description

Surface: Even surface, dark grayish brown (10YR4/2) sandy silty clay, abundant elongated arenaceaous foraminifers, common small dropstones and mudballs, rare bivalve fragments



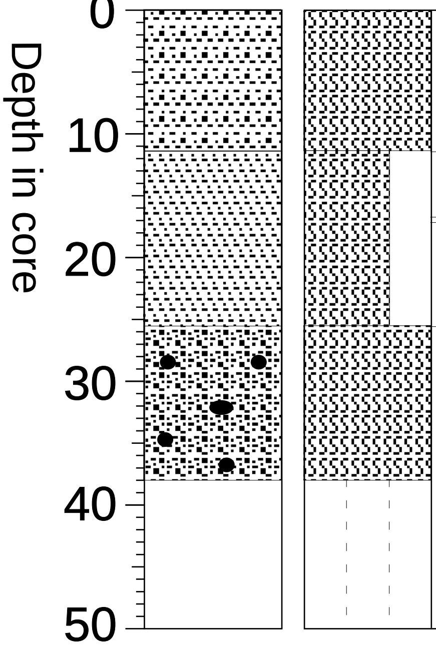
Color	Description
10YR4/2	0-19 cm: Dark grayish brown sandy silty clay, homogeneous bioturbation visible at base
10YR5/2	19-30 cm: Grayish brown silty clay, strongly bioturbated olive colored (2.5Y4/2) horiz. streaks at 21.5 cm olive colored (2.5Y4/2) thin layers (3 mm) at 27.0 and 27.5 cm
2.5Y4/2	30-35 cm: Dark grayish brown silty clay, slightly olive, strongly bioturbated
10YR5/2	35-45 cm: Grayish brown sandy clayey silt, homogeneous, with common small dropstones

PS93/031-5 (GKG) NE Greenland continental margin

Recovery: 0.38 m 79°20.97'N, 3°31.43'W **Water depth:** 2135 m

Lithology	Texture	Color	Description

Surface: Even surface with 4 crater-like structures (6-8 cm), dark grayish brown (10YR4/2) sandy silty clay, abundant elongated arenaceous foraminifers, abundant large calcareous benthic foraminifers (*Pyrgo*), abundant small mudballs



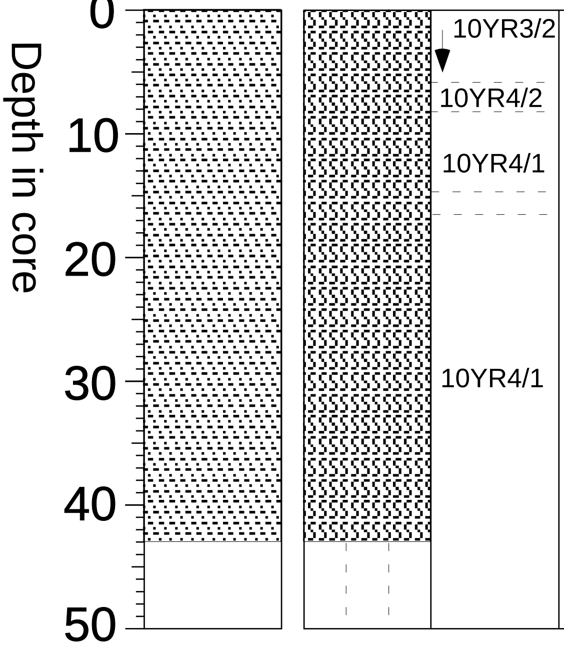
Color	Description
10YR4/2	0-12 cm: Dark grayish brown sandy silty clay, homogeneous common *Pyrgo* at top (rare at base)
2.5Y4/2-10YR5/2	12-17.5 cm: Dark grayish brown to grayish brown silty clay, irregular horizontal streaks, brownish burrows
	17.5-18 cm: Grayish brown (10YR5/2) silty clay, homogeneous
2.5Y4/2	18-25 cm: Dark grayish brown slightly sandy silty clay with irregular horizontal brownish and darker grayish streaks, common sandy burrows (material from below)
10YR5/2	25-38 cm: Grayish brown sandy clayey silt, homogeneous, with common small dropstones

PS93/039-5 (GKG) NE Greenland shelf

Recovery: 0.43 m 78°44.92'N, 9°35.3'W Water depth: 401 m

Lithology	Texture	Color	Description

Surface: Soft even surface, very dark grayish brown (10YR3/2) silty clay, common mudballs (<2 cm), abundant planktic foraminifers, common calcareous benthic foraminifers



0-8 cm: Very dark grayish brown silty clay, homogeneous,
at 6-8 cm: color change to dark grayish brown

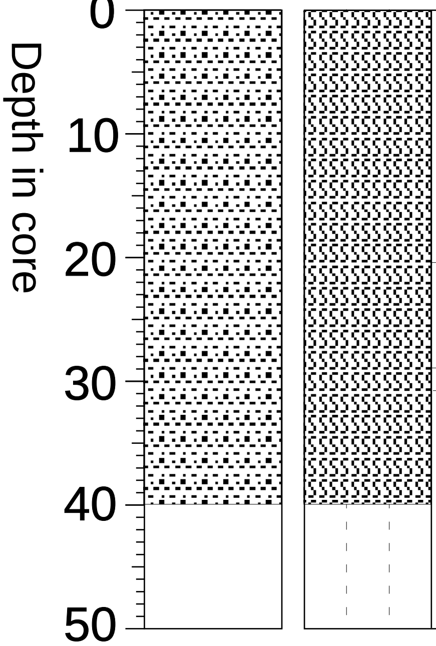
8-43 cm: Very dark gray silty clay, homogeneous
at 15-17 cm: Very dark gray (10YR3/1) layer

PS93/041-1 (GKG) Northern Greenland Fracture Zone

Recovery: 0.40 m 76°57.79'N, 3°26.85'W Water depth: 1768 m

Lithology	Texture	Color	Description

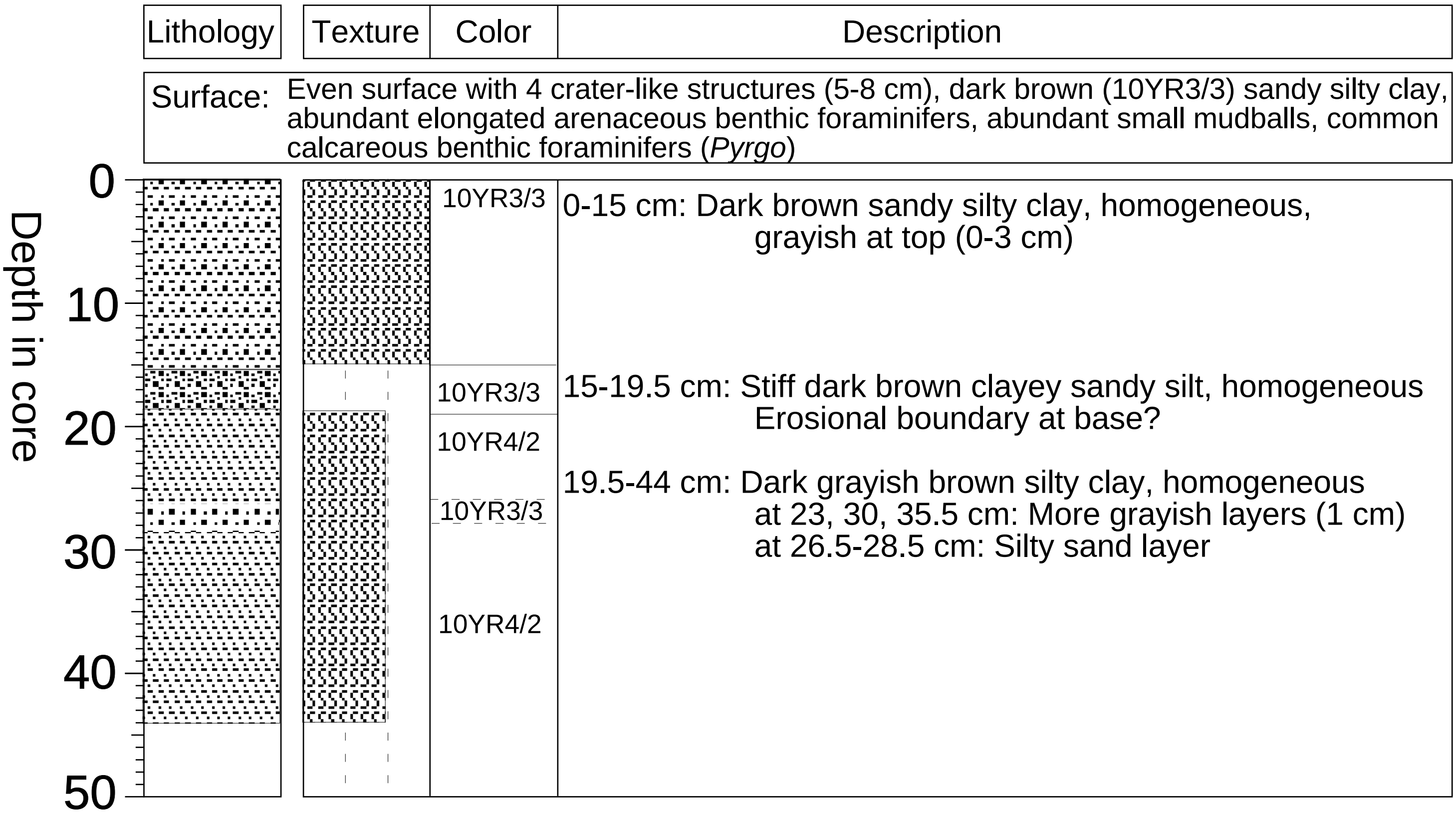
Surface: Even surface with 4 crater-like structures (5-8 cm), dark brown (10YR3/3) sandy silty clay, abundant elongated arenaceous benthic foraminifers, abundant small mudballs, common calcareous benthic foraminifers (*Pyrgo*)



Color	Description
10YR3/3	0-20.5 cm: Dark brown sandy silty clay, homogeneous, few irregular horizontal streaks/burrows
10YR4/3 10YR4/1 10YR4/3	20.5-40 cm: Brown sandy silty clay, more sandy in lower part (33-40 cm) homogeneous, few irregular horizontal streaks/burrows at 29.5-31 cm: Very dark grayish brown layer

PS93/042-1 (GKG) Northern Greenland Sea

Recovery: 0.44 m 75°44.39'N, 3°09.05'W Water depth: 3625 m

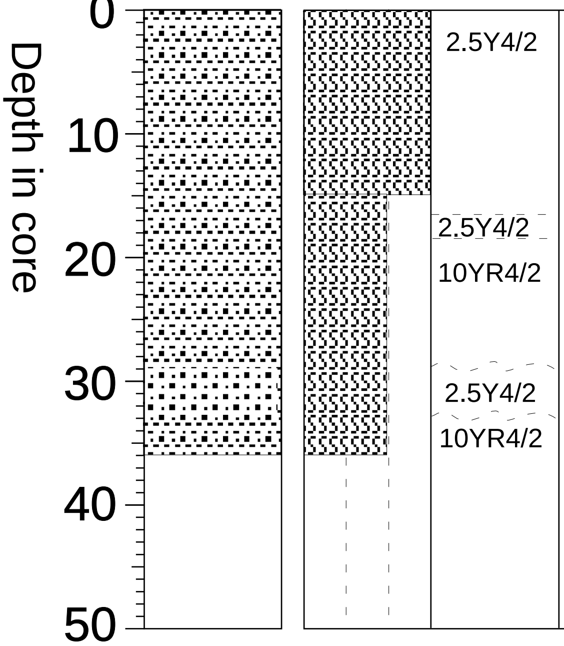


PS93/046-3 (GKG) East Greenland continental margin

Recovery: 0.36 m 76°05.08'N, 6°48.72'W **Water depth:** 2457 m

Lithology	Texture	Color	Description

Surface: Even surface, dark grayish brown (2.5Y4/2) sandy silty clay, abundant elongated arenaceous benthic foraminifers, planktic foraminifers, calcareous benthic foraminifers, common small dropstones and small mudballs, rare bivalve fragments



0-17.5 cm: Dark grayish brown sandy silty clay, homogeneous, abundant planktic and benthic foraminifers

17.5-19 cm: Dark grayish brown sandy silty clay, slightly darker than above

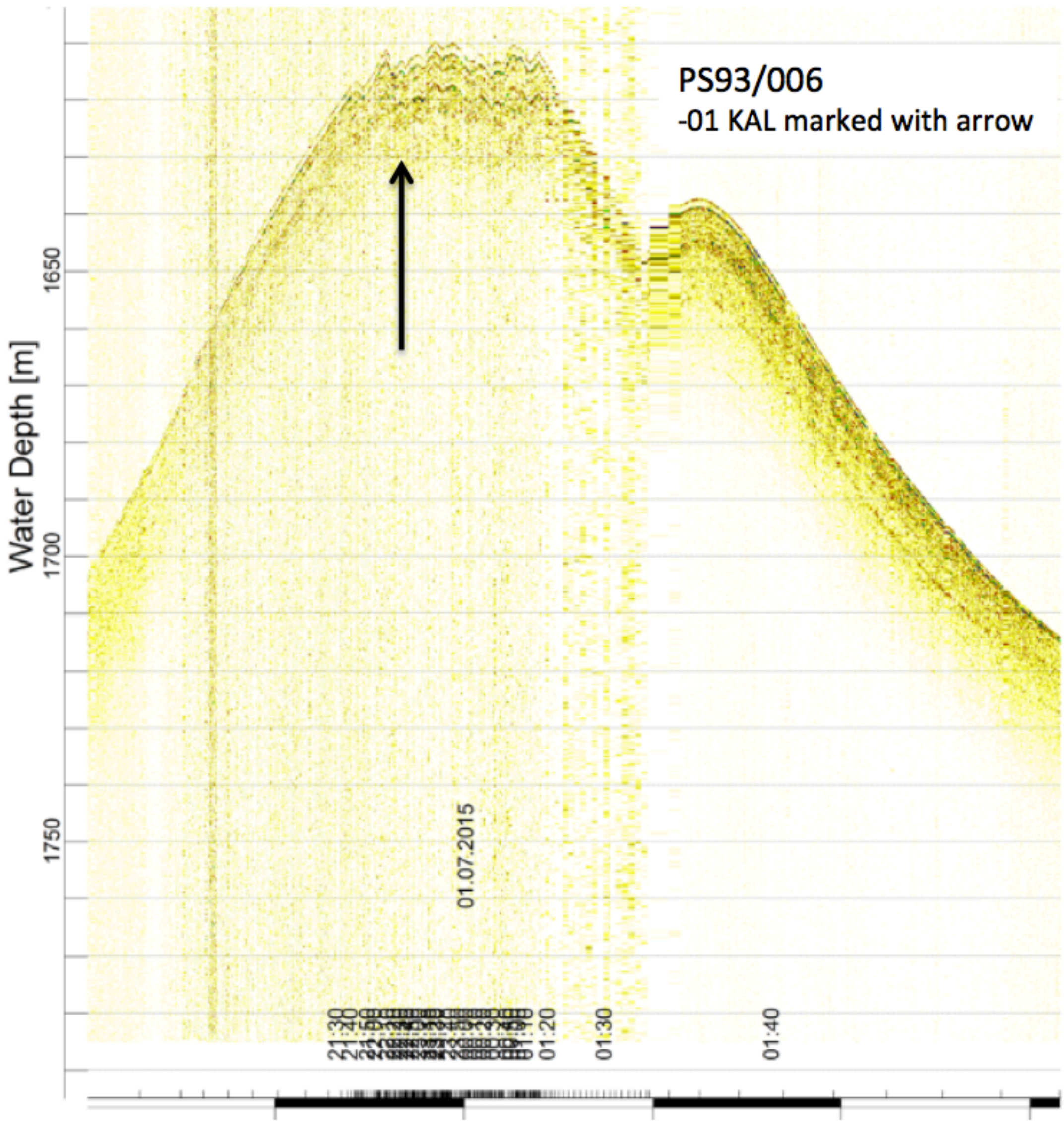
19-29 cm: Dark grayish brown sandy silty clay, less sandy than above,
at 21-24 cm: common small burrows (1-2 mm)
at 23-27.5 cm: Very dark grayish brown (10YR3/2) irregular horizontal streaks/burrows

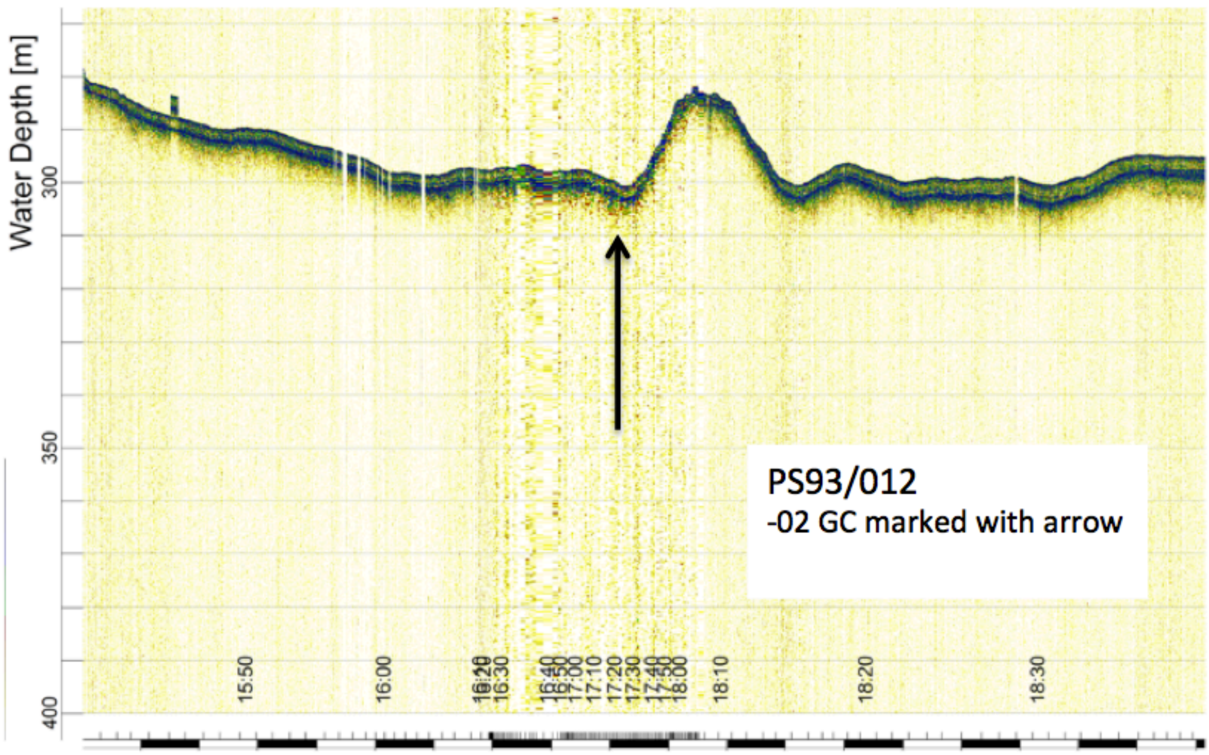
29-33 cm: Dark grayish brown silty sand layer, burrowed

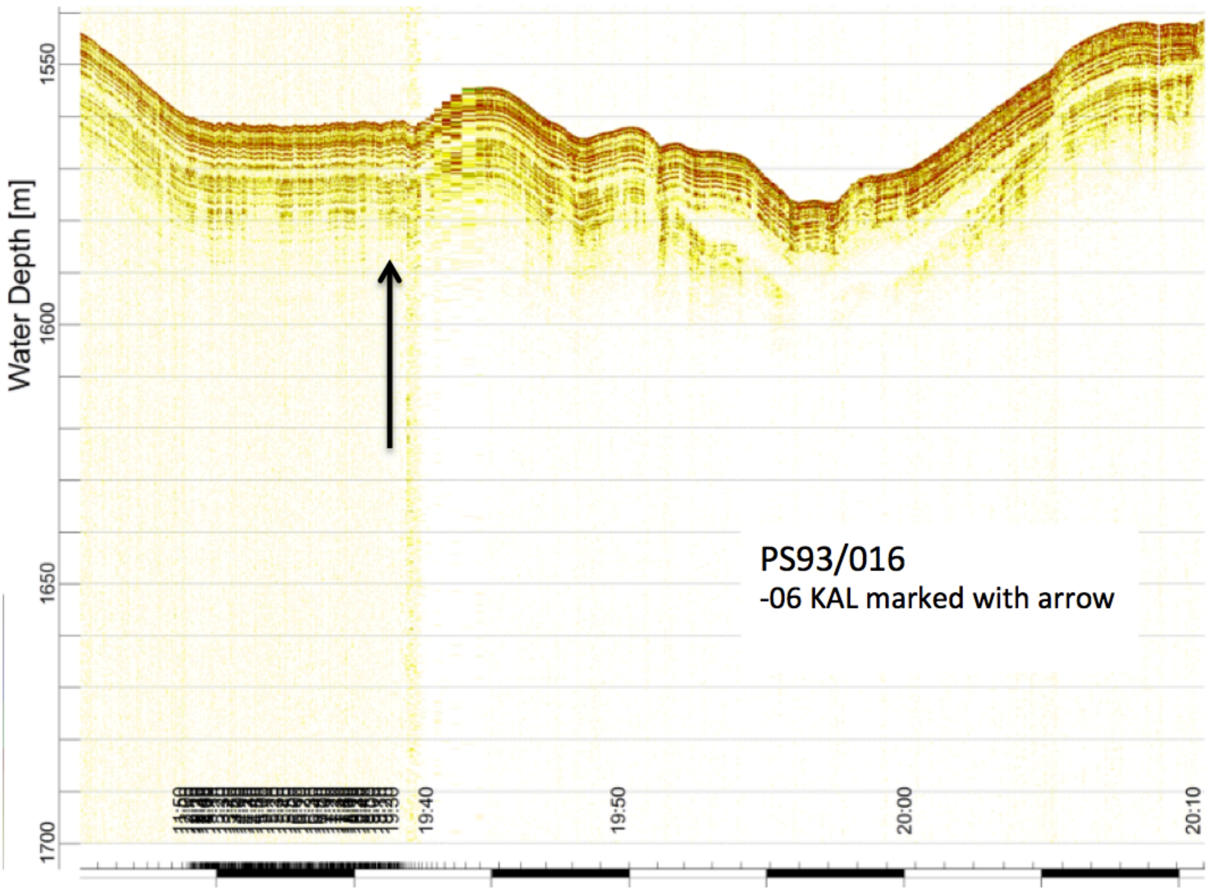
33-36 cm: Dark grayish brown sandy silty clay,
at 34-36 cm: Irregular sandy lenses

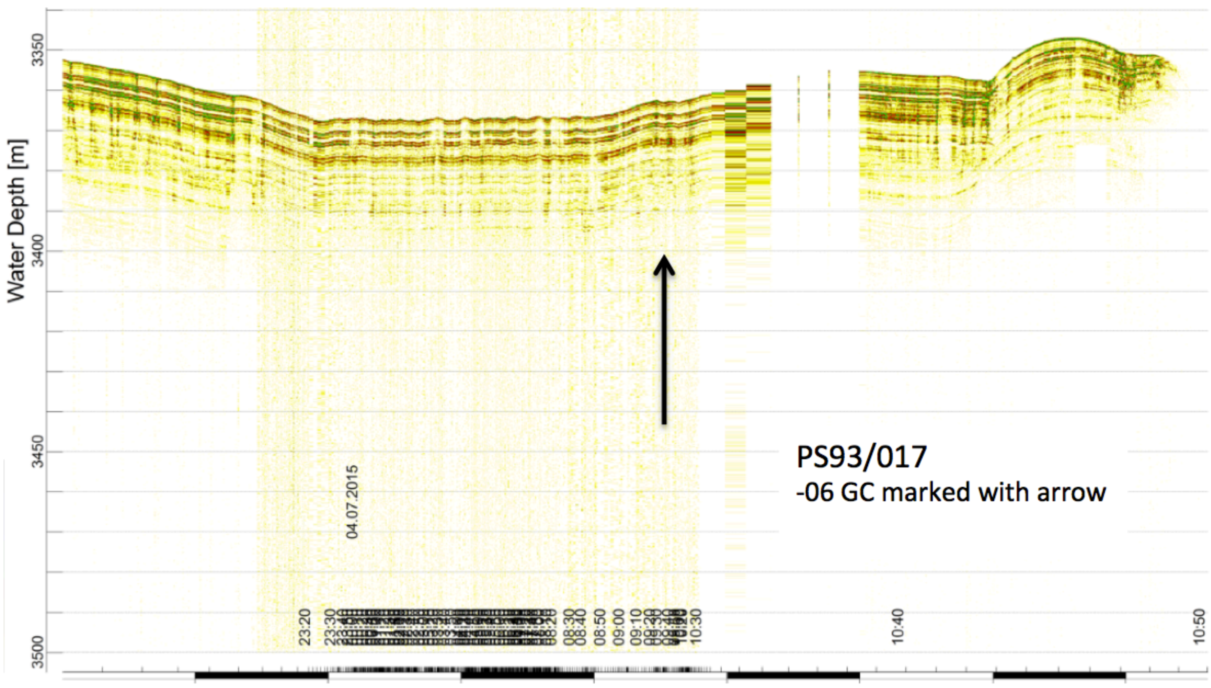
Legend

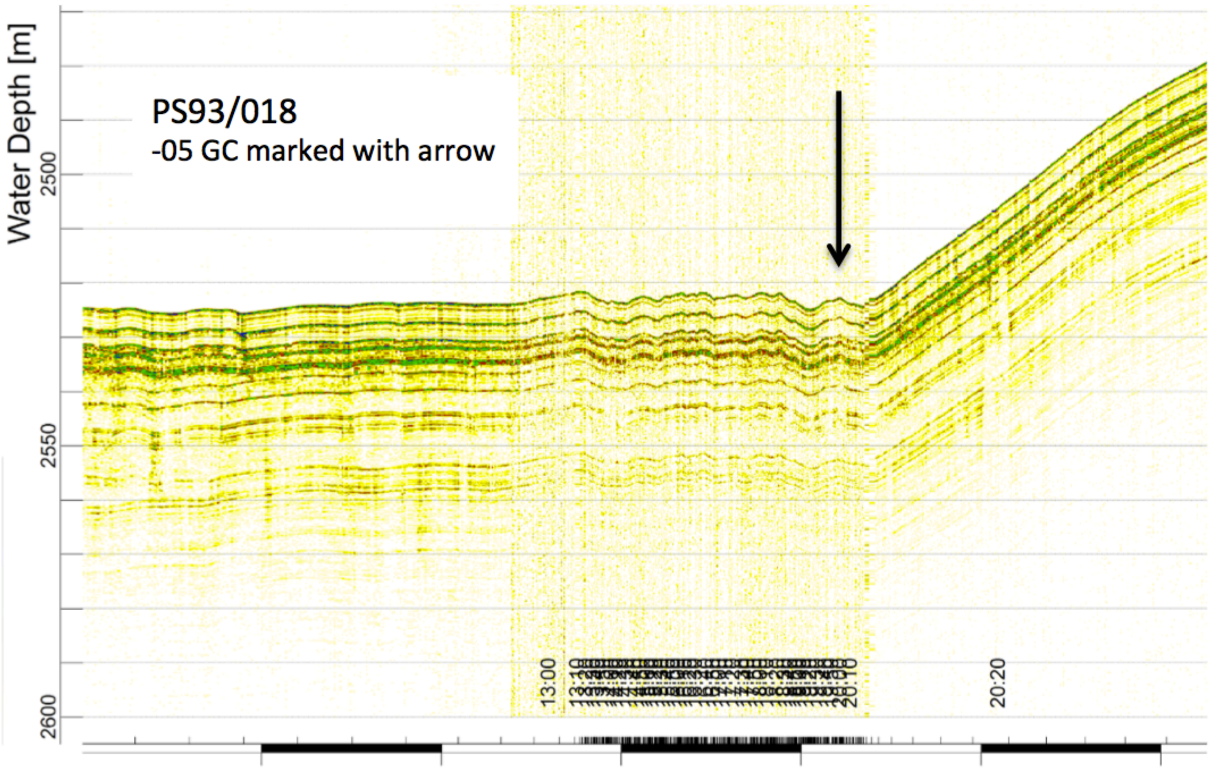
Lithology	Structure
Sandy silt	Bioturbation
Clayey sandy silt	Sharp boundary
Sandy silty clay	Gradational boundary
Silty clay	Wavy boundary
Dropstones	


PS93/006
-01 KAL marked with arrow
Water Depth [m]
1650
1700
1750
01.07.2015
21:30
21:40
21:50
01:20
01:30
01:40


Water Depth [m]
300
350
400
PS93/012
-02 GC marked with arrow
15:50
16:00
16:20
16:30
16:40
16:50
17:00
17:10
17:20
17:30
17:40
17:50
18:00
18:10
18:20
18:30


Water Depth [m]
1550
1600
1650
1700
19:40
19:50
20:00
20:10
PS93/016
-06 KAL marked with arrow


Water Depth [m]
3350
3400
3450
3500
04.07.2015
23:20
10:30
10:40
10:50
PS93/017
-06 GC marked with arrow


Water Depth [m]
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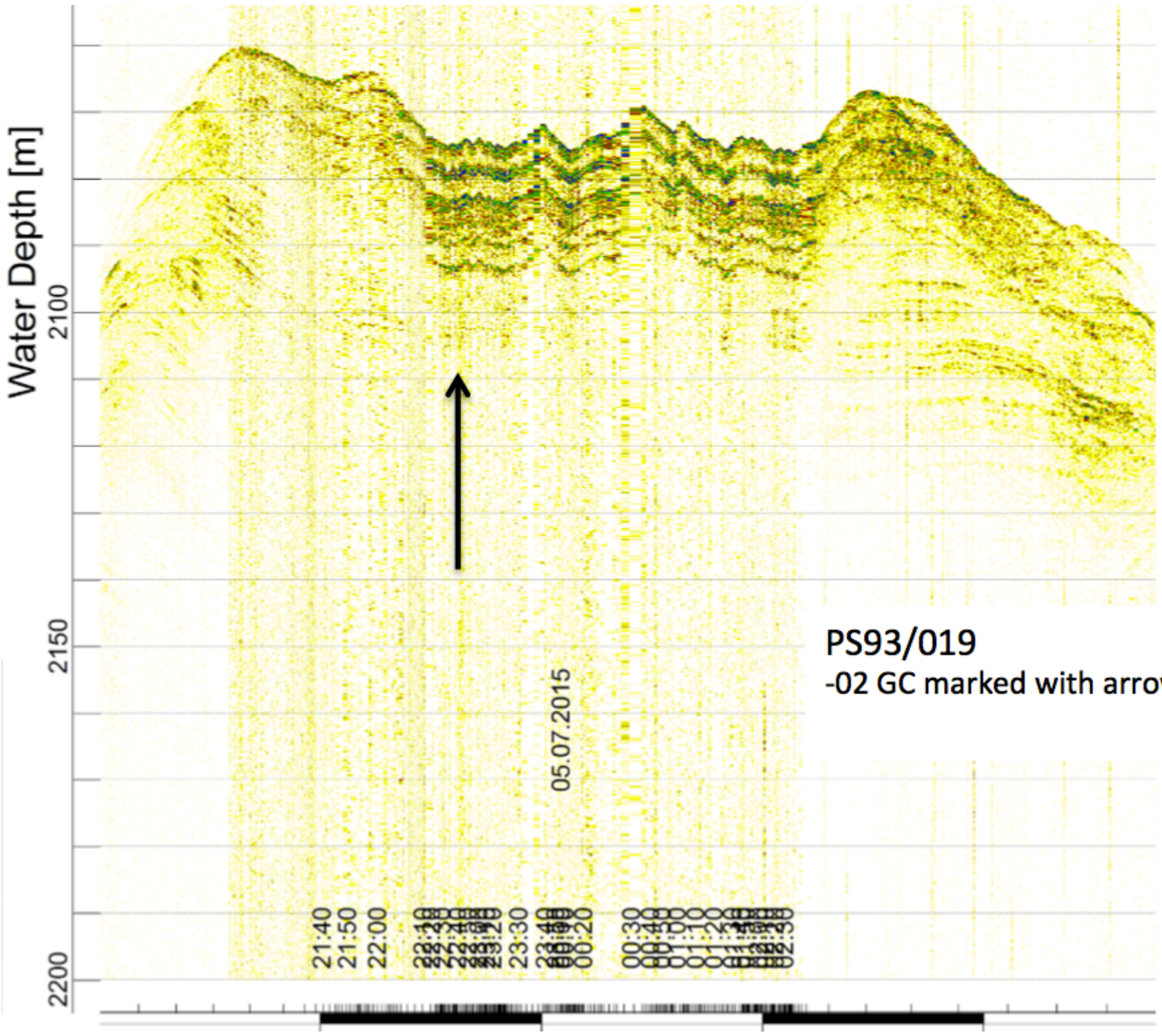
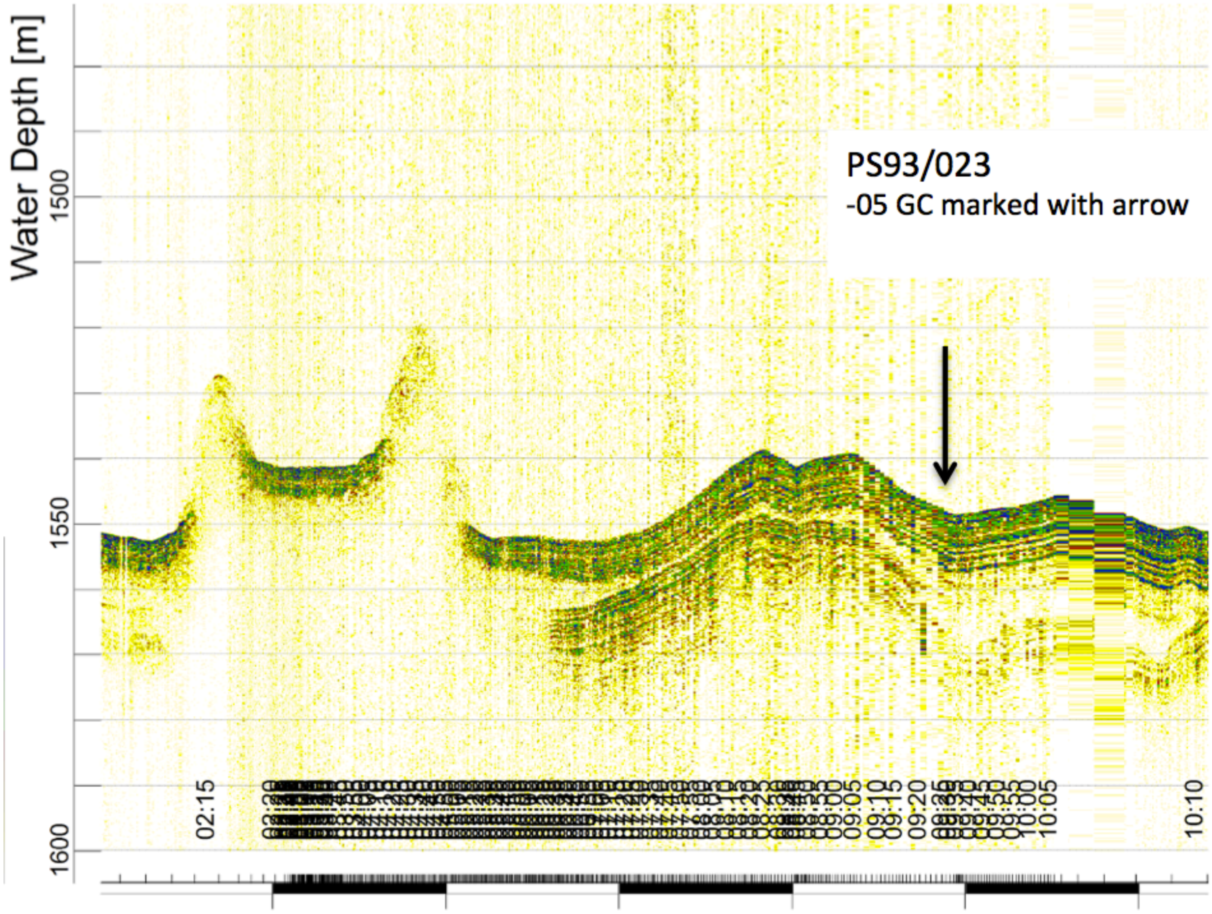
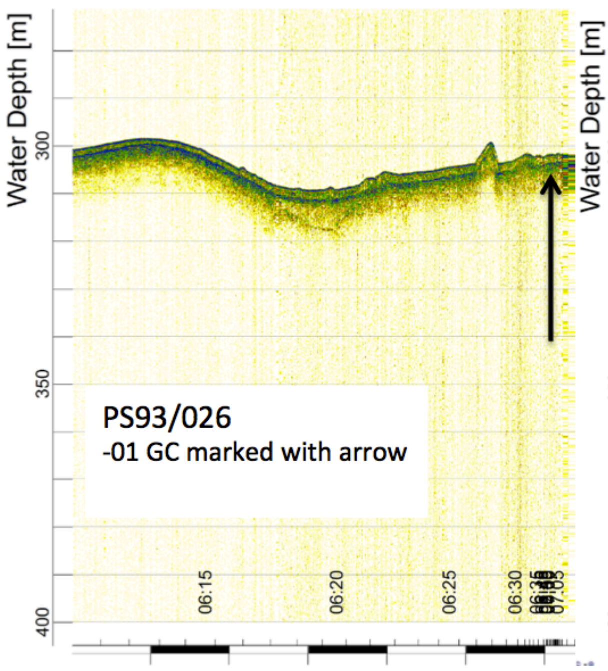
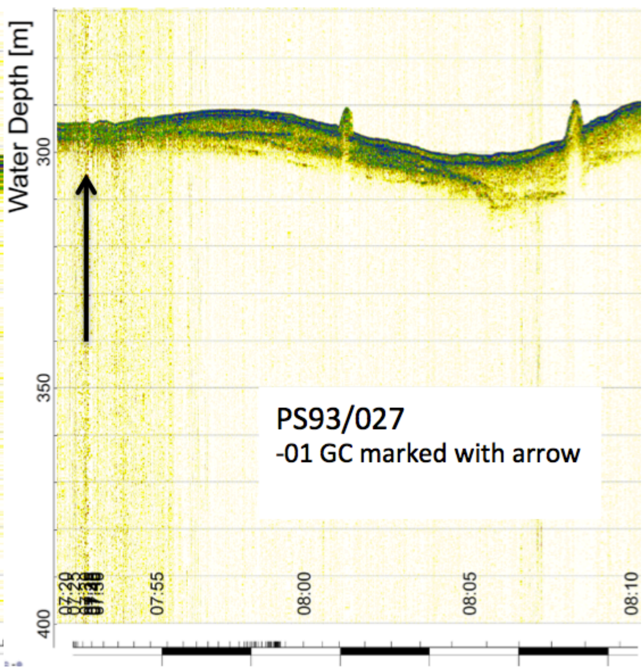
2550
2600
PS93/018
-05 GC marked with arrow
13:00
20:20


Water Depth [m]
2100
2150
2200
PS93/019
-02 GC marked with arrow
05.07.2015
21:40
21:50
22:00
23:30
00:20
00:30


Water Depth [m]
1500
1550
1600
PS93/023
-05 GC marked with arrow
02:15
09:05
09:10
09:15
09:20
10:10


Water Depth [m]
300
350
400
PS93/026
-01 GC marked with arrow
06:15
06:20
06:25
06:30


Water Depth [m]
300
350
400
PS93/027
-01 GC marked with arrow
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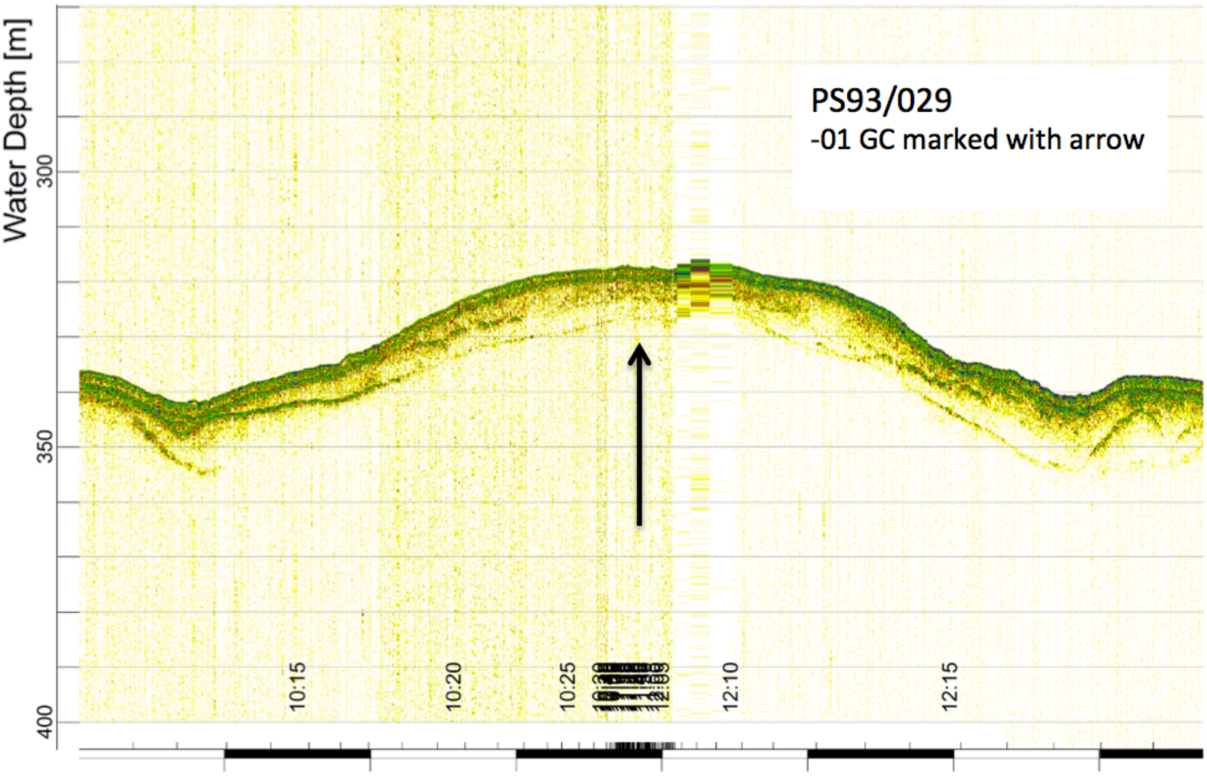
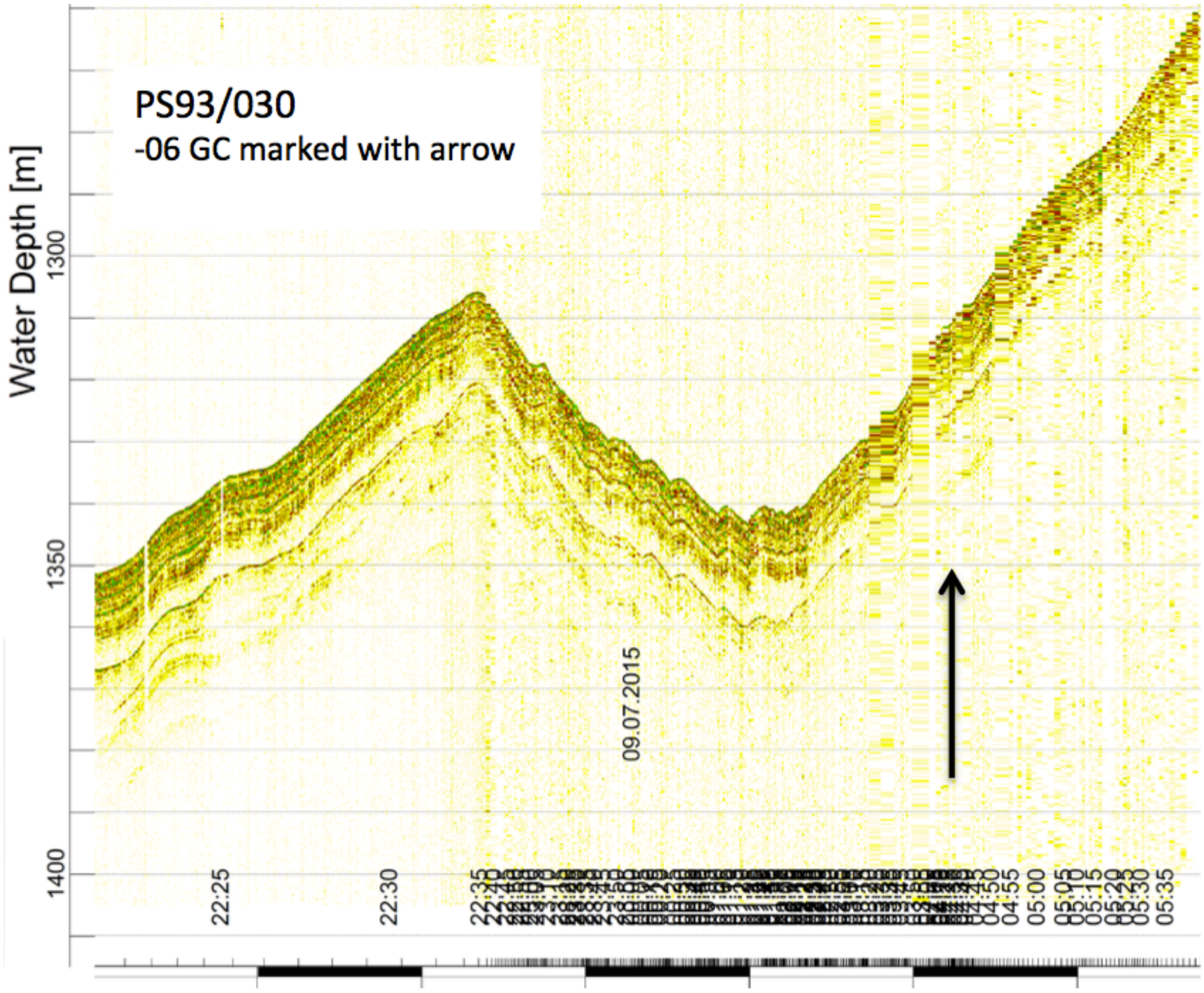
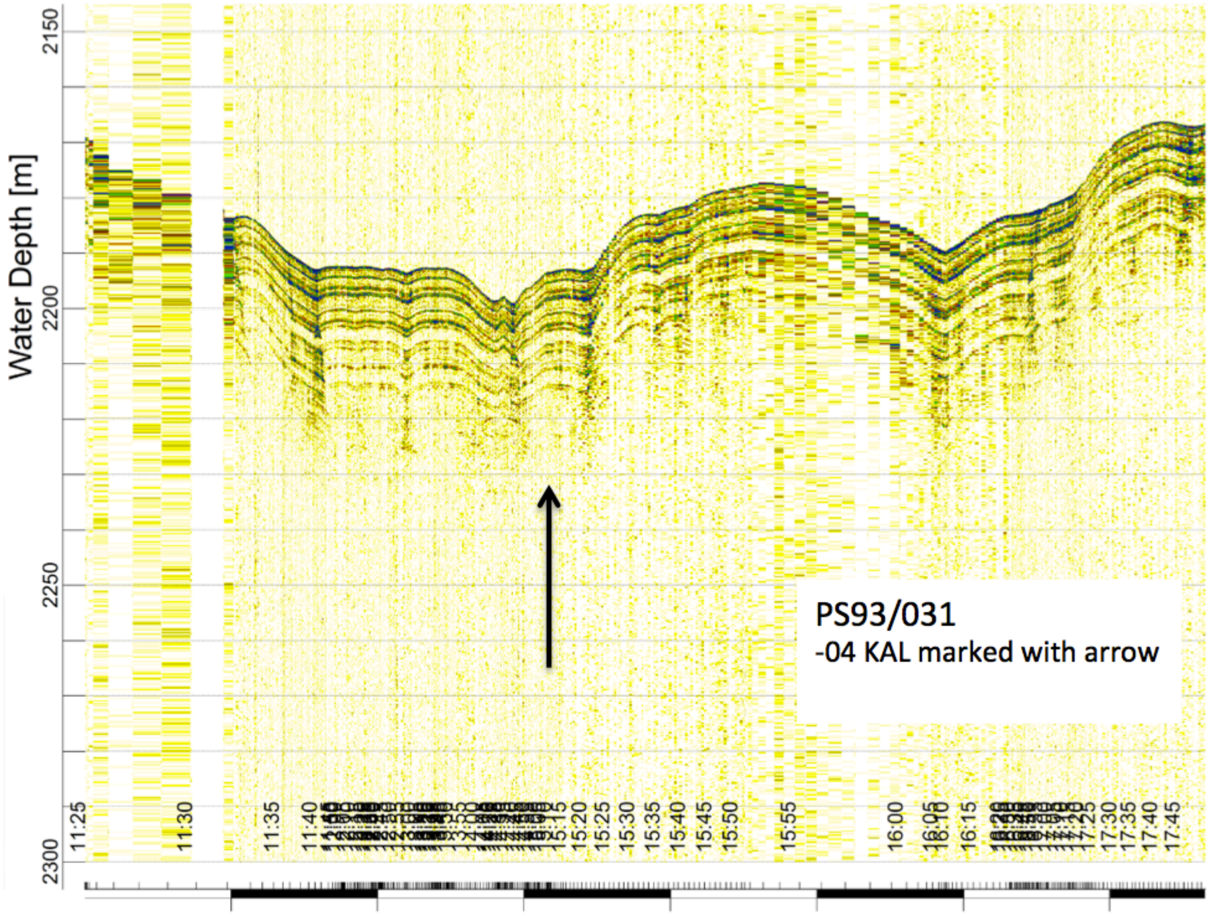
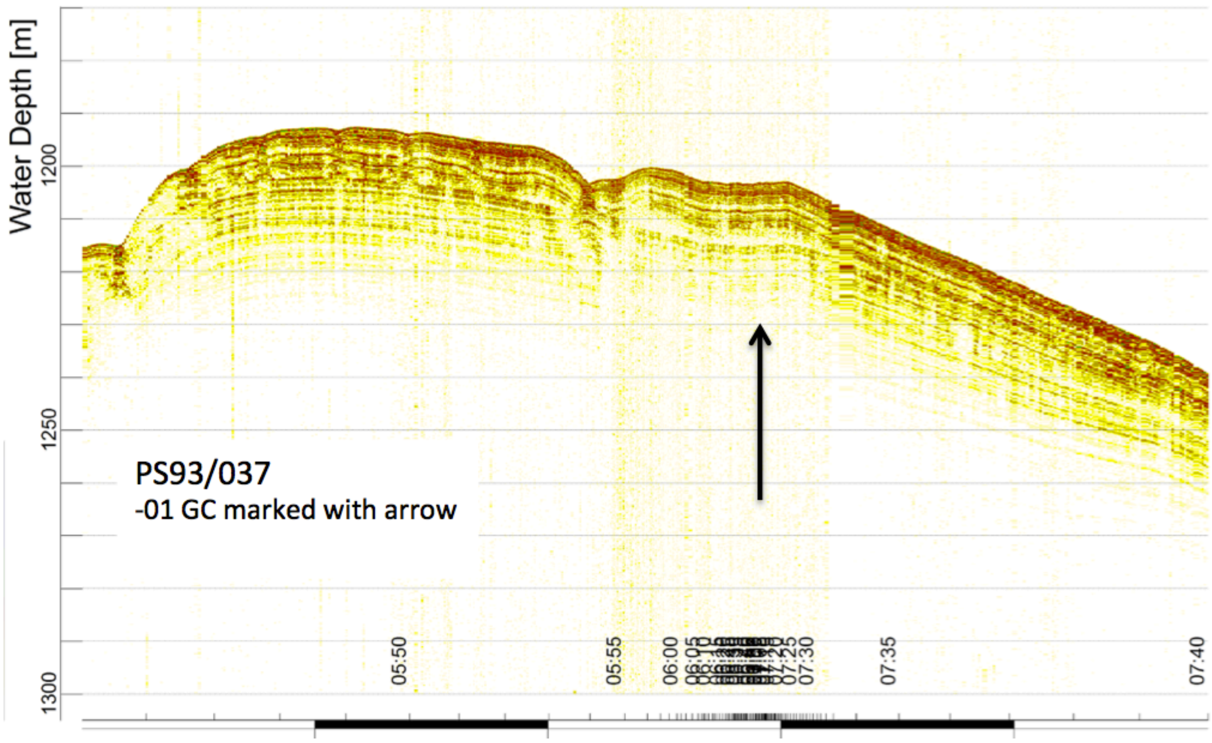
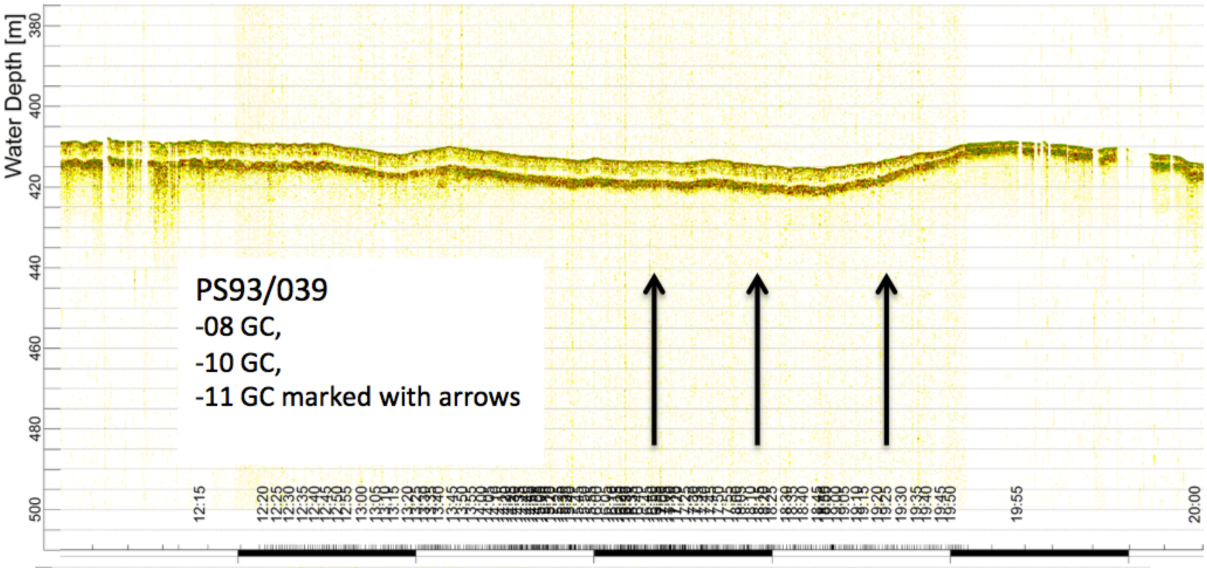
08:00
08:05
08:10

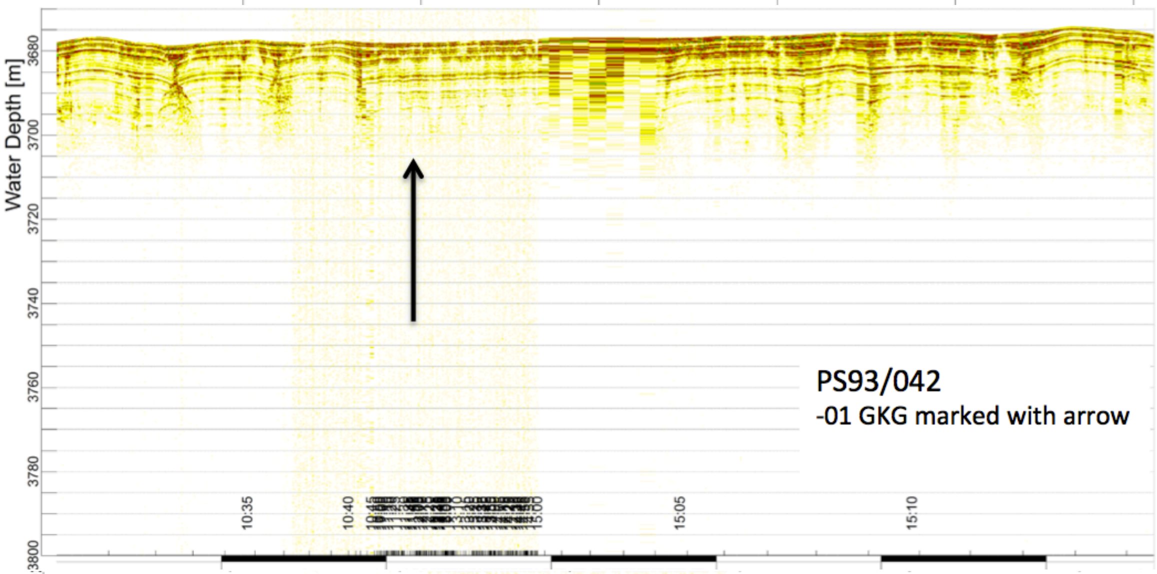

PS93/029
-01 GC marked with arrow
Water Depth [m]
300
350
400
10:15
10:20
10:25
12:10
12:15

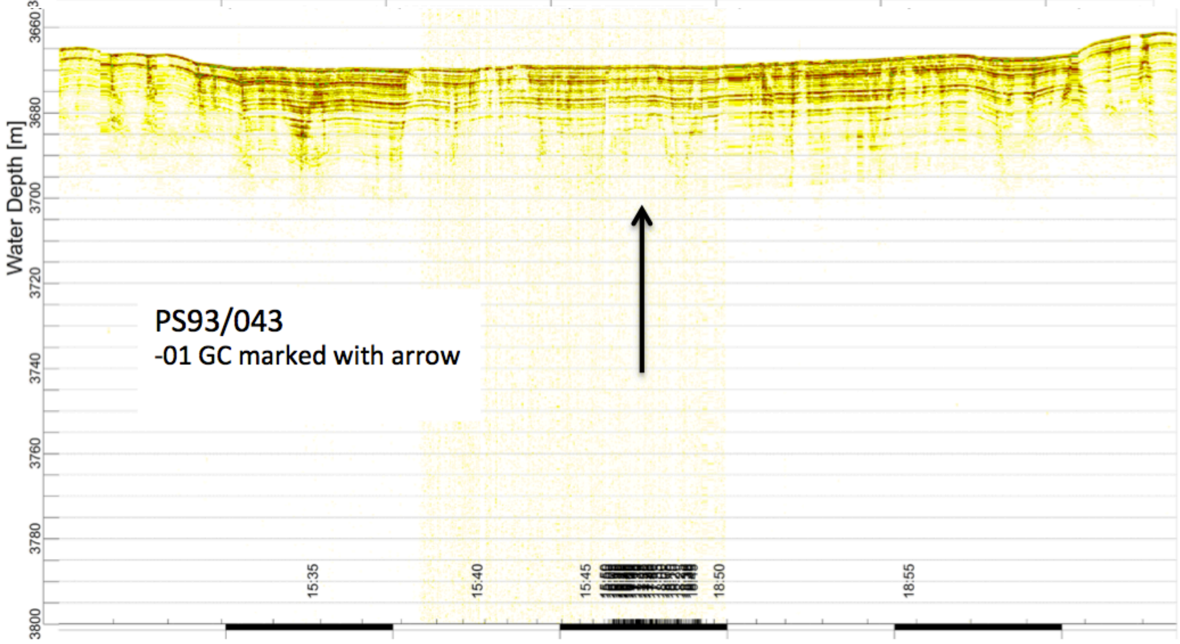

PS93/030
-06 GC marked with arrow
Water Depth [m]
1300
1350
1400
22:25
22:30
09.07.2015
04:55
05:00
05:35

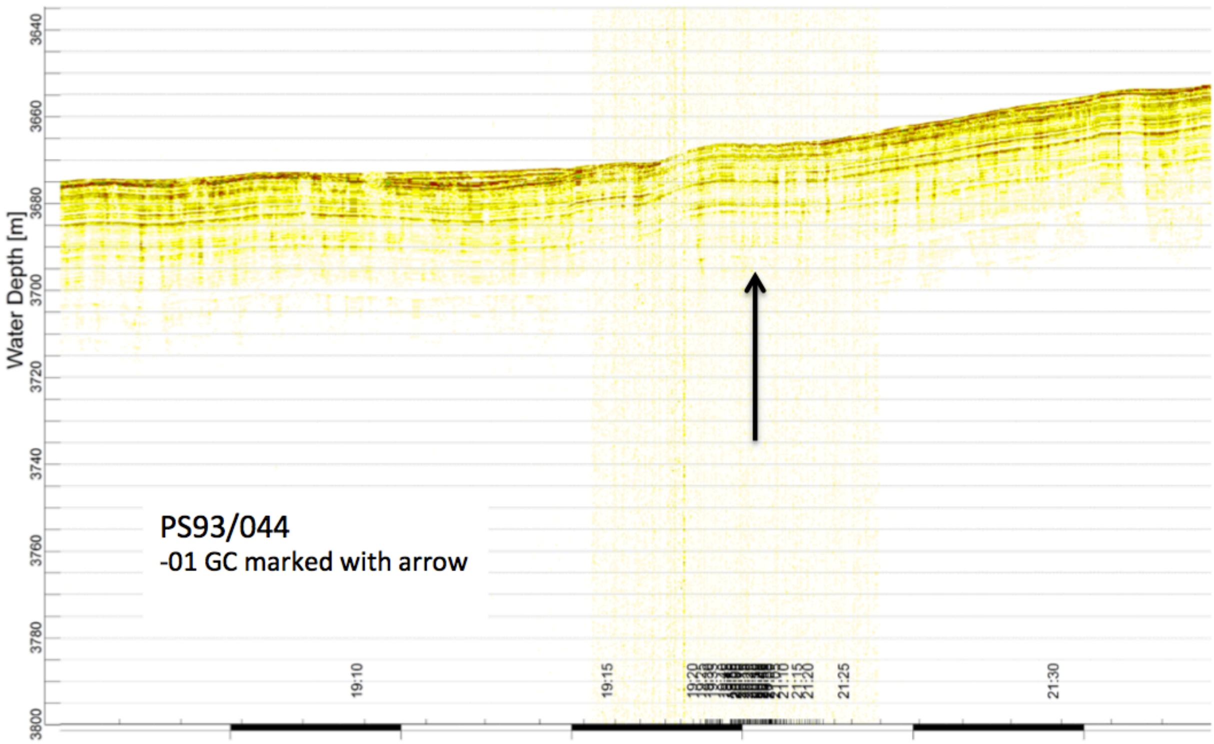

Water Depth [m]
2150
2200
2250
2300
PS93/031
-04 KAL marked with arrow
11:25
11:30
11:35
11:40
15:15
15:20
15:25
15:30
15:35
15:40
15:45
15:50
15:55
16:00
16:05
16:10
16:15
17:25
17:30
17:35
17:40
17:45

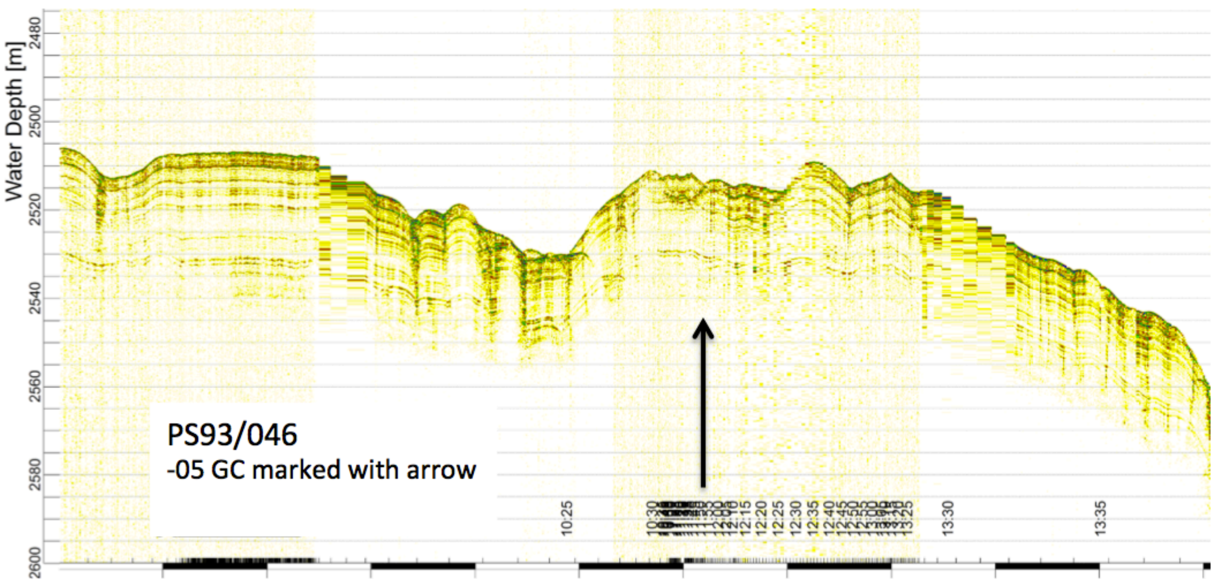

Water Depth [m]
1200
1250
1300
PS93/037
-01 GC marked with arrow
05:50
05:55
06:00
06:05
07:25
07:30
07:35
07:40


Water Depth [m]
380
400
420
440
460
480
500
PS93/039
-08 GC,
-10 GC,
-11 GC marked with arrows
12:15
19:55
20:00


Water Depth [m]
3680
3700
3720
3740
3760
3780
3800
PS93/042
-01 GKG marked with arrow
10:35
10:40
15:05
15:10


Water Depth [m]
3660
3680
3700
3720
3740
3760
3780
3800
PS93/043
-01 GC marked with arrow
15:35
15:40
15:45
18:50
18:55


Water Depth [m]
3640
3660
3680
3700
3720
3740
3760
3780
3800
PS93/044
-01 GC marked with arrow
19:10
19:15
21:25
21:30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ArcTrain Floating University on board of Polarstern Expedition PS93.1
Group Report of oceanography activities

Laura C. Gillard and Yarisbel Garcia Quintana
(University of Alberta, Edmonton, Alberta, Canada)

To be on board of the Polarstern was one of the best experiences that we have had as part of our training as PhD students and thanks to the ArcTrain Program. We think that to really understand the processes that, in our case, we are trying to represent and understand by using ocean modeling it is of vital importance to be on the field. By “be on the field” we mean: collection of different measurements, experience the weather of the area and its influence on the ocean, work with the equipment on board to collect the data, and what is more, to take a look to that data that we helped to collect. That is what the Floating University 2015 offered to us and what we, with hunger of science, took.

Everything was new from the very beginning. Just to be on board of an icebreaker for the first time was an adventure. We quickly had to adapt to the schedule and routines on board and adjust to the close living quarters. During the cruise different activities were done. We had the unique opportunity to get involved with difference fields of science, getting out of our comfort zones and literally, get our hands dirty. Here only those directly related with oceanography measurements will be described, from our perspective and according to our experiences.

Many activities concerning to the measurement of ocean parameters were performed. Maybe one of the most important was the deployment of two seagliders.

Fig.1. Glider deployment

The gliders deployed were named Agatha and Bella. Gliders have the ability to travel far distances, over long periods without servicing. It is these characteristics along with advancements in sensor technologies that are making gliders more and more important as tools for collecting ocean data. This information creates a more complete picture of what is happening in the ocean. These “robots” collect information from deep water, as well as at the surface, at lower cost and less risk than ever before. Once the glider is on the water is important to verify that is transmitting the data collected correctly and that starts diving.

The first glider to be deployed was Agatha, followed by Bella. Once Bella was in the water it was noticed that Agatha wasn't diving and it was also knew that the transmission of the data was somehow failing. Thus it was recovered from the water and the setup done again. After that it went into the water again and everything worked properly.

Fig. 2. CTD and water sampling

At certain locations previously selected CTD profiles and water sampling (Fig. 2 – left) was done. The CTD allowed to measure density, conductivity and temperature of the water column and it was incorporated to an array of Niskin bottles (Fig. 2 – right). Niskin bottles on the other hand allowed to collect water from different depth along a water column. When the array descends the bottles are open and the exact moment and place to close them is determined on board, that way you get to know the depth at what a water contained inside the bottles is. Further analysis to the water sampled was intended to do later on.

The under-way CDT (**UCTD**) is another sensor that was used. This sensor is really special as it allows to profiling while the ship is moving what can be a way to save resources by reducing the time of the cruise. This activity was actually quite similar to fishing. The sensor was attached to a thin Kevlar line and was the ship was moving from one location to the other it was put on the water releasing line for around 60 seconds and then line was recovered again until the sensor was around 15 meters away from the ship, and then release the line again starting again, repeating the procedure as many times as the time to the next station allowed it. The depth reached by the UCTD depends on the velocity of the ship, increasing as the velocity decreases.

We got also the opportunity to help in a mooring deployment. The mooring is held up in the water with various forms of buoyancy such as glass balls and syntactic foam floats and is like a collection of devices connected to a wire and anchored on the sea floor. The instrumentation attached it can be CTDs, current meters, biological sensors and other devices to measure various parameters and they can be measuring in a fixed place during a long period of time. During the cruise two moorings were deployed in Frame Strait which are expected to be on the water recording data for at least two years.

Fig.3. Mooring deployment

During previous expeditions moorings were also deployed in Frame Strait. Actually one of the goals of this cruise was to recover four of those moorings that were in the water for almost three years which gives high scientific value to the data recorded inside them. Once the ship was on the area where the mooring was deployed a hydrophone was put on the water, lowered over the side of the ship until it was about 15m depth. This hydrophone tells to a sensor (acoustic releaser) located on the anchor of the mooring that is time to release. If everything goes okay in a few minutes you will be able to see on the horizon the distinguishable orange dots of the buoys. That is if everything goes okay. The thing is that those sensors stay in the water for even more that two years and the salinity of the water can be really aggressive with them, as we actually saw from the sensors from the moorings recovered (Fig. 4). One of the moorings that was planned to be recovered never went out. Apparently the sensor on the acoustic releaser was damaged. Hopefully it will be recovered by another expedition collecting such a valuable data from the depths of the ocean.

Fig. 4. Mooring recovery

Mooring data analysis

While we spent time collecting moorings from the ocean, afterwards the oceanography team allowed us to get our hands on samples of data. For many of us, this was our first time interpreting real data, and we learned about he the hard challenges that comes with observational oceanography. A few of the sensors had been destroyed in the ocean, and therefore the data was storage was full of inconsistent errors. Some measurements were corroded due to the sea salt, and batteries also died a lot sooner than expected.

ArcTrain Floating University on board of Polarstern was a taste of what observational sciences really are. It showed us that is a hard work, long hours where the weather is not always on our favor and that you might not get all the time what you are looking for. But all these inconveniences make us enjoy even more the final result: a better understanding of our ocean.

ArcTrain Floating University on board of Polarstern Expedition PS93.1
Group Report

Tilia Breckenfelder, Andrea Klus, and Raul Scarlat
(Center for Marine Environmental Sciences – MARUM, University of Bremen, Germany)

As the research area for all ArcTrain students is the Arctic, participating in the Floating University provided a unique opportunity for us to actually visit this region. Nineteen ArcTrain students studying in Germany and Canada all with very different scientific backgrounds have been on board the research vessel Polarstern between the 29th of June and 17th of July 2015. For many of us just the experience of living and working on a research vessel was new, and we also got to see how the actual field data that we use in our projects are collected.

The possibilities to get an insight into the scientific work on board have been broad. In order to get to know different measurement techniques and devices used at sea in different fields of research the students rotated between the different working groups throughout the cruise. The oceanography group dealt with the recovery and deployment of moorings, the release of floats and gliders as well as CTD (Conductivity, Temperature and Depth sensor), and underway CTD measurements. The biology group did ice and water sampling as well as multi-net and hand-net/bucket sampling. The geology group, the largest group on board, dealt with the multitude of coring activities using the multi-corer, box corer, gravity corer and kastenlot. Additional to these different tasks ArcTrain students were divided into day and night shifts for the duration of the cruise in order to keep a constant monitor on the parasound mapping of the sea floor.

Fig.1 Polarstern close to Longyearbyen
(Photo: Andrea Klus)

Fig.2 Working on deck with the gravity corer
(Photo: Andrea Klus)

The Floating University, besides the practical approach of integrating the students in the on board scientific work groups, also consisted of several lectures and presentations given for and by the students themselves. Introduction to the Python scientific package "Canopy" was taught and exercises were applied to data extracted from the Polarstern DSHIP data acquisition and storage system. The oceanographic software package "Ocean Data View" was also presented and used for plotting CTD and UCTD data as well as for making bathymetric maps. Furthermore we were part of the Polarstern blog team, which wrote blog entries for the AWI webpage. In these blogs we wrote about our experiences on board the ship, for example one article is about the work with the CTD-Rosette and another about the life on board as an ArcTrain student.

Every day during the morning meeting the chief scientist gave an overview about the activities of the previous day and presented the plans for the current day. This meeting concluded with the weather report of the German Weather service (DWD) on board. Among other things here we would see how sunny and warm the weather that we were missing back in Germany was.

The scientific program started with mooring recovery after the departure from Longyearbyen through the fjord. Unfortunately only three of the five moorings across the Fram Strait, which were deployed three years ago, were recovered. The cleaning, maintenance, reading out the data, and safe stowage of the instruments was an on-going task during the entire cruise. The focus of the majority of the stations was biology and geology. Prior to each station preparation work needed to be done, labelling the sampling glasses and containers, preparing the CTD-Rosette and the coring instruments, all relatively simple technical jobs where helping hands were welcome.

A typical station started with the CTD-Rosette going down. It records profiles of temperature, pressure and conductivity on its way down to the sea floor and takes water samples in different depths on its way up. The water will be further used to perform geochemical analysis such as: $\delta^{13}C$, $\delta^{18}O$, nutrients, Neodymium (Nd) and Hafnium (Hf). After the CTD-Rosette was on deck, samples were taken with a hand net/bucket from board or using a zodiac to collect algae (*Melosira Arctica*) and phytoplankton from the upper water column. The next instrument was the multi-net, which was followed by different coring instruments. During our cruise the coring instrument fleet consisted of multi-corer, box corer, gravity corer and kastenlot and they typically went in that order to the sea floor to take samples.

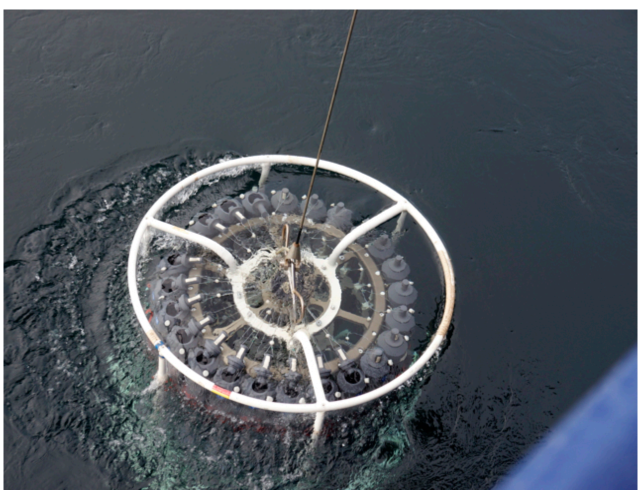


Fig.3 CTD-Rosette
(Photo: Tilia Breckenfelder)

Fig.4 Getting the multi-net back on board
(Photo: AndreaKlus)

During transit to the next station the deck and gear had to be cleaned and prepared for future use. Furthermore biological samples were analyzed under the microscope and the different cores were "slaughtered" and packed for storage.

After first worked in the mooring and then in the CTD/water sampling group we switched to other areas. For example we worked with the multi-net. The multi-net has five nets, which can be opened and closed individually in different water depths. By pulling it through a water layer animals and plants in this specific layer are caught inside the net. Usually it is used up to a depth of 600 m and the size of the investigated layers depends on the profiles of the CTD-Rosette and the corresponding research question. The samples are sieved with different grain sizes and stored for further investigation into small glasses.

Fig.5 Classifying phytoplankton
(Photo: Steffi Gäbler-Schwarz)

Fig.6 Polarstern in the fog seen from the Zodiac boat
(Photo: Antje Wildau)

The next working area we took a deeper interest in was the geology group. Here we helped amongst others with the box corer and the multi-corer. The latter can collect up to eight cores at once. They are approx. 60 cm long and were cut into 1 cm thick slices before zipped up in bags.

Fig.7 Opening a kastenlot
(Photo: Andrea Klus)

Fig.8 Discussing the sediment sample
(Photo: Tilia Breckenfelder)

Not all activities on board meant we had to wear our water proof equipment though. The data collected by the moorings and through the UCTD device also had to be analyzed, filtered and stored for later processing back home and a few students did this in the Computer Lab on board. In fact alternating between the electric lights of the ships interior and the perpetual sunlight outside was a good way to cope with the lack of night during the cruise. Having more manpower to deal with the small things seemed to have been very nice also for the senior scientists who were able to get more things done by delegating some of the work.

For some of us the work we were asked to perform was completely new, but the enthusiasm of the senior scientists was always contagious. Because we kept rotating between groups, the scientists would have to constantly introduce new people to the work but they never seemed to be tired of it and they enjoyed having so many students interested in what they do. In the second half of the cruise we could already share experiences between students who had already been part of one work group or another and get the training done before the station was reached. Spontaneous organization amongst students was a nice effect of the work schedule. Getting everything done properly and in good time so as to clear the deck for the next group became a matter of professional pride. The same was true for sharing the work shifts. People were always on standby in case they were needed.

One of the best aspects of such a cruise is that the field work can be part discovery and part adventure. Because of this there was never a lack of volunteers for going on the helicopter for sea ice monitoring flights as well as trips by zodiac boat to launch oceanographic gliders or get sampling done on ice floes floating nearby. To actually step on a floe and touch the sea ice was a great adventure. During one of these trips we experienced the unpredictability of the artic weather. We started off by sun shine and only few moments later and only few meters away from the Polarstern fog came in and wrapped Polarstern nearly completely. Polarstern was now like a ghost ship and we steamed closer to it to avoid getting lost in the mist.

Fig. 9 Looking for algea and phytoplankton with the Zodiac (Photo: Andrea Klus)

Fig.10 Nice ice formation passing bye (Photo: Tilia Breckenfelder)

The crew was very welcoming and the comfort on board was enough to make us forget quite often that we were sailing thousands of kilometers away from civilization, as we knew it. Integrating into the life cycle of the ship was not difficult and we could soon split our sleeping and eating time for the transit periods between stations. The planning and organization was in constant flux but this made every day different than the last and kept boring routine away.

After the last station and after nearly three weeks of sailing through ice floats, seeing polar bears and experiencing sunny nights, it was time to pack the containers and write the packing lists while Polarstern steamed towards Tromsø.

Cruising on the icebreaker Polarstern in the Arctic was a great opportunity to learn more about different measurement techniques and devices used at sea in different fields of research. Furthermore we were able to experience the Arctic, our research area by ourselves and were able to broaden our scientific network. We would like to thank our chief scientist Rüdiger Stein and all the other scientists participating in the cruise for their enthusiasm in integrating us in their projects and their never ending patience in explaining and answering our questions. We also want to thank Captain Wunderlich and his crew who welcomed us into their home on board and for the help they provided both for work and comfort. Last but not least, we thank ArcTrain that made this great experience happen for us.

ArcTrain Floating University on board of Polarstern Expedition PS93.1

Group Report

Amélie Bouchat, Yukie Hata, Mathilde Jutras, Mathieu Plante, and James Williams

(Department of Atmospheric and Oceanic Sciences, McGill University, Montreal, Canada)

Part 1 : Sea Ice

Figure 1 : Sea Ice (photo credit Mathieu Plante)

As a team of sea ice modelers, this expedition was also a great opportunity to observe first hand the Arctic sea ice. Many of the processes that we tackle in our every-day work were visible at first sight from the deck. The smooth and thin first year ice flows were full of marks of past deformations, ridges delineating the surface, with recent sharper ridges and older smoothed ridges. As the Polarstern entered thicker ice regions, the height the ridges increased, and it was possible to see, from nearby leads, the deep draft of their associated keels. Melt pounds, which constitute one of the biggest challenges for sea ice modeling, where also everywhere on the ice surface, darkening the sea ice. The shallowest ponds featured a clear blue color, while deeper ponds were darker, their bottom being closer to the ocean bellow. While these features are easy to recognize and understand, a closer look revealed other sea-ice characteristics that are more puzzling, and sparked very interesting discussions among students.

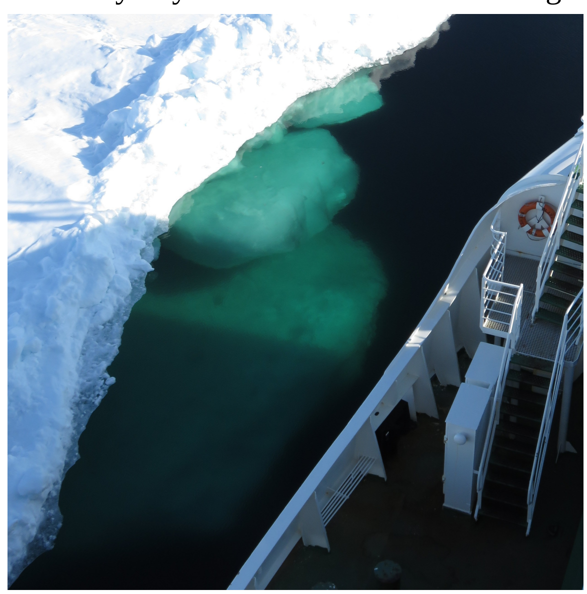


Figure 2 : Ice formation and big keel (photo credit : Mathieu Plante)

Among these characteristics, the formation of thin plates of transparent ice in leads adjacent to the ice floes was often pointed out by students (see Figure 2, by the bottom left ice edge). These ice plates were related to the presence of melt water. With the summer temperature, the ice floes melt and get surrounded by its fresh water, which floats on top of the ocean. The freezing temperature of fresh water being warmer than that of sea water, it is easier to freeze the melt water when the air temperature drops. Also, while cooling fresh water becomes lighter close to freezing point, salty water keeps getting denser as it cools, and sinks. Thus, a much deeper column needs to reach freezing point for sea ice to form. During the expedition, we had the chance to observe these fresh ice plates and refreezing melt pounds, even though the weather was too warm for the observation of frazil and oil ice.

Figure 3 : Brine channels in sea ice (photo credit : Mathieu Plante)

Another of these characteristics is the very bright blue color sometimes featured by the sea ice, most often in aggregates of blocks of ice or recent ice ridges (see Figure 4). This color is due to the porosity of the sea ice, which is one of its main difference with lake ice. The freezing of sea water being turbulent, multiple air pockets are trapped in the sea ice after its formation. Also, when sea water freezes, the salt it contains is ejected and collected in little pockets of dense, salty water called brine. With time and as the sea ice grows, part of the ice flows rise above the sea level and the brine is drained from these pockets by gravity, leaving air pockets in the sea ice. It is these compacted air pockets that cause the porosity of sea ice, and cause a refraction of incoming light that creates this blue color. Furthermore, as the brine drains from the sea ice, it slowly makes its way downward, creating vertical “brine channels”. This causes a visible vertical structure within the sea ice, that is simply the exposed brine channels (see Figure 3).

Figure 4 : Deep blue color in ice ridges (photo credit : Mathieu Plante)

Part 2 : Oceanography

Part 2.1 : CTD Profiling

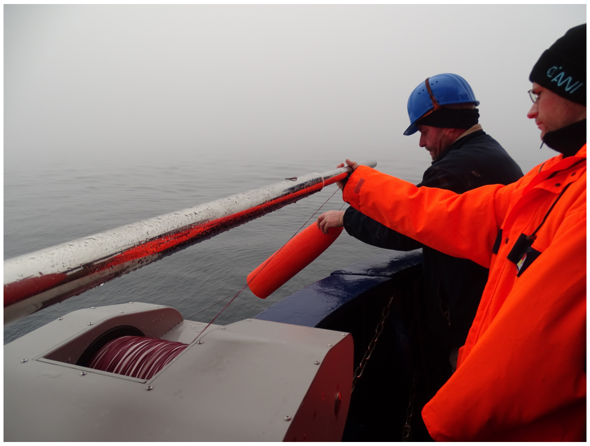


Figure 5 : Attaching the protection foam on the UCTD line (photo credit : Amélie Bouchat)

On a large number of stations, CTD (conductivity-temperature-depth) profiles were obtained along with the operation of the rosette. Apart from locating where to take the water samples with the rosette, the CTD profiles thus obtained will be useful for later analysis and mapping of the water masses we encountered during our cruise. It was interesting to go up in the winch room to see the results of the CTD sensor printing live on the screen. On each CTD profile, two casts are done. On the first one, the downcast, a preliminary CTD profile is obtained and used to decide where the water samples from the rosette will be taken. The second cast, the upcast, is done when the rosette moves back up to the surface. The two CTD profiles are kept and combined together later.

Later during the cruise, some ArcTrain students got involved with the Underway CTD (UCTD) profiling stations that were done during open-water transit sections on our way back to land. Under the supervision of Wilken-Jon von Appen, a small group of us received a training to familiarize ourselves with the instrument since none of us had seen something like that before. We learned how to do a splice in the line (a really interesting method to fix a line back on itself without using knots), how to operate the winch and maneuver the CTD probe and how to extract the data on the computer. After a couple trial casts with a dummy probe and fixing a software problem, we started profiling with the UCTD and experimented with the different options of continuous casting or recasting by taking the probe on board after each cast. Since taking the probe back on board turned out to be time consuming and potentially dangerous to damage the probe, we decided to do only continuous casts. After a first exhausting night shift spent in the cold and the fog to operate the UCTD non-stop during the first open-water transit section, we rapidly realized the need for more people to join the profiling team. The first ArcTrain trainees were then responsible to train fellow ArcTrain students and the remaining transit sections were profiled successfully. In a following ArcTrain seminar, André Paul showed us how to plot and analyse the data we took with the CTD during the cruise. It was fun to be part of this new project on board and learn how to perform the whole process of data acquisition and analysis.

Figure 6 : The UCTD probe ready to be taken back onboard (photo credit : Amélie Bouchat)

Part 2.2 : Ocean Glider Deployment

From Polarstern, two research ocean gliders were deployed into northern Fram Strait to measure oceanic state variables as they explore the arctic seas over the course of several months. An enormous amount of planning was required for these autonomous vessels to be safely and successfully launched. The dynamic of deployment itself was a highly organized feat: Four scientists donning survival suits sitting aboard an inflatable zodiac boat in the ice covered waters of the arctic waiting for launch instructions from a group scientists in front of computer screens at the Alfred Wegener Institute thousands of kilometers away. This was the final step of a well orchestrated process which included calibration and testing of each glider which was not without complication. One glider had trouble communicating with the satellite which had to be resolved before any deployment attempt would be possible. The other glider had to be recovered from the ocean and retested aboard Polarstern due to a faulty internal pump. Once this was fixed and all safety procedures again followed the glider was successfully deployed with the help of the controllers at home in Bremerhaven.

Being a part of this deployment process illustrated to me, the vast amount of preparation and planning that is required for conducting scientific field work an environment as harsh as the Arctic Ocean. To have a safe and successful operation, it is necessary to consider all possibilities and be prepared with contingency plans and back up systems should there be a malfunction or accident. This implies that a researcher doing field work but not only be well versed in the scientific theories he or she is studying, but also the best practices and safety procedures required to conduct the experiments. The first hand experience I had working as a part of this glider deployment instilled a great respect for the importance of all steps of the process leading to such a launch. I was only apart of the final act of sending the gliders into the ocean; however, it was readily apparent that the operation would have never been possible without the knowledge and preparation of many others.

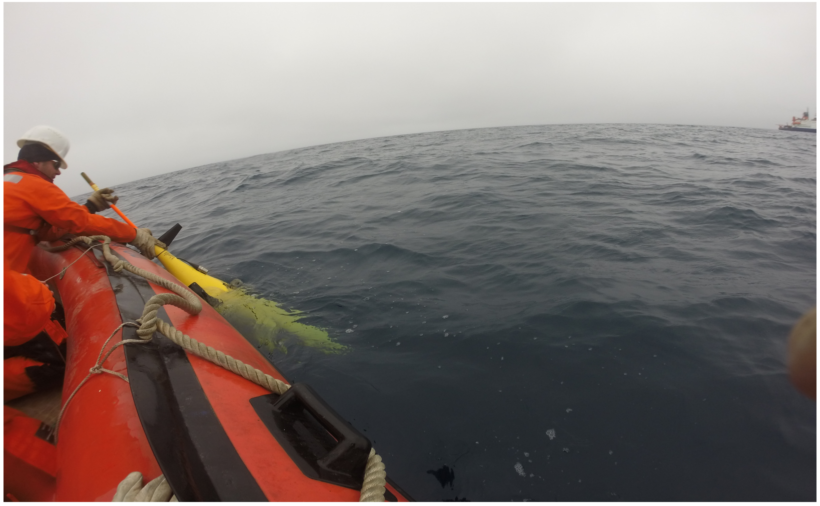


Figure 7 : The insertion of the ocean glider into the water. Polarstern can be see in the background (photo credit : James Williams)

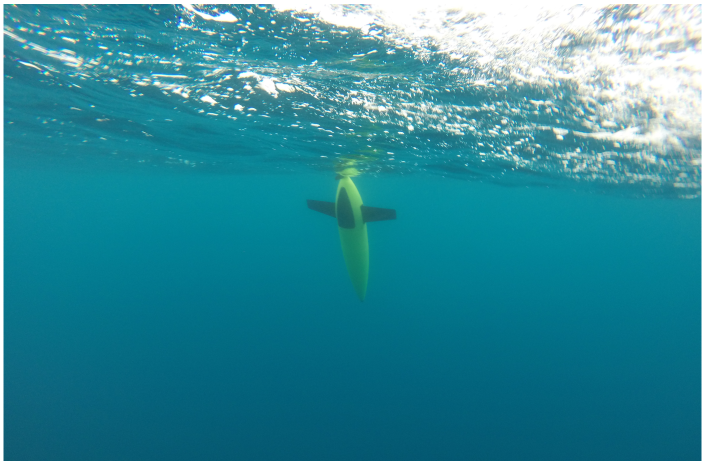


Figure 8 : The ocean glider seen from underwater awaiting the dive command from its controllers in Bremerhaven (photo credit : James Williams)

Part 3 : Sea Sediment Coring

We, the ArcTrain students, were on board the Polarstern with the four kinds of sediment corers: a kastenlot corer, a multi corer, a gravity corer, and a box corer.

The most beautiful sediment core was obtained by the kastenlot on 1st July. It was one of the first kastenlot sediment core, and it uplifted the atmosphere among scientists. The core was about 6-m long. Dr. Rüdiger Stein and Dr. Henning Bauch gave us a lecture in front of this sediment core (see Figure 7). The core contained a large range in the size of the grains and in color. As a results, it was beautifully layered. The two possible fine grains types, clays and silts, are indistinguishable by vision. Dr. Henning put each part of the sediment on his tongue and demonstrated us how to distinguish them. Silts are too fine, so a tongue detects them as smooth; on the other hand, clays are detected as arenaceous. The kastenlot collects sediments deep down from an interface; therefore, it contains longer time series of climate data. It is, however, nearly impossible to collect undisturbed interfaces, and we loose the recent climate information recorded in the sediment close to the interface.

We observed that the multi corer collects sediment samples that includes the undisturbed surface (the interface of water and sediment) during the sampling the sediment cores. The undisturbed interface is important to the recent climate studies. The multi corer has 12 core tubes about 1 m long. When we sampled the multi core, the obtained sediment cores were about 30-50 cm. We had a chance to observe at the interface some organisms: sea urchins, starfish, and leeches. Some of them were still living and moving, which implies the interfaces were disturbed very little.

The experience of the sediment coring was extraordinary to me, as a student studying the sea-ice physical properties. The sediments are brought not only by glacier/iceberg, but also by some sea ice, and possibly contain information about sea-ice motion and dynamics. This experience interests me and makes me think of the possible research subject on both sediments and sea-ice dynamics.

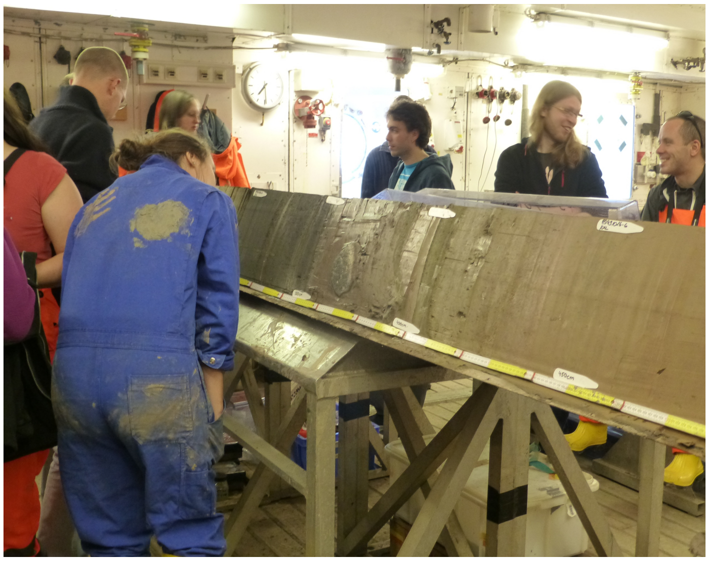


Figure 9 : The ArcTrain students attended the lecture about the kastenlot sediment core given by Dr. Rüdiger Stein and Dr. Henning Bauch. (photo credit : Yukie Hata)

Part 4 : Biology

During this expedition, ArcTrain students participated in helping scientists with biological sampling and analysis. Most ArcTrain students were able to help with either both or one of the following : (i) sampling or (ii) microscope analysis.

(i) Sampling was made by collecting water samples from the ocean when the ship was stopped, either with the handnet, the multinet or a bucket. With the handnet, the goal was to collect micro-organisms, and with the bucket, to collect visible algae growing under the ice. The students were able to operate the handnet by themselves by simply throwing it overboard, down to about 10 m deep, and getting it back on the ship. When taking it out, some water was flowing trough the net, while the biological part of the sample was being concentrated and then collected. The samples were stored in a cold chamber with solar lamps to keep the organisms alive.

Most of the students were very surprised by the amount of life there is under the ice, and how much mass of micro-organisms there is in such little quantities of freezing Arctic water. Those maneuvers therefore showed us the importance of the ecology of the surface ocean. We could in particular observe some copopodes – insect like organisms of about 1cm long – which were very often present in the samples.

(ii) Some students had the chance to analyze water sampling collected as explained in (i) with a microscope. The goal was to identify the different species and to try to take pictures of micro-organism behavior in relation with each others. All this part of the experiment was conducted in a cold chamber located in a container. The students could prepare the samples by putting some water-micro-organism mixture on a slice and observing it with the microscope. The microscope was plugged to a computer to allow to take pictures.

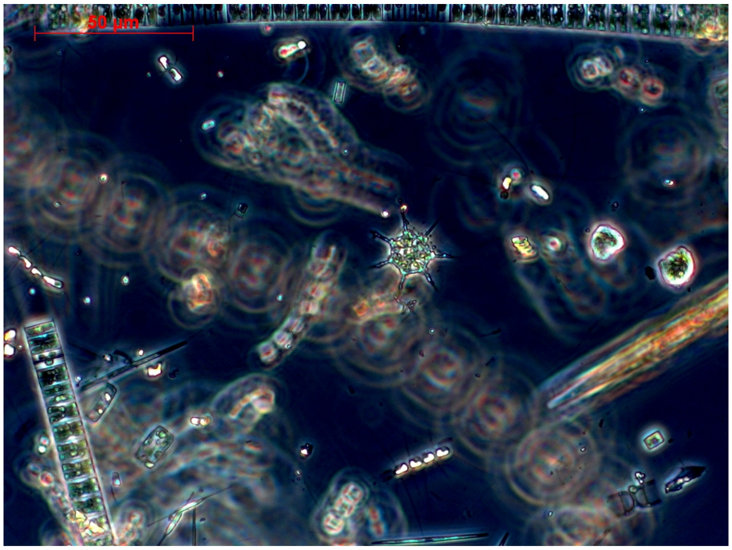


Figure 10 : Water sample seen from the microscope (photo credit : Steffi Gäbler-Schwarz)

During this experience, students learned about the diversity of oceanic micro-organisms and had the chance to see interactions at a level we never saw before. With the microscopes, it was also easy to see very well the structure of very small organisms (see picture 2), teaching us about how this different type of life works.

Of course, if we talk about biology, we did not only observe organisms barely visible to the human eye. All students were also very attentive to the observation of larger animals. Many birds were seen: penguins closer to the land, petrels and a puffin. The petrels were following the boat for the whole trip, resting where we stopped. In terms of mammal, some seals were observed in the ice, and polar bears were seen at a few times, especially close to the ice edge.

ArcTrain Floating University on board of Polarstern Expedition PS93.1
Group Report

Annegret Krandick and Kerstin Kretschmer
(Center for Marine Environmental Sciences – MARUM, University of Bremen, Germany)

The ArcTrain Floating University gave us the opportunity to get insights in Arctic research on board the research vessel *Polarstern*. We got hands-on experience in collecting (paleo-) oceanographic data that we often use for comparison with our model results.

During this research cruise we gained experiences in a lot of disciplines covering physical oceanography, geology and biology. We actively took part in the CTD water sampling, box and multi-coring, hand net sampling, in examining biological samples under the microscope, maintaining the nutrient analyzer “CuNo” and monitoring the parasound profiling. Besides this practical work we had the chance to join the ArcTrain seminar where interesting presentations and computer courses have been offered. The course dealt for example with the use and visualization of shipboard data, directly measured during our cruise.

Starting in Longyearbyen, facing north, our first working station was the recovery of moorings and subsequent cleaning of the instruments (Fig.1+2). It is, in general, really hard to find the buoys indicating the position of the mooring after it has been released from the ocean floor and sometimes, unfortunately, the mooring does not appear. The moorings we wanted to recover were deployed ~3 years ago and the data might provide information about e.g. current velocity, temperature and salinity in the eastern Fram Strait. In the end, we collected and cleaned three of five deployed moorings.

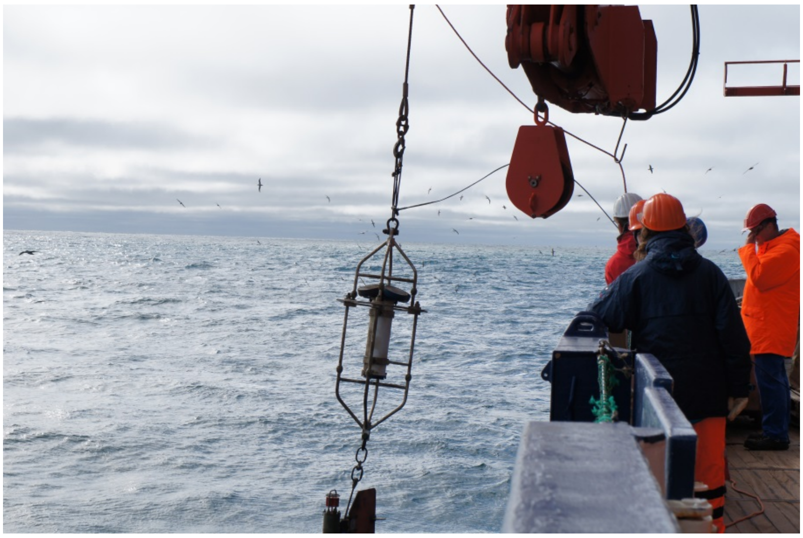


Fig. 1: Mooring recovery. *(Photo: A. Krandick)*

Fig. 2: Instrument cleaning. *(Photo: A. Klus)*

Shortly after, we reached the sea ice-edge. Within the following two weeks, the focus was set on geological and biological sampling. A typical station list during these days was: first CTD profiling and water sampling, followed by multi net and hand net sampling as well as collecting of dirty ice and under-ice water samples by using the zodiac. Subsequently, the box corer, multi corer and last but not least the kasten- or gravity corer were deployed and recovered. Depending on the water depth, this kind of station can last for several hours.

We had the opportunity to gain a broad experience in working on the aft deck and in the laboratories by rotating between the different working groups. We started in the working group of CTD water sampling for geochemical analysis: $\delta^{13}C$, $\delta^{18}O$, nutrients, Neodymium (Nd) and Hafnium (Hf) (Fig. 3+4). Besides the water sampling, CTD profiles were taken. These profiles provide information about ocean properties of the whole water column like temperature and salinity.

Fig. 3: CTD-rosette. (Photo: A. Krandick)

Fig. 4: Water sampling for $\delta^{13}C$, $\delta^{18}O$, nutrients, Nd and Hf analysis. (Photo: A. Krandick)

After several stations of helping with the water sampling we moved to the biology working group. Before doing that, we explained the water sampling-procedure to our replacing fellow ArcTrain students while we were introduced by other ArcTrain students to the biological sampling. Arctic algae and phytoplankton were caught with the hand net (Fig. 5) in the upper water column from the aft deck and the zodiac. These samples were then prepared for microscopic analysis (Fig.6). Thus, we got the chance to directly analyze the diversity of arctic algae under the microscope that we collected before.

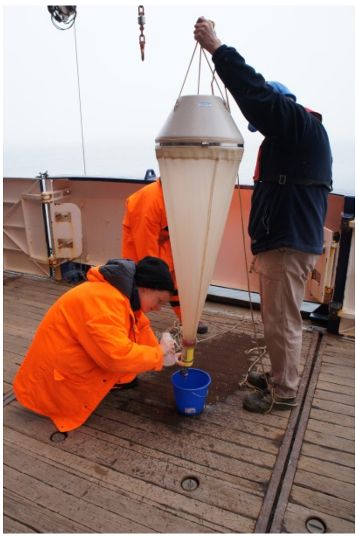


Fig. 5: Hand net sampling. (Photo: T. Breckenfelder)

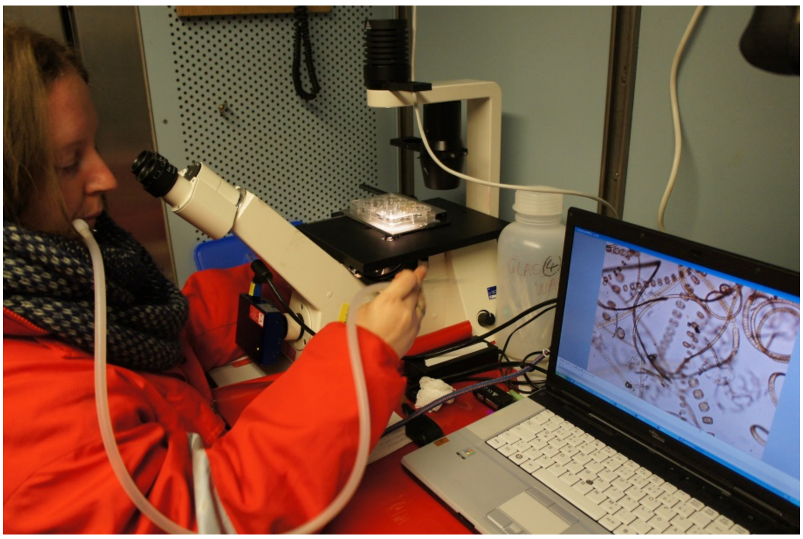


Fig. 6: Biologist Dr. Steffi Gäbler-Schwarz isolating phytoplankton at the microscope. (Photo: A. Krandick)

After that, we were part of the geology group including box-, multi-, kasten- and gravity coring. During a so-called GEO station the different coring devices were used to retrieve sediment of up to 10 m core length. For each gear the sampling started immediately after the recovery on deck (Fig.7+8). Every helping hand was always welcome.

Fig. 7: Sampling the box corer. *(Photo: A. Krandick)*

Fig. 8: Cutting the multi corer in 1 cm thin layers. *(Photo: K. Kretschmer)*

Every morning at 8:30 am, often during station, the scientific meeting took place. The preceding day and the up-to-date station plan were discussed. The meeting finished with the weather report from the meteorologist of the German Weather Service. While most of the scientists were involved in the "slaughtering" of the different cores, the helicopter started off to observe the sea ice-conditions along the planned ship track. Two scientists were allowed to accompany the helicopter crew. This was a great opportunity for some of the ArcTrain students. When a station ended and all gear was back on deck, the preparation of the next station started: Labeling of sampling containers, cleaning of deck and gear. During the transit the core sampling was still in progress and the biological diversity of the hand net samples was analyzed with the microscope. Furthermore, the sea floor and the uppermost sediment layers were mapped along the cruise track using the parasound and hydrosweep systems. All ArcTrain students were part of the parasound team, divided in different, rotating shifts, also during night. The last part of the cruise, leaving the sea ice behind, was dedicated to physical oceanography: Moorings have been recovered. Later on, one mooring, two seagliders (Fig. 9) and two floats (Fig. 10) were deployed. Furthermore, the so-called underway-CTD was "flying" through the water to measure temperature and salinity profiles.

After the last station, Polarstern set course towards Tromso. On our way back all samples and instruments had to be packed into boxes and stored in containers, while packing lists have been written.

Fig. 9: Sea glider on the way to its mission.
(Photo: A. Krandick)

Fig. 10: Float deployment. (Photo: A. Krandick)

The three weeks on board RV Polarstern have been a great experience. Besides the hard work we really enjoyed the company of the crew and the other scientists, as well as the surrounding ice floes, polar bears, and the midnight sun. We would like to thank Captain Thomas Wunderlich and his crew who helped us in every possible way. Furthermore, we thank our chief scientist Rudy and the other scientists participating in this cruise. Finally, we are grateful for this opportunity to take part in this expedition given by ArcTrain.

ArcTrain Floating University on board of Polarstern Expedition PS93.1

Group Report

Sam Davin, Coralie Zorzi, Aurélie Aubry, and Jade Falardeau

(GEOTOP, Université du Québec à Montréal, Montréal, Canada)

Part I: Shipboard scientific activities

Hand net

The hand net is a simple, manual device used to catch marine organisms at depth. This activity was one of the first to be done when we arrived at a station. The hand net was done first because the water column needed to be not disturbed by all the coring activities.

The use is very easy and fast (~10min): outside from the deck and far from the boat's engines, we put the net in the water and let it go down to a desired depth. Once the depth was reached (a few meters), we hauled it back by pulling it up with a rope. Then, carefully, we emptied the net filter into a plastic bucket. This bucket was labeled and stored in a cold room to await microscope observations. You can actually "see" the

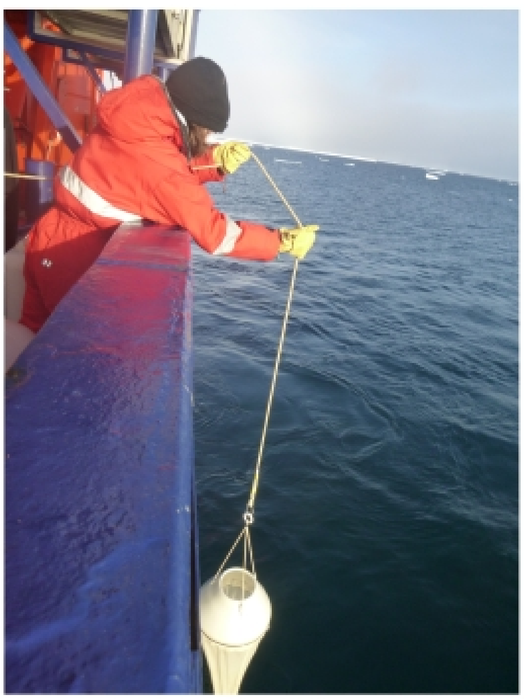


Figure 1: Lowering the hand net overboard to collect biological specimens. Photo credit : Aurelie Aubry

Figure 2: Students extracting living specimens from the hand net on the working deck of Polarstern. Photo ctedit : Aurelie Aubry

plankton in the filter on the form of a “brown jelly”. It is surprising to see how much of it is in the arctic waters.

Optical microscope

The second part of the biological work on board was to observe the bucket contents. In a tiny (and cold) container were installed 2 optical microscopes fitted with cameras. However, before observations could be made we had to prepare our samples. After mixing the bucket contents we would take a small amount of water/plankton with a pipette and put it on a special thick glass microscope slide (previously labeled with the name of the bucket!). We had to be careful to evacuate all of the air bubbles when we sealed the slides. Once the slide was ready, we started the observations. Then… it’s an amazing world, which opens just in front of your eyes. You can watch the organisms moving in the slide and try to follow them or try to understand interactions among them. You can see diverse plankton communities with silicate organisms, carbonate organisms and organic matters organisms, including: diatoms, planktic foraminifera and dinoflagellatea. All of the internal and external cellular organization was there for us to see, including: nuclei, chloroplasts, cell walls, and species-specific ornamentations. Our job was to take pictures (with a camera and a computer) to illustrate the planktic diversity and to attempt to identify discrete specimens.

Figure 3: Laura examining samples under the optical microscope in the cold room. Photo credit: Aurelie Aubry

Figure 4: The thriving microscopic world of the Arctic. Photo credit: Steffi Gaebler-Schwarz

Parasound watch

During the mission, a parametric sub-bottom profiling (parasound) was continuously operated in order to map sediment formations. To support this part of the expedition Arctrain students participated the parasound watch, 24-hours a day. We traded off with each other every 2 hours during days and every 4 hours during nights. The job consisted of watching display monitors and (1) watching for error messages and (2) making sure that the display recording didn't extend beyond the bounds of the screen. It was a simple task but it required all our attention.

The parasound works like this: A transmission source is fixed under the boat and creates acoustic beams. These beams reach the sediments and are reflected or refracted along discontinuities due to changes in the density and propagation speed properties of the material. Sensors are also under the boat and catch the signal back. This is the double time travel (time for the beam to go down and come back to the sensor) that is recorded and translated by special software for data acquisition to “image” of the sediments stratification and formations.

It was not surprising to have a bad or a lack of signal because of the ice thickness. Indeed, by breaking the sea-ice, the Polarstern crates waves that can disturb the signal. Similarly, broken ice under the boat sometimes masked the sending and/or receiving signal.

Box corer

When you think about the Arctic Ocean, you can easily imagine a white desert of sea ice, freezing air and strong winds. I experienced some of this reality while working aboard Polarstern in the Northern Fram Strait. However, what I learned above all is that even if the Arctic is an environment where extreme conditions exist, it has remarkable biodiversity. We saw whales, birds, algae, copepods in water samples and so on. This amazing living world also includes life at the bottom of the ocean.

During our tenure on Polarstern ArcTrain students, including myself, carried out a specialized task involving the box corer. For every box core, we picked shells and other macrofossils in order to assess the diversity and distribution of benthic fauna. We identified a number of animals, including gastropods, bivalves, sponges, agglutinated foraminifers. It is likely we’ll find many others after detailed microscope analyses of these sediments.

I remember while we were close to Northwestern coast of Greenland, the surface of the box core was covered in pebbles, we could then know that the bottom current was quite strong. It was the perfect environment for certain sponges who are filterers. It was full of tiny spicules. At this site something of note also caught my eye: the relatively big (for macrofossils) agglutinated foraminifers, some reaching over two centimeters. These large forams are well known in the Arctic, but for me it was totally new and interesting experience. After picking the macrofossils, we sieved them in order to clean what was collected. These samples were dried and ultimately sent to **Geotop** at the University of Quebec in Montreal.

Figure 5: A sea star accidentally caught by the box corer. Photo credit: Jade Falardeau

Figure 6: Agglutinated foraminifers at the surface of the box core. Photo credit: Maciej Mateusz Telesinski

The Multi-corer

geological activities represented an important part of the work done during the cruise PS93.1. Marine material was extracted from the sea-floor in different ways to meet distinct scientific needs and objectives: the boxecore collecting the surface sediment, the multicore that well preserves the water-sediment interface and the Kastelnot and gravity cores , which record both long marine sequences.

Figure 7: Coralie and Valeria sampling a multicore sediments. Photo credit: Kirstin Werner

Composed by many tubes, each of which each collect a sediment core less than 1m in length, the multi-core is a means of collecting and sharing the same sediment portion between the different labs and/or scientists participating in the expedition. During this cruise, eight mutlicore stations were successfully carried out. Sometimes, one or several tube did not close due to issues with large ice-rafted debris or resistant bedrock. However, generally at each multicore station seven cores were sampled: one for sedimentology (Geomar), one for the biomarkers (Ruediger Stein-AWI), one would be used for the planktonic forams (Geomar), one for the water-sediment inferface (Kirsten Fahl-AWI), one for dinocysts (Anne de Vernal-Montréal), one for geochemistry analyses (Antje Wildau-Geomar) and one as an archive. Maciej Telesinski and Kirsten Fahl led the multicore activities on the deck and in wet lab, respectively.

The ArcTrain students' work starts when the mutlicore goes up: on the deck, each tube is capped on the bottom and on the top right away. The point of this operation is to act quickly for preventing sediment loss. This activity sometimes the from the complications that arise from frozen hands and liquified sediment. Except for Kirstin's and Antje's sampling, who only use sediment from the tops of these cores, the entire sedimment cores were sampled at centimeter resolution in the wet lab. To prevent contamination, we cleaned the sampling knife after cutting each section. The samples we cut were then preserved in labeled boxs and placed in a refrigerator (~4°C) and sent to different at the end of the cruise.

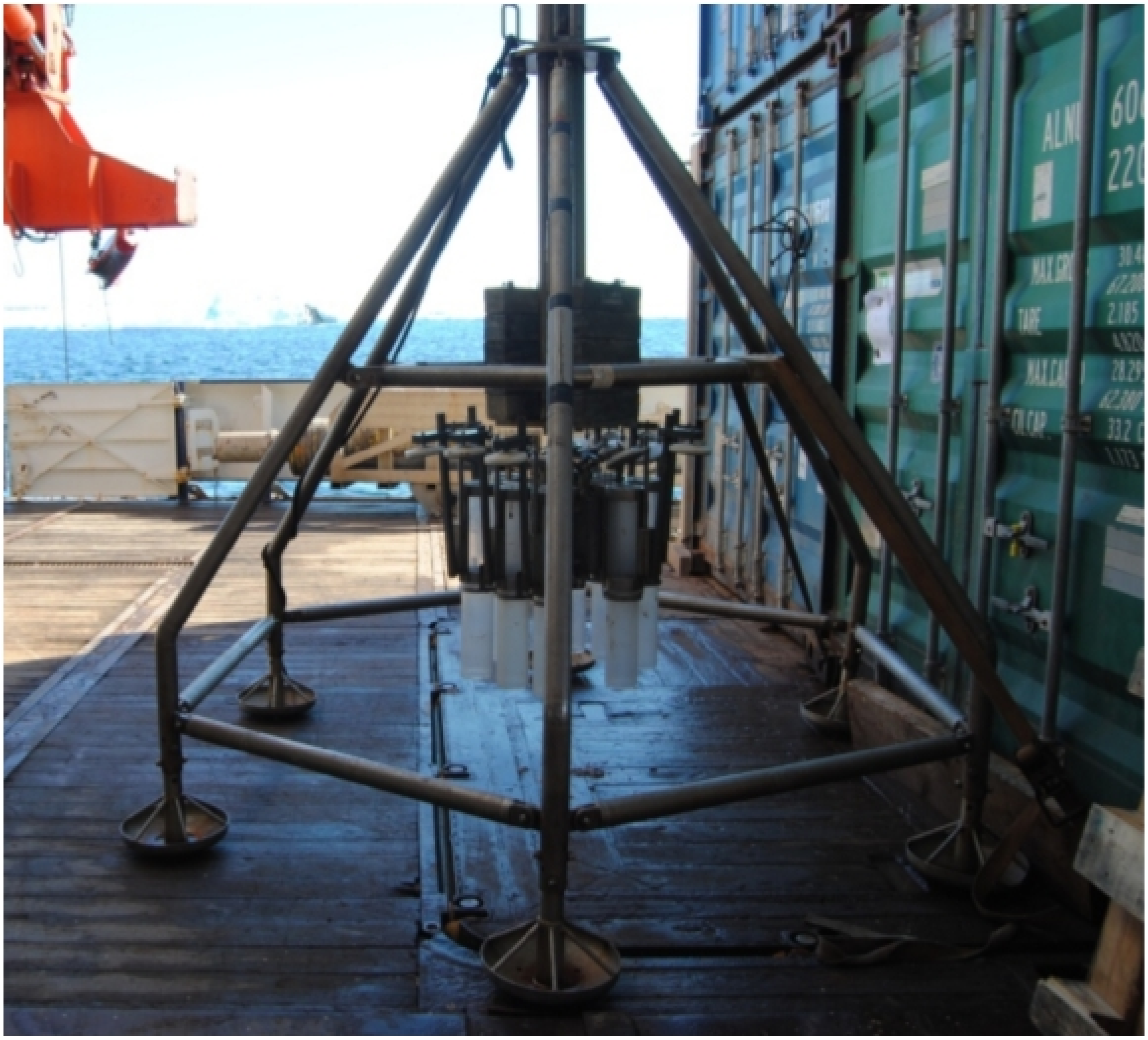


Figure 8: The multi-corer awaiting deployment on the working deck. Photo credit: Kirstin Werner

Kastenlot corer

The purpose of Polarstern expedition PS 93.1 was multifaceted, having geological, biological, oceanographic, atmospheric, and educational objectives. However, aside from providing a wonderful education to all shipboard students, geological activities dominated the work of this expedition. Of this geological work a major component was the collection of marine sediment cores. Sediment cores represent archives of Earth history, their volumes extending further back in time with older, deeper sediments. Marine sediment cores are capable elucidating millions of years of Earth history, albeit at a a relatively poor resolution. To develop a better understanding of environmental conditions in the Arctic during the Cenozoic, a number of cores were taken during the expedition. The longest and most voluminous of these cores were the kasten cores.

Due to the size of the kasten cores, most if not all ArcTrain students were afforded the opportunity to work on the tasks associated with them. At a typical station where the kasten corer was being deployed the following steps were taken:

(1) Students would construct the kasten core barrel inside the Wet Lab by bolting the large, L-shaped sections of steel together to form a long, continuous, and rectangular core barrel. The final step in the construction process would be to install the core catcher, a simple mechanical device located at the bottommost terminus of the barrel designed to retain sediment post-capture. (2) The assambled kasten corer would then transported to the working deck where it would be fitted in steel scaffolding and equipped with 2.5 tones of lead weight to ensure it would able to sufficiently penetrate the sea floor. (3) Polarstern crew members would then lift the kasten corer with a crane and deploy it into the sea. (4) After the core reached the bottom and had sunk into the sediment it would be winched up by the crane and brought back into deck. Being much too heavy to lift the core would be hoisted back into the wet lab by a smaller shipboard crane. (5) Back in the Wet Lab, students would remove sections of the core barrel to expose the entire length of the sediment core. (6) From here on our students would then collect discrete samples to be used for various research projects as well as core sections to be logged on the multi-scan core logger.

Part II: Feelings and impressions

Aurelie Aubry:

The crew was composed of very nice people who let us live with them (we were guest in their home!). I remember the nice conversations we would have when the stewards would come to clean our cabin. I have a lot of respect for them and I'm thankful for everybody we interacted with. It was very nice and very unusual to meet new people so far in the North.

The scientific team was amazing. All of the scientists, post-docs, PhD students, and Master's students had so much to share with one another. The "teachers" shared their knowledge and expertise on scientific shipboard research, sampling, interpretation, organization, cleaning, … everything that could help us to understand what we were doing.

As ArcTrain students we lived together for 3 weeks and thus we were able to build a strong sense of friendship and camaraderie. After this experience together we have become more than just a working group studying the Arctic: we are friends too.

The best thing about this experience was the feeling that I was a useful part of a team conducting scientific studies in the Arctic. I am used to analyzing marine core sediments, but for the first time in my life I took part in the initial sampling processes. I also had the chance to fly in the helicopter and it would be a lie if I said it wasn't one of the most amazing I have ever done before.

I learned so much in these 3 weeks: how to operate the box corer, gravity corers, and the multicorer, how to sample them (and play with mud…), how and how to recognize the Eemian! I also gained manual dexterity, precision, and patience. It was also a great learning experience on how to live in a small group. Overall, this adventure has enriched both my professional life as well as my personal life.

Living in a small place with a lot of people with no private life and no real schedule was sometime difficult. I can't really complain about the work because I love everything I did, but sometimes it was difficult especially because of the lack of sleep and regular schedule. You could have a lot of times with nothing to do between two far stations and then so much to do in a short time when stations were close to each other. The “typical day” did not exist anymore and only the meals were there to remind us what time it was. The 24 hours of sun didn't help…

If I have to chose the funniest moment of this adventure I will chose without hesitation the wet lab. Living and “playing” in the mud in the middle of the ocean was unimaginable. The long nights of sampling and singing with the sun, the waves, the ice breaking, and the team made for a fantastic blend of business and pleasure.

This experience shows me the reality behind the small sample bags that I’m used to receiving by post. Especially in the arctic, sampling conditions are hard and complicated, and working as a team is the most important.

Coralie Zorzi:

I choose to summarize my feelings and impressions in four points: the best, the hardiest, the funniest times of this Floating University and how this experience impacted me!

For me, the best moments of this cruise were in the wet lab, working hard, slicing sediments, cleaning and labelling cores, gossiping and dancing to nice music with the funniest team of the cruise...

A cruise the Arctic is a unique and amazing experience! Oftentimes the environment cant be very harsh and challenging, complicating shipboard work. Even if I did all I could, it was sometimes difficult to participate in all of the activities. If only I could duplicate myself to be everywhere at once! Overall, this was a good challenge to define my physical limits!

My funniest memory is related to short experience in the wet lab ! I used a hair drier to quickly analyze the superior fraction of the sediment (especially the forams component) after sieving! It was really funny to use this type of instrument in this place, full of knifes, saws and cutting tools!

To summarize, I learned so much during this cruise, about Fram Strait sediments and glacial/deglacial rhythmicity (thanks to Henning fo taking time for explaining it in front of beautiful kastenlot core), about glacial margin features during Mathias Forwick's talks and about parasound activities (thanks to Florian for his practical explanations). The scientific discussion with Michael Shrek (the busy man of the wet lab) about dinocysts was really helpful for my expertise! This cruise keep a special place in my memory, and I would thank to Ruediger for giving me this opportunity!

Jade Falardeau:

Being on an research vessel is a very unique experience. The view, the freshest air you can possibly breathe, all the different fields of research you get in touch with… everything is nourishing. Nevertheless, even if you are far away, with no roads and no civilization, you still live in a confined environment with others. This particular situation makes the people you are with very important. Happily the crew was incredible. Our colleagues and the senior scientists were always patient and ready to to provide us with explanations when we needed them. I especially remember Kirstin Werner working with the CTD and explaining to me the water stratification and the what the data we were collecting meant. Robert Spielhagen, the master of the box corer, also showed us his different sampling technics. Also, Henning Bauch took the time to tell the story behind the huge kastenlot, and Michael Schreck and Matthias Forwick were always giving us things to do and keeping a very cheerful atmosphere in the wet lab. I must thank all of them, including the chief scientist, Rüdiger Stein, and all the crew, who made this cruise an unforgettable experience.

The thing I liked the best was working with Robert Spielhagen on the box corer. This is where I learned the most. I was always curious to see what would be at the surface of the box core and Robert would always give quick explanations on the sedimentary sequence we could see. After a long day of scientific exploration, the little break we took in the wet lab after everything was done was always nice and it was a good opportunity to get to know the students and the researchers better.

Of course, life on the boat isn’t the cruise vacation people from the outside world might think. During an expedition, there is no proper break time and the schedule is always changing, so you might have to work at any hour of the day and you need to be always ready. I think the hardest for me was the sea sickness. Unfortunately, I’m very sensitive to motion and I often felt ill, especially the last days when there were stronger winds and we had to clean up the wet lab. It was truly hard for me.

Expedition PS93.1 was conducted scientific exercises directly related to my Master's research. This was excellent for my academic progress. I had the chance to meet incredible researchers working in Fram Strait including my co-writer, Robert Spielhagen. During the 3 weeks, we had several talks about this particular region and it truly helped me understand the oceanic currents circulation and the role of Fram Strait in heat advection into the Arctic Ocean. Also, during the kastenlot presentation, we got few insights about the regional dynamics during the Last Glacial Maximum, which again touches my subject directly. Finally, not only have I learned about Fram Strait itself, but now I have expertise as a shipboard scientist and I am more conscious of how hard it is to collect data in such conditions.

Sam Davin:

From a personal perspective, life aboard Polarstern was wonderful. Free of distractions, save from each other and our work, life was natural and deliberate. The sun never set, we nearly fell from our beds when ramming through multi-year ice, and we often had to wake at strange hours to work. These experiences might sound unpleasant, but they really weren't. If anything, they merely cemented our sense of camaraderie and gave us all something to laugh about.

The funniest experience I personally had occurred one evening while sailing south through thick ice. On this particular evening there was little work to be done, and a number of us found our way to the E Deck swimming pool for a game of wasserball. All began normally, but soon the pool was churning madly from the constant up-and-down motion of the ship. This resulted in the water in the pool rushing from one end to the other, so that a player might find themselves in knee-deep water one moment, and capable of touching the ceiling the next. Needless to say, game play was wildly entertaining.

It is with a heavy heart that we all parted ways in late July. I suspect each of us found something in this expedition that we needed in our lives. Though we have since been scattered across the world, I take solace in that I will see many of you again. To my colleagues, now friends: be it 2015 or 2050, think back to the adventure we all had together. Pick up the phone, look each other up, and book plane tickets. It is said the world is a small place, but that is only true if we maintain the stitches that bind us together.

Figure 9: Priority space -- The Wet Lab. Photo credit: Sam Davin

ArcTrain Floating University on board of Polarstern Expedition PS93.1

Group Report

Wei Leng, Martin Bartels, and Valeriia Kirillova

(Center for Marine Environmental Sciences – MARUM, University of Bremen, Germany)

The ArcTrain Floating University provided us the great opportunity to take part in all research activities that were carried out during the cruise. The scientific program included marine geology, biological sampling as well as oceanographic and atmospheric measurements. Such a diverse program was especially useful for students who have never been on a research vessel before. In addition to the practical work in the laboratories, seminars and talks given by senior scientists took place. Topics covered data processing and plotting, ocean currents in the Fram Strait, algae growth at the sea-ice edge, sedimentological processes in fjords and ocean basins etc. Also several students used this chance to present their research. It was very inspiring to have profound discussions with the numerous experts working in this area for many years. They contributed a lot to our comprehension of the mechanisms and conditions in the Fram Strait.

Even those of us participated in the cruises before, learned a couple of new methods. It was great and inspiring for all of us to see how the sampling gears really work and not only read about them in the book. And those students who have never worked in any kind of a lab before were very excited and sometimes even nervous when working with the sediment for the first time. This is definitely one more evidence for a multidisciplinary team of young researchers being raised. Moreover, a research cruise is always an opportunity to gather people from different countries, with different status and different research areas, so special and wonderful. It’s a chance to expand your scientific network, to learn, to discuss your topic and of course to find new friends.

The work in the wet lab included sampling the box corer and the large Kastenlot, cutting the gravity cores as well as slicing the smaller cores that were retrieved with the multicorer.

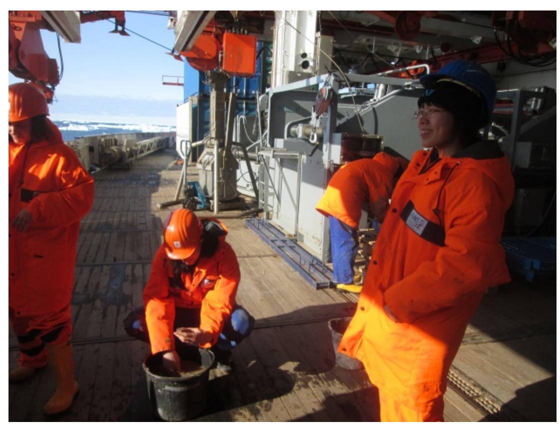
It might be the first time for most of us to deal with the **box corer**, which is a huge heavy metal instrument with a box, a spade swings, a large plunger and the main coring stem. The whole set runs slowly down to the sea bed and penetrates by it self’s weight and gravity, and then the spade is closed to prevent loosing of the sediments during its way back on board. The penetration depth could be up to 0.5 meters but mostly it not filled completely. Sometimes the box corer couldn’t close so we failed to get any sediment at all, and we had to check the equipment and to have another run. If the box hits the big rock, than it is loses its shape. So when we run the box down we don’t known what we may get.

The whole run takes up to one hour (depends on the water depth); therefore we have enough time to do the preparation for the sampling. It is good to work fast and finish the sampling shortly after the box corer is on board. We were preparing the cut tubes, plastic boxes and syringes for sediments as well as warm water and strings for cleaning and also some other sampling tools like spoons, knives and pincette.

It has always been a happy but busy time for us when we get sediments successfully from the sea floor. First thing we did - we placed the box corer with a slight angle and were trying to find the way to get rid of the seawater. Usually we just used the rubber tube to suck out the water - that's where you can taste the ocean! Also just opening a small gap in the box door sheet helped to let the water slowly flow out of the gear. Then comes the core description together with photos – not forgetting about the label and the scale! After that we can start sampling with taking the surface samples, both the sediments and fauna. With spoons or pincette we were picking macrofossils as many as we could, since they made a good contribution to the micropaleontological studies.

Then we already could press in the PVC tubes to take short but continuous sediments cores. It is not an easy job, and we always asked help from the strongest guys, who struggled with the tubes using their hands, arms and the whole body! Afterwards we used the screw driver to loosen the screws on the door sheet, and the tricky part was to choose the sequence of all the screws. With the help of a string we carefully opened the door sheet trying to keep the sediment stable and undisturbed.

The next but the major step is to take box samples and syringes sample. These samples will be later used by different methods and for various disciplines to have a better understanding of the sediments and the environment. For example the syringes samples may be used for the pore water analysis and some of the box samples are saved for the X-ray scanning.



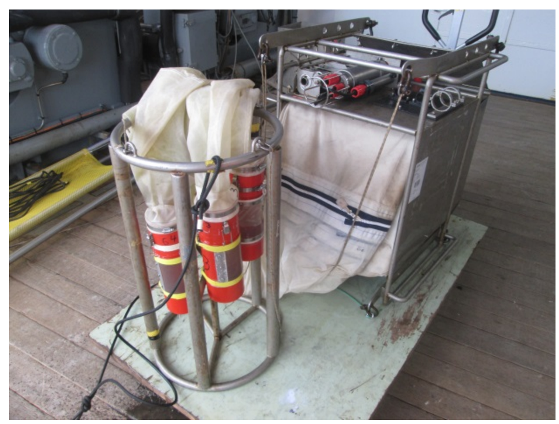
The last step but perhaps the most difficult is the cleaning. After taking enough samples, we could throw the rest of the sediments overboard and clean the box corer set with water guns. We also had to clean all the equipment as well to label and store the sampled material.

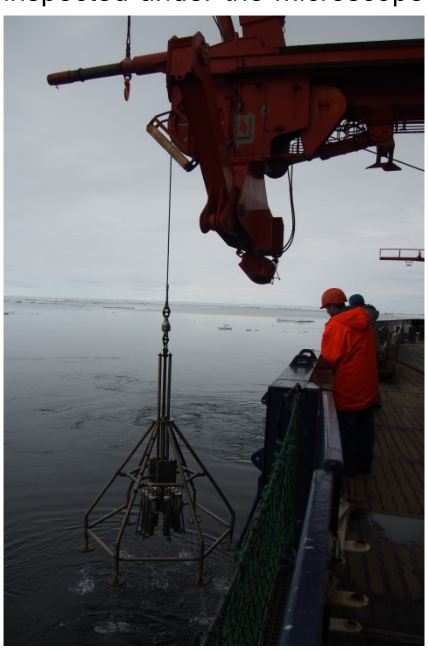
All the sampling steps may seem simple but in fact they were not so easy for us, who have no experience with box corer. But practice makes perfect, we enjoyed learning new skills and managed to become better and better every time. And of course you cannot do it yourself without the team. We were happy working together and having fun even during the hard times. We laughed at each other for the dirty work suit and dirty face, but also found a pleasure in having a shower after the sampling just under the water gun on the deck. Meaning the shower for the dirty work suit but not for ourselves!

After recovering, the sometimes more than seven meters long **Kastenlot**-cores were opened vertically. Therefore we already had the opportunity to inspect the sediment structure. Coarse grained layers and large drop-stones that interrupt the mainly muddy sediments were visible. These layers had been deposited during glacial periods. Due to different source areas and geochemical processes alteringcolors from reddish to greenish-gray could be seen. The probable age of the sediment can already be estimated when looking at the sequences of glacial and interglacial sediments. Due to pretty low accumulation rates in the deeper basins of the Fram Strait it could even be possible that we hit the last interglacial (the Eemian). After the first visual inspectionwe sub-sampled the core with plastic boxes for different purposes: sedimentological, microfossil, geochemical analyses and X-ray images. Since these cores contain enough available material, multiple vertical layers could be sampled.

Gravity cores were divided into one meter long sections before they were scanned with a so-called multi sensor core logger (MSCL). This instrument measures the density of the sediment and the magnetic susceptibility (to estimate the terrigenous influence). Also some sub-samples from the Kastenlot have been measured with the MSCL.

At most of the stations a **multi-net** has been deployed. This device enabled us to sample plankton from different water depths. The main interest was in the distribution of planktic foraminifera, but we also “fished” other tiny organisms that live in the water column like copepods. These samples were directly inspected under the microscope after retrieving. Also some of the sediment samples – especially from the bottom of the cores – were washed through a sieve to examine the fossilized foraminifera under the binocular. This offered a little glance into the past or at least into its fauna.





We applied the **multicorer** many times since it was important to have undisturbed surface sediments from all the sampling locations. The device could collect up to 8 mini cores at once. If all of them were filled with sediments, it allowed every interested institution/research group to sample these cores. One core has always been saved for an archive, the rest was distributed between GEOMAR and AWI working groups. Even such easy thing as labeling is important since you needed your attention not to mix up the sample bags, keep an eye on the quantity and order. And you catch yourself thinking how exhausting and stressful the process of the preparation for the cruise must have been. Just imagine: you have to remember about every little thing and foresee the possible accidents or situations! This is something one learns through years for sure, but still deserves respect. Sometimes one or even more cores came up empty and this is one of this unpredictable situations that could appear during the cruise, when the person in charge has to make a decision. In this case it is a decision about dividing samples between the groups. Luckily this doesn't happen often and we hope everyone is happy with their samples.

Some of us have been dealing with the core sampling before. Usually it is the core from the repository, enough time for work and a comfortable lab. The principle for the multi corer sampling is the same – you slice up the core in 1 centimeter intervals trying to be very careful. Sometimes collecting the surface samples separately is essential. Before you start any sampling procedure you have to release the freezing water from the core tube, and it was one of the fun moments you can probably only have in the wet lab.

You always worked in a group of 2-3 people with one core. And this is another thing you learn – team work in the lab. Maybe it is not always easy, but in the end it is nice to see how fast and efficient the sampling can be. For all other activities you also worked with other scientists together and sometimes had to organize the work of your team, decide on the tasks or negotiate. It is a very useful skill which is important not only in the lab but in everyday working life.

Parasound survey has been carried out 24 hours a day, and everybody participated with two hour day shifts or four hour night shifts. They were performed to investigate the sediment structure and to find suitable coring locations (which we did quite successfully).

All in all it was a unique experience to travel to the Arctic –with an icebreaker. We will never forget the infinity of the sea and the midnight sun playing on the ice so beautiful and calm.

We would like to thank ArcTrain and the AWI Bremerhaven who gave us the opportunity to participate in this cruise. We also thank Rüdiger (the chief scientist) for a well-organized cruise and his daily, very informative morning meetings. Last but not least we thank all the participants for a relaxed working atmosphere even during busy times and lots of fun during our spare time.

Image courtesy: Wei Lang, Valeriia Kirillova, Maciej Telesiński, Andre Paul

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