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CRUISE REPORT

CAGE, OA and Paleo-CIRCUS cruise to Northwest Norway, Jan Mayen and East Greenland:

on R/V Helmer Hanssen, June 23rd to July 7th 2013

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1. Summary

From the morning of June 23rd to the morning of July 7th 2013, the Department of Geology of the University of Tromsø, Norway, arranged a scientific cruise aimed at investigating the western Northern Norwegian margin and the central Nordic seas and east Greenland margin| on R/V “Helmer Hanssen”. Investigated areas were (in order of visiting sites on the cruise): the northwestern Norwegian Sea margin to north of Jan Mayen, and the western Greenland Sea north and off Scorebysund (for locations see Fig. 1). The scientific sampling was done within the framework of ongoing projects at the Department of Geology, University of Tromsø: “CAGE (CoE): Arctic Gas Hydrate, Environment and Climate”, hereunder the projects “OAFS-Ocean Acidification Fram Strait” and “Paleo-CIRCUS” (see below).

A total of 12 gravity cores, 5 piston cores and 9 multi-cores (with a total of 27 sub-cores retrieved), 15 plankton net casts and 20 CTD (conductivity-temperature-depth) casts were performed at the western Barents Sea slope, and the Barents Sea.

>44 chirp profiles and multibeam echo sounder lines were acquired during transits and during surveys of potential core sites.

-4 seismic lines using GI mini airgun

2. Background

During the cruise, data were collected for the following projects:

- Two projects in the framework of **CAGE, Centre for Arctic Gas Hydrate, Environment and Climate**:
 - **OAFS (“Ocean Acidification; Effects of ocean chemistry changes on planktic foraminifera in the Fram Strait: ocean acidification from natural to anthropogenic changes”)**. The overall purpose of the project is to study the preservation patterns of planktic foraminifera (living, recently settled, subrecent and fossil) within and below Atlantic-, Arctic-, and Polar surface water along the Barents Sea-Svalbard margin and the Barents Sea compared to natural and anthropogenic variations in climate at present and in the past during the last 30,000 years BP. For the project we aim to collect gravity and multicores and plankton net samples and CTD records and water samples at a transect from Lofoten, the Vøring Plateau across the Nordic seas via Jan Mayen to the east Greenland slope.
 - **Paleo-CIRCUS (“CO₂ and the ocean circulation system: Natural variations in CO₂ and climate during the last interglacial-glacial cycle”)**. The overall purpose of the project is to study and reconstruct the exchange of Atlantic surface water and polar water along the Svalbard margin compared to natural variations in climate in the past during the last 150,000 years BP and on millennial time scale. Focus is given on calculating the CO₂ concentration in the ocean and atmosphere compared to ocean circulation intensity, ocean acidity and paleoproductivity in past climate conditions during interglacials that were warmer than today and glacials that was colder than today and before human influence as well as during the most recent times of global warming. For this project we aim to collect piston-, and gravity and multicores and CTD records as well as acoustic and seismic data.

3. Objectives

The objectives of the cruise were:

- To collect gravity- and multicore cores in high-resolution, undisturbed sediments of the slope of northwestern Norway following the ridge via Jan Mayen into Greenland territorial waters to collect samples on the East Greenland margin to obtain sediments for the above three projects of paleostudies
- To collect plankton samples and sediment-surface samples with the purpose of studying the content of living and sub-recent planktic foraminifera and the conditions of their shells in order to elucidate the effect of CaCO₃ preservation on the living and recently dead planktic foraminifera in connection with recent and subrecent anthropogenic changes.
- To acquire swath-bathymetry, chirp data, and seismic data to form the basis for pinpointing core sites with undisturbed sediments and to link the core data with the sedimentary history and setting.

4. Participants

Crew R/V "Helmer Hanssen":

Captain:	John K. Almestad
Vice captain:	Inge Berg
Chief engineer:	Samal Jacup Isaksen
Second engineer:	Odd Erik Jensen
Boatswain:	Oddmund Kopperstad
Boatswain:	Stig Eliassen
Able seaman:	Lars Brunnes
Able seaman:	Stein Einar Hansen
Able seaman:	Oskar Torgersen
Stewart:	Svend Krøyserth
Galley assistant:	Steven Andresen
Navigation student:	Øyvind Andersen

Scientific crew:

Participants	Affiliation
Rasmussen, Tine Lander (Professor; chief scientist)	UiT
Tove Nielsen (Senior researcher; co-chief scientist)	GEUS
Katarzyna Zamelczyk (post doc; co-chief scientist)	UiT
Steinar Iversen (Engineer)	UiT
Antoon Kuijpers (Senior researcher)	GEUS
Mohamed Ezat, PhD student	UIT
Eleen Zirks, BSc student	UIT
Manon Chaillan, BSc student	UIT
Kate Salmon, PhD student	OU
Ewa Lind, PhD student	SU
Marco Melita, Scientist	UM
Elina Bertell, MSc student	UH
Soma Baranwal, Post doc	NGU

UiT = University of Tromsø, Norway
NGU = Geological Survey of Norway

GEUS = Geological Survey of Denmark and Greenland
SU = Stockholm University
UM = University of Messina, Italy
UH = University of Helsinki, Finland
OU = Open University, UK

5. Equipment

Acoustic equipment

- Kongsberg Maritime EM 300 multibeam echo sounder
- EdgeTech 3300-HM hull-mounted sub-bottom profiler ("Chirp"); 4*4 arrays
- Kongsberg Maritime EK60 splitbeam echosounder (18, 38 and 120 kHz)
- One Sercel GI mini airgun (45 cubic inches) and Fjord Instruments single-channel streamer (6 m active section with 20 hydrophones)

Sediment sampling

- Gravity corer (total weight 1900 kg; 6 m steel barrel; inner diameter of steel barrel: 11 cm)
- Multi corer (MC) KC model 72.000 with 6 core liners (1 m length each)
- Piston corer (total weight >2000 kg, 12m steel barrel, inner diameter 11 cm)

Water properties:

- CTD (Seabird 911 Plus) with compact rosette with water samplers

Plankton net:

- Type WP-2 net from HydroBios

6. Methods

Sediment sampling

Gravity-cores and piston cores were retrieved from the northeastern Norwegian Sea slope, and the Greenland Sea. Plastic liners with an outer diameter of 11 cm (inner diameter: 10 cm) were put into the steel barrel. After retrieval, the plastic liners were cut into sections of up to 100 cm length. They were covered with plastic caps, taped, labelled and stored at +4°C.

Multi-cores cores were retrieved from the northeastern Norwegian Sea slope, central Norwegian and Iceland Seas and Greenland Sea. 6 plastic tubes with 10 cm inner diameter were intruded into the sediments. 1 or 2 tubes were subsequently sub-sampled in 1 cm and/or 0.5 cm intervals, respectively, to a depth of 5 or 10 cm. The samples were preserved in alcohol (96%) with Rose Bengal in order to stain the living foraminifera. One multicore was stored in the cooler for later diatom studies and one was stored in the freezer for almost each station.

Plankton sampling

Plankton nets were cast at all sites for capture of planktic foraminifera for investigations. Mesh size were 90 micron. Samples were preserved in 96% alcohol with Rosa Bengal and buffered with Disodium Hydrogen Phosphate and Sodium Hydrogen Phosphate. The tows were done at 50 m and 100 m.

Water properties

The water properties – temperature, salinity – were measured at all sites using a *Seabird 911 Plus* CTD. Data collection was performed during downcasts at a speed of approx. 1.0 m/s. The data of selected CTD stations were used for records of modern water mass properties records for the paleo-studies and studies of living planktic foraminifera and to calculate sound-velocity profiles for calibrating the multibeam echo sounder system.

Water sampling for water chemistry analyses

Water sampling for chemistry analysis has been undertaken at x CTD stations; 7 of these stations Sampling occurred in 200ml glass vials with were poisoned by HgCl to stop all bacterial activity. Alkalinity, 18O, Boron isotope ratio will be analyzed at AWI, Germany and at the Polar Institute, Tromsø.

Sample depth varied at each station.

Acoustic investigations

Seafloor mapping:

Swath-bathymetry surveys were carried out using a *Kongsberg Maritime EM 300 multibeam echo sounder*. Sound-velocity profiles of the water column for calibrating the equipment were recorded from CTD casts where necessary. Swath-bathymetry data was also collected during the transits between working areas and stations. The equipment worked well during the acquisition and the data are of good quality. Some preliminary data cleaning was performed using the software programme *Neptune* version 6.6.

Acoustic and seismic profiling:

High-resolution seismic profiles (Chirp), using an *EdgeTech 3300-HM* hull-mounted sub-bottom profiler, were collected along the ship tracks during the swath-bathymetry data acquisition as well as during transits. Pulse mode and shot rate were varied, depending on the water depth. The equipment worked well and the data are generally of good quality.

After the departures soft starts of the Chirp system were performed, starting with 1% of the total effect, followed by a doubling of the effect every minute. No marine mammals were observed during seismic acquisition. We saw whales near the south end of Jan Mayen on the 4th of July in the afternoon on transit.

Air-gun seismic data were collected with a *Sercel* GI gun attached to a metal array. The reflected signal was received with a single channel *Fjord Instruments* streamer containing a 10 m long dummy section and a 6 m long active section with 20 hydrophones. The air gun and streamer were towed 65 and 60 m behind the vessel, respectively. The equipment worked excellent, and data are of good quality.

7. Preliminary results and outcome of the cruise

Scientific goals:

In general, because of the generally good weather all planned stations were done with plankton net, multi,- gravity,- and/or piston coring. Some stations we had to abandon because of either bad weather or sea ice, but we could return to most of them and finish the sampling plan. The acoustic survey of Scoresbysund Fan had to be postponed 24 hours due to sea ice conditions. We succeeded in getting all wanted CTD's in the end and plankton net tows for the Ocean Acidification project with the required associated sediment sampling at practically all planned stations.

7.1 OA-Ocean Acidification

A total of 19 stations were visited (3 stations twice) and 20 CTD casts were done spanning the Atlantic, Arctic, and Polar water zones from west Norway over Jan Mayen to East Greenland. A total of 15 plankton net tows with generally two or three casts at each station were performed (to 50 m water depth, 100 (East Greenland, only), and 200 m water depth in the water column). The content was sieved onboard and preserved in alcohol with Rosa Bengal and buffered with Disodium Hydrogen Phosphate and Sodium Hydrogen Phosphate. A total of 9 multi-cores (three were collected). The samples will be analysed at the Department of Geology, University of Tromsø by a post doc as part of ongoing research within the OA-program (financed by the NFR). Water samples were taken at xx stations (xx full stations with 12 samples and xx stations with one or two samples) to be analysed later onshore.

7.2 Paleo-CIRCUS

A total of 12 gravity cores and 5 piston cores were collected in slope sediments for the study of paleoceanography and climate from the last interglacial to today (last 150,000 years). The long piston cores from East Greenland is expected to reach into the Saale glacial (>130,000 years BP). The cores from Lofoten Drift and the Vøring Plateau are expected to record the last glacial maximum in high detail. Acoustic surveys give an overview of the sedimentary history and setting for the coring.