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CRUISE REPORT

CAGE-18-3 Cruise to the Barents Sea, Storfjorden Trough, East Greenland Ridge (Leg 1, 2), Arctic Ocean Vestnesa Ridge, and PKF, (Leg 3)

on R/V Helmer Hanssen, June 29th – July 19th, 2018

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1. Summary

From the evening of June 29th to the evening of July 10th 2018, CAGE at the Department of Geology Uit, the Arctic University of Norway, arranged a scientific cruise aimed at investigating methane seep sites by surface sediment sampling, sediment core sampling, plankton sampling and water sampling. The areas for investigation were the Barents Sea (Crater area), Storfjorden Trough (Pingo area), East Greenland Ridge (non-seep, for IODP-proposal) (Leg 1 and 2) and the western Svalbard margin, Vestnesa Ridge, Arctic Ocean and Prins Karls Forland (Leg 3) on R/V “Helmer Hanssen” (Fig. 1). The scientific sampling was done within the framework of several ongoing projects at the Department of Geology, University of Tromsø: “CAGE - Centre for Arctic Gas Hydrate, Environment and Climate”-WP6: “Methane Release, Ocean Acidification and CO₂” hereunder ocean acidification impact on marine calcifiers (planktic foraminifera and pteropods, methane seeping impact on ocean acidification and productivity, the state of the inorganic and organic biological pump from foraminifera, bottom water temperature change and impact on release of methane, living benthic microfauna studies from seep sites for geochemical investigations for calibrations for paleostudies.

A total of 15 gravity cores (c. 60 m), and 31 CTD (conductivity-temperature-depth) casts were performed, 11 plankton net (no. 12 failed because the net was torn completely), 22 boxcore samples x 6 surface samples for each. A total of 137 lines of acoustics and seismics together were performed.

Chirp profiles and multibeam lines were acquired during transits and in surveys (mapping of new seep sites northeast of “Crater” area, seep sites in Storfjorden Trough, East Greenland Ridge, seeps in Hinlopen trough and Norske Banken, the east slope of Yermak Plateau, active and inactive pockmarks at Vestnesa Ridge and a small patch off PKF for WP4 .

All acoustic and seismic investigations were performed with soft-start of all instruments (Echo-sounders, deep-penetrating echosounder (‘Chirp’), Multibeam echosounder and mini-airgun).

2. Objectives

The objectives of the cruise were:

- To collect CTD and water samples from the entire planned study areas for water properties and chemistry for ocean acidification studies.
- To retrieve plankton net samples for the study of planktic foraminifera and their preservation in relation to seeping of methane and ocean acidification
- To retrieve gravity-cores from active pockmarks of methane gas seepage in order to study the pore water and sediment records at new and previously investigated sites, at new sites to investigate foraminiferal-fauna assemblages in past and present environments affected by release of methane and reconstruct variations in activity of methane seeping in relation to climate and deep water temperature change
- To collect high resolution cores from contourites for bottom bottom water temperature reconstructions in relation to climate change and methane seepage
- To study (and find) new seep sites
- To retrieve box cores for surface samples for living benthic foraminifera and the geochemistry of their shells for calibration for paleostudies

3. Participants

Leg 1 and 2:

Scientific crew:

Name	Affiliation
Rasmussen, Tine Lander (Professor; chief scientist)	UiT
Tove Nielsen (co-chief scientist)	GEUS
Truls Holm (Engineer)	UiT
Steinar Iversen (Engineer)	UiT
Siri Ofstad (phd-student)	UiT
Naima El Bani Altuna (phd-student)	UiT
Emmelie Åström (post doc)	UiT
Cheshtaa Chitkara (Master student)	UiT
Anna Mamadzhanian (Bachelor student)	SPU
Anastasiia Frolova (Bachelor student)	SPU

UiT = Uit, the Arctic University of Norway

GEUS= The Geological Survey of Denmark and Greenland

SPU: Sankt Petersburg University

Leg 3:

Name	Affiliation
Rasmussen, Tine Lander (Professor; chief scientist)	UiT
Tove Nielsen (co-chief scientist)	GEUS
Troels Laier	GEUS
Truls Holm (Engineer)	UiT
Steinar Iversen (Engineer)	UiT
Siri Ofstad (phd-student)	UiT
Naima El Bani Altuna (phd-student)	UiT
Arunima Sen (post doc)	UiT
Cheshtaa Chitkara (Master student)	UiT
Anna Mamadzhanian (Bachelor student)	SPU
Anastasiia Frolova (Bachelor student)	SPU

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4. 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)
- Mini-air-gun (*Sercel* GI)

Sediment sampling

- Gravity corer (total weight 1900 kg; 6 m steel barrel; inner diameter of steel barrel: 11 cm)
- Giant box corer (50*50*50 cm³)

Water properties:

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

5. Methods

Sediment and pore water sampling

Sediment sampling was done by box coring and gravity coring to retrieve surface samples and sub-recent samples, respectively.

Water properties

The water properties – temperature, salinity – were measured at every sampling station and at regular intervals using a *Seabird 911 Plus* CTD. Data collection was performed during downcasts at a speed of approximately 1.0 m/s. The data of selected CTD stations were used for records of modern water mass properties and nutrient records for ocean acidification studies. CTD stations were also taken at intervals to calculate sound-velocity profiles for calibrating the multibeam echo sounder system. Water samples were taken on a regular basis for water chemistry analyses for acidification studies.

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.

Sub-bottom 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 during transits. Pulse mode and shot rate were varied, depending on the water depth. Soft start of the chirp was performed well out in the Barents Sea on day two, starting with 1% of the total effect, followed by a doubling of the effect every minute. The equipment worked well and the data are generally of good quality.

Echo-sounder flare observation

The echo-sounder installed on RV Helmer Hanssen was planned to be used to detect gas bubbles rising from seep sites at the seafloor on transits and on site surveys.

7. Preliminary results and outcome of the cruise

Scientific goals:

In general, despite occasional bad weather and ruined plankton nets, we met most of our goals for the cruise, especially because of exceptionally good weather conditions for most of the time at Vestnesa (winds almost zero), we were able to sample all five pockmarks with the gravity and boxcorer, necessary for core and surface samples for PhD students and post docs. We managed to sample the crater area and Pingo areas (Barents Sea and Storfjorden Trough), in fairly poor weather conditions and do a survey of the areas with chirp and multibeam. North of Svalbard we surveyed two seep areas, also in poor weather conditions, but had good weather for mapping and sampling the eastern flank of Yermak Plateau slope into Sofia Deep, going further north to almost 81.40N.

CAGE projects:

We obtained most of the planned samples. 83 stations were done with CTD, water samples, plankton net for planktic foraminifera and chlorophyll, boxcoring and gravity coring, samples were collected for porewater, sediment and TOC and TC analyses, foraminiferal and macrofaunal analyses and their geochemistry. All route was covered by echosounding, chirp, and multibeam and seismics were done at selected areas. 31 CTD casts were performed, 11 plankton net (no. 12 failed because the net was torn completely), 22 boxcore samples x 6 surface samples for each, and 15 gravity cores were retrieved in total for the projects. CTD's were taken to analyse water properties and gravity core stations for pore water and gravity core sediment samples for sulphate-methane and TOC, and for foraminiferal and geochemical analyses. Boxcore samples were taken for microfaunal (foraminifera) analyses and their geochemistry. Plankton samples were taken for the analyses of planktic foraminifera and effects of ocean acidification on calcareous planktic organisms. A total of 135 lines of acoustics and seismics together were performed.