

CAGE17-1-Leg 2 cruise report

R/V Helmer Hanssen, May 17th – June 2nd, 2017

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Steinar Iversen and Bjørn Runar Olsen contributed with data processing and handling of acoustic CTD equipment connected with this cruise. All cruise participants contributed to the collection of the data. They are all warmly thanked for their great contribution to make this cruise a great success.

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1. Summary

From the afternoon of May 19th to the early morning of June 2nd 2017, CAGE-WP6 at the Department of Geology Uit, the Arctic University of Norway, arranged a scientific cruise aimed at investigating sediment cores and porewater, and water masses, at the western Svalbard margin, Fram Strait, East Greenland Ridge, and Storfjorden Trough, visiting methane seep sites off Vestnesa Ridge, and in Storfjorden Trough on R/V “Helmer Hanssen”. Investigated areas were (in order of visiting sites on the cruise): Prins Karls Forland (PKF) (overlap with ‘leg 1’ 17th to 19th of May – see Leg 1 report), southern Yermak Plateau, Vestnesa Ridge, East Greenland Ridge, Storfjorden Trough and Storfjorden (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”. Planned surveys north of Svalbard was abandoned due to extensive sea ice cover and the East Greenland Ridge was surveyed instead. Sea ice over outer Vestnesa prevented surveys there and Storfjorden trough was also completely covered, but the sea ice broke up towards the end of the cruise and thus could be surveyed during the very last part of the cruise.

A total of 15 gravity cores (c. 60 m), and 20 CTD (conductivity-temperature-depth) casts were performed along the western Svalbard margin (Vestnesa and PKF and Yermak). Data were also collected at East Greenland Ridge and in Storfjorden Trough and Storfjorden, brine overflow was detected. The CTD casts and chirp- and multibeam lines from PKF May 17-19th are reported in the cruise report for Leg 1.

Chirp profiles and multibeam lines were acquired during transits and in surveys (mapping of East Greenland Ridge, moraine systems and basins in Storfjorden Trough, active and inactive pockmarks at Vestnesa Ridge and over and to find potential core sites.

2. Background

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

- **CAGE – Centre of Arctic Gashydrate, Environment and Climate-“WP6-Methane Release, Ocean Acidification and CO₂”**, The overall purpose of the project is to study and reconstruct the emission of methane through time in relation to past climate change. The majority of gravity cores at Vestnesa are aimed to get pore water and sediment samples for sulphate-methane and TOC measurements on sites of previously investigated cores with stable isotope records and at new sites. The purpose is also to study the development of deep-ocean temperature at seep sites in relation to release of methane and climate in the past and changes in ocean circulation by reconstruction of bottom current strength in different depth transects in the Nordic seas from shelf to deep sea (3D) in relation to climate change through time (4D).

3. Objectives

The objectives of the cruise were:

- To collect CTD and water samples from the entire planned study areas for water properties and chemistry. In Storfjorden also brine overflow will be studied by CTD

- 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 current variations in relation to climate change
- To study the brine formation in Storfjorden during winter conditions with CTD and water sampling - part of ongoing projects since 2002

4. Participants

Scientific crew:

| Name | Affiliation |
|---|-------------|
| Rasmussen, Tine Lander (Professor; chief scientist) | UiT |
| Tove Nielsen (co-chief scientist) | GEUS |
| Troels Laier (co-chief scientist) | GEUS |
| Bjørn Runar Olsen (Engineer) | UiT |
| Steinar Iversen (Engineer) | UiT |
| Fatih Sert (phd-student) | UiT |
| Pär Jansson (phd-student) | UiT |
| Pavel Serov (phd-student) | UiT |

UiT = UiT, the Arctic University of Norway

GEUS= The Geological Survey of Denmark and Greenland

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)

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

6. Methods

Sediment and pore water sampling

Sediment sampling was done by gravity coring to retrieve surface samples and sub-recent samples. Core liners were prepped for pore water sampling by drilling holes every 10 cm. Sediment were sampled at core ends and through the drilled holes with syringes. The first sample for methane analyses (also GEUS labs), and a second sediment sample for TOC, TC and S

(Tromsø lab) in each hole. Pore water was sampled at regular intervals with Rhizon filters to measure content of sulphate at GEUS labs.

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 the paleo-studies and to calculate sound-velocity profiles for calibrating the multibeam echo sounder system. Water samples were taken on a regular basis for water chemistry analyses (WP-4 of CAGE).

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. The multibeam was started late on day two after the first CTD for calibration. Weather had not permitted a CTD to be taken before that time.

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 over the shelf edge 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 off PKF (see Cruise Report Leg 1, 17-19th of May, 2017) Vestnesa and in Storfjorden Trough.

7. Preliminary results and outcome of the cruise

Scientific goals:

In general, because of good weather conditions stations most planned stations at Yermak Plateau and Vestnesa were visited however, sea ice prevented us from sampling outermost Vestnesa Ridge. The plan to go north of Svalbard could not be performed due to solid sea ice and instead we mapped the southern and central part of the East Greenland Ridge – the northern part could not be reached because of sea ice. Only in Storfjorden Trough were we met with sea ice with bad weather on top – much as we are used to. We managed to sample the flare area and do a survey of the area with chirp and multibeam, before weather stopped us. A small CTD survey was performed in the trough and southern Storfjorden to ride out the bad weather in the calmer condition in the ice. Brine overflow were recorded at most stations. Despite continuing poor weather conditions in Storfjorden Trough, we managed to do a chirp and multibeam survey of Storfjorden mid-ridge.

706 samples were collected for porewater, sediment and TOC and TC analyses, 5 bottles were collected with brine at one station and almost 60 m of sediment cores were collected.

CAGE projects:

20 CTD casts were performed, 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 sediment samples for sulphate-methane and TOC for the CAGE- "WP6-Methane Release, Ocean Acidification and CO₂".

The collected material will be analysed at the Department of Geology, UiT, the Arctic University of Norway, as part of ongoing research (seniors, researchers, Post docs, Phds) and also form a basis for future master, PhD and post doc studies a.o. Pore water samples and sediment samples will be analysed for pore water chemistry at the Geological Survey of Denmark and Greenland (GEUS, Copenhagen, while TOC and S will be done in Tromsø.