

Transit from Tromsø and first research operations in the Northeast Greenland area

[14. August 2018]

The cruise PS115.1 on Polarstern focuses on a geoscientific research program, which has the aim to clarify the geological development of the northern North Atlantic and the shelf area of the surrounding regions.



New samplings of near-surface seabed sediments help to reconstruct the sediment basin development since the opening of the Arctic ocean almost 60 million years ago. Additionally, analysing microbiological communities in the Arctic sediments is part of the working program.

Models explaining the sedimentary basin evolution of the Arctic ocean not only hold information for science but also help establishing a verifiable rating of the resource potential of this so far poorly evaluated area. There are incomplete data bases concerning risk assessment in the possible future usage of those resources. The BGR Hannover's aim of the GREEMATE project which is conducted in cooperation with AWI Bremerhaven, UFZ Leipzig and the University of Bremen is to contribute to both topics. Furthermore scientists from GEOMAR Kiel, further AWI work groups and scientists of the Laboratory of Polar Ecology Bruxelles are on board to work on additional projects.



*Outcome of a successful sampling with the dredge
(Photo: Sophie Peschke)*

All scientific instruments had been installed by the PS115.1 participants during the three day stopover of RV Polarstern in Tromsø. Preparation works could be completed and all permissions concerning the scientific research had been granted well in time, so that PS115 started towards the destination area, which had been estimated to be about 450 sea miles away. Very contrary to the summer

heat at home, the temperatures in the research area were expected to be only a little bit above the freezing point.

The required transit time was filled with the obligatory security and rescue instructions, as well as all necessary preparations for the survey operations in the dedicated research area.

Before reaching the Greenlandic waters, the actual research area, a first geological sampling on the East Greenland Ridge was conducted. A successful dredge-pull delivered an unexpected amount of sampling material, which is going to be used for the petrographic

analysis and age determination to understand the genesis of the ridge structure. In the course of the first week we have continued the geological sampling on the adjoining shelf with the gravity corer as well as the multicorer. The gained material will be used by the different groups on board. Accordingly, the reviewing of the material for the following geomicrobiological, organic-geochemical, and further sedimentological investigations is very diverse. While the geological and chemical labs were busy since the middle of the week, the geophysical group was testing individual scientific instruments. After completing the testing on Thursday the first seismic streamer of 600 meter length was deployed and recorded the first seismic profile heading West until the nearshore. We were expecting increasingly thick ice, thus we wanted to gather experience first in case of expected collision caused by changing ice conditions in order to deal fast and safely to prevent damage on any of the instruments. Thanks to the colleagues from German Weather Service on board we have a daily weather and ice forecast available. Unfortunately, the prevailing weather situation with fog does not provide good framework conditions for seismic operations with long towed equipment which demands good visibility in ice covered areas. An interruption of seismic profiling on the following day due to a necessary repair of the airguns was used for another sediment sampling on the surrounding flat shelf regions. After 24 hours the geophysical profiling could be resumed on a profile parallel to the coast towards the North.



Deployment of the seismic streamer (Photo: Sophie Peschke)

Since the ice conditions for the further profiling towards the North are promising, it was decided that the seismic streamer could be extended to 3000 meters to allow for a better data quality. Since Sunday afternoon the marine geophysics is continuously acquiring seismic, magnetic and gravity data, which will come to an end when reaching the 81st degree of the Northern latitude. Our operations are

supervised by two contracted marine ecologists of the company Seiche/UK to ensure minimum impact of our activities on the marine wildlife, such as whales. They are also ensuring that all regulations and requirements for mitigation measures of the Greenland authorities are being adhered to.

On board everyone is doing just fine.

Best regards on behalf of all colleagues on Polarstern

Volkmar Damm

(12.08.2018 Position 80°15'N, 6°51'W)

Geophysics in the fog and an exciting sediment core

[20. August 2018]

In week two of our four weeks of expedition we have continued our reflexion seismic work in the Northern Greenland Sea.



The decision to extend our streamer to the maximum length was provoked by very fortunate ice conditions and turned out to be right.



Logo_PS115.1.jpg (Photo: Alfred-Wegener-Institut)

Fig. 1: A sediment core is brought to the lab for further analysis. (Photo: Martin Krüger)



Fig. 2: The box corer is retrieved after successful extraction of samples. (Photo: Michael Schauer)





Fig. 3: Teams of geologists are preparing to be flown to the near coastal outcrops. (Photo: Thomas Funck)

Thanks to the good weather and ice condition forecast, as well as the predictive and safe ship navigation any collision of our dragged 3 km streamer and drifting ice flows or smaller ice bergs (growler) could be avoided. Besides seismics, other geophysical methods like gravimetry and magnetics could be deployed, giving us further insight to the sub-seafloor structures of the only 150 - 300 meters deep shelf

area. With the collected data we aim to image the over 11 kilometers of sediment in the Danmarkshavn Basin to define the 300 million years that shaped the deep, coast parallel sedimentary basin. Observed upwards propagation of older salt diapirs into stratigraphically younger layers hint on passed deformation processes and explain zones of weakness, which can be brought in coherence with the opening of the North Atlantic over 55 million years ago.

Our goal is not only the reconstruction of the basin's geological evolution, but also to determine the extent of transformation of organic material to hydrocarbons since its deposition. After having collected seismic profiles with a total length of nearly 1000 kilometers, the continuous geophysical work came to a scheduled hold and geological sampling was recommenced in the night of Wednesday to Thursday.

So far, dense fog has been our companion, making helicopter missions impossible. However a forecasted, short good weather period with clear skies had us expecting good flying conditions on Friday. Whilst the station work on board of Polarstern continued outside of the 12-miles-zone, one of the two helicopters repeatedly took teams of geologists to the coastal area for sampling. The gathered sediment- and bedrock samples are to contribute the same, already discussed, objective as the marine sediments.

For the GEOMAR colleagues, who are working on reconstructing the environmental and climatic evolution of the last 150.000 years, long sediment cores are essential. Therefore the extraction of a 9.09 meters long - and thereby possibly record-breaking - sediment core on Saturday was a huge success. This together with the so far highly successful first half of the cruise provided a good reason to celebrate the cruise summit together with the ship's crew.

Everyone on board is doing fine.

On behalf of all colleagues

Volkmar Damm

Position 83°42'N, 24°30'W

Surprising ice conditions favor measurements further north

[27. August 2018]

The second half of our cruise started with a northwesterly directed transit. To follow the originally planned seismic profiles we would have had to cross an ice field of approximately 40 nautical miles.



This would have posed as a great threat for our dragged streamer and airguns, leading us to the decision of aborting the original profile plans for ones further north in hope of better ice conditions.

Larger ice-free areas north of 83°N are highly unusual, hence science program at that latitude was not considered in the planning prior to the cruise. Anyhow, satellite data showed a 50-100 kilometers large ice-free surface (seasonal polynya) of the northeastern coast of Greenland caused by katabatic winds that originate from the Greenlandic ice cap and push away coastal ice.

Seeing this as a spectacular opportunity to survey unmeasured areas up to more than 84°N in the Lincoln Sea, we restarted seismic profiling with the 3 kilometer streamer after leaving the mentioned ice field behind at 83°N on Sunday morning.



Fig. 1: Sea ice patches off Cape Morris Jesup make it difficult to continue surveying with the geophysical equipment towed behind the vessel. (Photo: Thomas Funck)

Of special interest for us was the Morris Jesup Rise, a sub-seabed structure that corresponds with the 500 kilometer distanced Yermak Plateau on the other side of the Gakkel ridge. Their possibly continental origin as also the process of their movement during the opening of the Arctic Ocean to their present position is subject of great discussion and essential for the reconstruction of regional geological developments.



Fig. 2: The airgun array is prepared for deployment to subsequently generate signals for the refraction seismic survey. (Photo: Viktoria Timkanicova)

At 84°18.73'N we reached the end of the BGR's most northerly reflection seismic profile so far. Thickening ice made us shift our work westwards to the eastern Lincoln Sea, where helicopter borne ice reconnaissance promised better working conditions.

After finishing four more seismic profiles in the eastern Lincoln Sea on Tuesday, reflection seismic was paused and all outboard devices were retrieved until midnight the following day.

In addition to the reflection seismic data, that depicts the shallower crust, a refraction seismic profile was collected, consisting of 9 equally spaced (10 km) ocean bottom seismometers (OBS) for further insight to deeper crustal structures such as the boundary of Greenland and the Morris Jessup Rise.



Fig. 3: An ocean bottom seismometer surfaced close to a sheet of ice. (Photo: Thomas Funck)

Fig. 4: Sediments samples are being collected at selected locations along the coastline logistically supported by the vessel's helicopter. (Photo: Sophie Peschke)

We terminated the profile Wednesday evening and began the, because of the ice, challenging retrieval of the OBSs. In this we were fully successful thanks to the perfect preparation and programming of the OBS and essentially the experience of the deck's crew and the nautical officers, our special regards go to captain Wunderlich and his crew.



Without a break the program switched directly to geological sampling, including gravity corers and box corers to analyse local marine sediment before RV Polarstern headed west to a position approximately 40 nm away at which dredging of rock of the Morris Jessup Rise was scheduled.

Satellite pictures had already implied that driving through ice would be necessary to reach our destination. Yet strengthening northerly winds changed the ice conditions so significantly and rapidly that an estimation of transit time grew increasingly unpredictable, thus we had to

drop the dredging location (approximately 15 nm away from the location) to not risk a delay of our arrival in Longyearbyen.

As an alternative we changed our course to the mainly ice-free Wandel Sea at the northeastern tip of Greenland at which we arrived on Saturday after a 200 nm transit.

Surprisingly we had radio contact with the Canadian icebreaking bulk carrier Nunavik on its way toward the Lincoln Sea for reconnaissance surveying, from which one can derive that the additional pull back of Arctic ice probably sometimes opens the northern route around Greenland to Baffinbay resulting in an additional Arctic seaway in the future.

With the best of wishes from board

On behalf of all colleagues

Volkmar Damm

Position 80°52'N, 03°25'W

Last work in the northeastern Greenland Sea in the final week of the cruise

[03. September 2018]

After returning to the part of the Wandel Sea just off the coast of Kronprins Christian Land, the northeasternmost point of Greenland, station work started including heat flow measurements and sediment sampling (box corer and gravity corer).



Additional helicopter flights were planned to proceed with on land sampling in the permitted area around 120 km away, unfortunately these plans had to be aborted because of heavy fog that only cleared for a brief period of time. Said time window was too short to cover the distance of 120 km in a helicopter and a Narwhale protection area made it impossible to shorten the necessary flight distance by moving the ship closer to the shore. For that reason geological sampling was postponed to the next good weather window and we switched over to reflections seismic measurements.



Fig. 1: Fields of sea ice in front of Kronprins Christian land- a polar bear eating his prey. (Photo: Christian R. Rohleder)

After deploying 3000 m of Streamer and maintenance work on our air guns we started acquisition of reflection seismic profiles in the Danmarkshavn Basin. We hope these perpendicularly orientated profiles of the basin with its up to 15 km of sediment thickness will not just enable us to reconstruct the opening of the North Atlantic but also to determine the

relationship of the northeast Greenland shelf to the Barents shelf.

Fig. 2: One of three weather balloons that ascend daily during PS115.1 as part of the co-user's project YOPP. (Photo: Kai Berglar)

As a consequence of steady technology and ice observation helicopter flights, reflection seismic measurements were continuous over the last week of the cruise, undisturbed of ice fields with coverage of 7/10 that could be found to our west and east. Solely the dragged magnetometer could not be used part of the time, since the ice bared too great



a danger for it. The mission to retrieve a GPS-Station from the TU Dresden and Collection of more Samples on land was given up, due to the absence of suitable weather for flying.

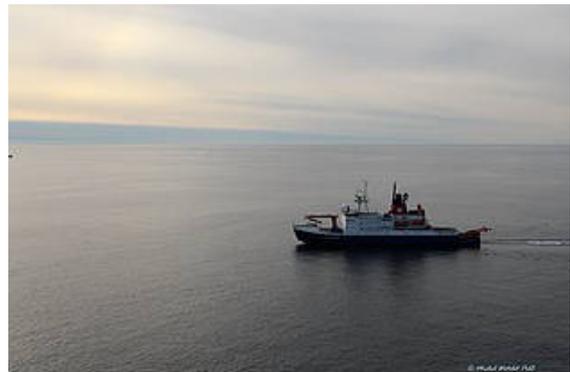


Fig. 3: Geological sampling ended successfully. (Photo: Michael Schauer)

Even still, we are very content with the outcome of the cruise and met more than just our expectations thanks to lucky ice conditions and the great motivation and work from everyone.

Fig. 4: RV Polarstern in the mainly ice free Greenlandic sea at 78°N. (Photo: Michel Watelet)

Our special Thanks go out to Captain Wunderlich and his crew not just for the competent collaboration but also their friendly support that essentially contributed to the success of the cruise and made it a very pleasant experience for all.



PS115.1 in a nutshell:

- 2523 km reflection seismic profiles, of which 2250 km were collected with a 3km long streamer up to 84°20'N
- A 100 km refraction seismic profile using 9 ocean bottom seismometers
- 1582 km of magnetic profiles
- Continuous gravimetric and bathymetric data acquisition
- 7 heat flow measurement stations
- 21 geological sampling sites were chosen, with all together one dredge (around 200 kg of sample), 16 gravity cores (total core length 65 m), 12 box corer and 6 multi-corer stations
- 18 onshore sampling sites, of which 7 were for hard rock samples with a weight of approximately 250 kg
- Complete execution of the co-user's science program on board

After one day of transit, the cruise PS115.1 will end in Longyearbyen/Svalbard on Monday morning.

One last time, best of wishes from Polarstern

On behalf of all on board

Volkmar Damm

Position, 76°7'N, 5°41'W