DANMARKS OG GRØNLANDS GEOLOGISKE UNDERSØGELSE RAPPORT 2012/99

Surveying for Gashydrates offshore Central West Greenland

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1. Introduction and Objectives

The MAGAS cruise with the Greenlandic research vessel R/V Paamiut took place in July 9th to 17th, 2012 and focused on the Disko region offshore central West Greenland. The purpose of the cruise was to locate and sample methane found as free gas or gashydrates in the sub-seabed, and detect possible seepage in to the water column. In order to meet these objectives, seismic and acoustic investigations were made to locate the possible gas loaded sites and seeps by their acoustic characters, followed by sediment sampling at these sites.

MAGAS stands for 'Marine Permagas', and is a contribution to the Danish Geocenter research project "*Impact on permafrost, gashydrates and periglacial processes following climate changes in Greenland* (Permagas)". The survey plan for the MAGAS cruise was based on the results of a Permagas pilot cruise performed in 2011 (GEUS report 2011/105).

The MAGAS cruise also contributed to the Norwegian research project "*Methane release and past climate change",* which objective was pursued by sub-sampling of the collected sediment cores for investigation of the foraminiferal fauna.

The MAGAS cruise was favoured by calm weather, though with fog and large icebergs

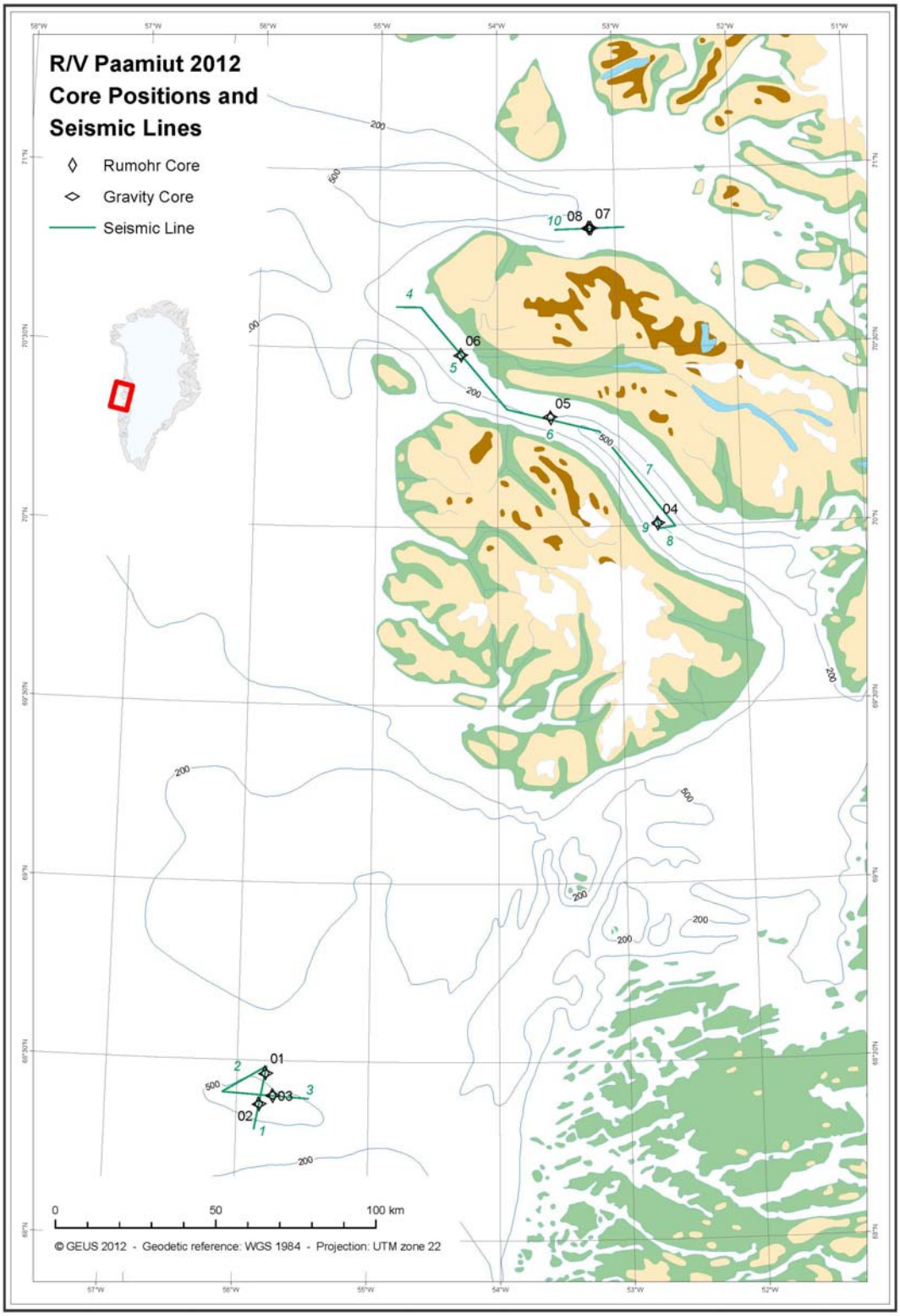

Figure 1 MAGAS study area showing the positions of acquired seismic lines and sampling sites of gravity and Rumohrlot cores.

2. General survey information

The 7 days long MAGAS cruise started as the vessel departed from Nuuk (West Greenland), 9th of July 2012 at 09:00 hrs (local time). After 1½ days of transit to the Disko Bugt region, the survey started the 10th of July at 15:30 hrs on the shelf area off Aasiaat and ended in the Uummanaq Fjord the 14th of July at 02:00 hrs. On the transit back to Nuuk, 2 persons were disembarked in Aassiat. The ship returned to Nuuk the 16th of July 2012 at 08:00 hrs, where the seismic equipment and Rumorhlot corer were packed to be shipped back to Denmark. The rest of the MAGAS participants disembarked the ship early morning the 17th of July, 2012.

The survey was favoured by good weather conditions throughout the period with almost no wind and only light swells. Despite fog and large icebergs in the Vaigat and Uummanaq Fjord areas, both seismic acquisition and sediment sampling went as planned without any technical problems and with good help from the ships crew.

During the 4½ days of surveying a total of 10 seismic lines, 14 gravity cores and 18 Rumohrlot cores were acquired (Fig. 1). The echo sounder was running and observed throughout the survey period.

2.1 List of MAGAS participants

Tove Nielsen (chief-scientist, GEUS)
Troels Laier (senior-scientist, GEUS)
Antoon Kuijpers (senior-scientist, GEUS)
Niels Nørgård-Pedersen (senior-scientist, GEUS)
Egon Hansen (technician, GEUS)
Tine L. Rasmussen (professor, Tromsø University)
Kamila Sztybor (phd-student, Tromsø University)
Adrianus Stolk (senior scientist, The Netherland)

2.2 Acknowledgements

The cruise was supported by a grant to the MAGAS project by the Danish Centre for Marine Research and conducted under the auspice of the Geo-Center Denmark project Permagas.

The success of the cruise strongly depended on the operational skills of the Captain and crew of the R/V Paamiut and their help with managing the seismic and coring equipment on board. The seismic and coring equipments were supplied by GEUS, and rigged on the ship while in port at Frederikshavn (Denmark) by GEUS technicians J. Boserup, E. Hansen and L-G. Røddel. We thank all for their valuable efforts in making the survey a success. Finally, Naja Mikkelsen (GEUS) is thanked for her effort in the preparation of the cruise.

2.3 Survey journal

All following indications of time refer to local Greenlandic summer-time that was 2 hours behind UTC. Location of mentioned study areas is shown in Figure 1.

A list of retrieved sediment cores is shown in Table 2 and 3. Sub-sampling of sediment and pore-water for post-cruise geo-chemical investigations were done on 7 gravity cores and 7 Rumohrlot cores immediately after retrieval of the cores on deck - see Table 4a-n. The remaining core material was sealed and stored for post-cruise geological investigations. On-board measurements of magnetic susceptibility were made on 11 of the Rumohrlot cores during transit.

Day 1 (09/7): Embarking the ship 09:00 hrs. Departure from Nuuk 12:00 hrs.

Day 2 (10/7): Arrival at the Aasiaat area ca. 15:30 hrs. Acquired seismic lines PA12_runin01, PA12_01 and PA12_02.

Day 3 (11/7): Acquired seismic line PA12_03. Seismic gear retrieved 03:00 hrs. Transit to coring positions. Acquired gravity and Rumorhlot cores PG2012-01GC1+2 & 01RC1(emty)+2+3; PG2012_02GC1+2 & 02RC1-3, and PG2012_03GC1+2 & 03RC1+2. Start transit ca. 17:00 hrs toward the western outlet of Vaigat.

Day 4 (12/7): Arrived Vaigat area 09:00 hrs. Start seismic acquisition, heading E-SE following the axis of Vaigat. Acquired seismic lines PA12_04, _05, _06, 07, 08 and _09.

Day 5 (13/7): Retrieved the seismic gear ca. 00:15 hrs in central Vaigat. Acquired gravity and Rumorhlot cores PG2012-04GC1+2 & 04RC1+2 in pockmark (sampling site 'Vaigat B' in the "Sampling Catalogue"). Transit toward west to next sampling site ('Vaigat A'). Acquired gravity and Rumorhlot cores PG2012-05GC1+2 & 05RC1(emty)+2+3+4. Transit to western outlet of Vaigat (off the Auvfarssuaq vally) and acquired PG2012-06GC1+2 & 06RC1+2. Start transit to Uummannaq fjord, north of Nuusuaq, at ca. 15:00 hrs. Arrived the area 18:55 hrs and acquired seismic line PA12_10, heading W-E along the coast. Ends seismic at 22:00 hrs and transit westward to next sampling site. Acquired gravity and Rumorhlot cores PG2012-07GC1 & 07RC1.

Day 6 (14/7): Acquired gravity and Rumorhlot cores PG2012-08GC1 & 08RC1+2. Stopped 01:25 hr and headed for Aasiaat. Arrived ca. 19:00 hr to bring AKU and EH on shore by the ships rubber boat. Continued transit toward Nuuk 20:00 hr.

Day 7 (15/7): Arrived Nuuk 08:00 hrs. Packed and disembarked GEUS equipments.

3. Methods, Processing and Storage

To obtain the objective of the cruise a high-resolution, single channel reflection seismic system was used to locate suitable sampling sites. For sediment sampling, a 6-m long gravity corer system and a 1-2 m long Rumohrlot corer system were used. The onboard echo sounding system was used to detect possible seepage in to the water column. For navigation and positioning the ships DGPS-system was used.

3.1 Navigation

The positioning was supplied by the ships DGPS navigational system. The position of the coring sites was determined by readings on the bridge at the time the corer hit the bottom. During seismic acquisition, the ships navigation was recorded directly on the SeisWiz recording system (see 3.2).

3.2 Seismic profiling

In order to map the shallow sub-seabed geology and find suitable sampling sites, a single-channel high-resolution seismic reflection system was used. Depending on the actual water depth, seabed geology and survey condition, this system penetrated up to 200 ms below the seabed, with a vertical resolution down to < 30 cm.

The system consisted of a Geo-Source 200 Sparker as source operated with a Geo-Spark HV power supply, and a short 8-element Geo-Sence Mini Streamer as receiver. For acquisition and recording the Chesapeak CTI SonarWiz 5 management system was used. Navigation was supplied by the ships DGPS system.

Figure 2 ***Left*** **- the Sparker in the water;** ***Right*** **– the seismic control room**

The Sparker was deployed mid-ships at the starboard side, using the ships crane and CTD bridge, and kept ~5 m out and ~20 m behind the ship during acquisition (Fig. 2). The streamer was deployed from the stern at the board side and kept ~5 m out and ~20 m behind the ship during acquisition.

The raw data were stored in Seg-Y format. Onboard inspection and preliminary interpretation was made using play-back and screen dumps (Fig. 2).

3.3 Echo sounding

For detection of water depths, seepage sites and bottom investigation prior to sediment sampling, the ships dual-frequency (28 & 50 Hkz) FURUNO Color lcd sounder fcv-1200 L system with hull mounted transducer was used. All data were recorded on the ships seamap plotter MAKSEA system, but due to a closed file format the data could not be copied. The search for seepage sites and the seabed morphology was therefore visual inspected on the screen during the survey (Fig. 3).

Figure 3 Monitoring the echo sounder for possible seeps into the water column

3.4 Gravity Coring

For coring a 6-m long gravity corer with an inner liner diameter of 12 cm was used. The corer weights 750 kilo when empty and ca. 1000 kilo when filled with sediments. The system was accommodated on the star board side, from where it was launched and retrieved at the stern of the ship using a hired 14 mm thick and 1000 m long steel wire. For cores taken with the purpose of geochemical investigations, 22 mm diameter holes were drilled in the core liner in order to obtain samples each 25 cm. The holes were sealed with tape before launching the system into the water.

When on deck, the core catcher was sampled first and hereafter the gravity core liner was cut into sections that was sealed and marked and brought to the onboard geochemical laboratory for sub-sampling. Sub-sampling at the bottom of each section was performed immediately after the cutting, prior to sealing of the section (Fig. 4). After sub-sampling, the holes in the liner were sealed again before final storage of the core.

Figure 4 ***Left*** **- Cutting the core into 1 m sections;** ***Right*** **- sediment sampling at the end of the section immediately after the cutting**

3.5 Rumohrlot coring

A 'Rumohrlot' corer system was used for undisturbed sampling of the seabed sediments. The weight of the corer is 80 kg. The plastic core liner was 75 mm in diameter and the length varied between 1m and 2m. The system was deployed from the port-side of the ship using the ships CTD bridge and wire system.

For cores taken with the purpose of making foraminifera investigations, the top 5 cm of sediments were sub-sampled (see section 3.7).

For cores taken with the purpose of making geochemical sub-sampling, 22 mm diameter holes were drilled at a distance of 10 cm along the length of the liner, and sealed with tape before launching the system into the water. When on deck, these cores were sealed and labelled and taken to the laboratory deck for geochemical sampling.

3.6 Magnetic susceptibility measurements

Using a Barthington Ltd. MS2C core logging loop sensors, measurements of magnetic susceptibility were measured every 3 cm on the Rumohrlot cores onboard (Fig. 5). Post-cruise measurements will be performed on the Gravity cores.

Figure 5 ***Left*** **- Onboard measurement of magnetic susceptibility on Rumohrlot cores** ***Right*** **– Sub-sampling for foraminiferal analysis**

3.7 Foraminiferal sub-sampling

Undisturbed surface sediments retrieved by Rumohrlot core were sub-sampled for foraminiferal analysis (Fig. 5). Five top centimeters were sliced in order: 0-1cm, 1-2cm, 2-5cm and preserved in 70% alcohol solution with Rose Bengal. Quantitative and qualitative analysis of living benthic foraminiferal assemblages will be performed. The remaining sediments (after sub-sampling top 5cm) were sealed, labeled and stored for the magnetic susceptibility measurements.

3.8 Geochemical sub-sampling

3.8.1 Methane concentration

A sediment sample of 3 cc was taken with a 3 mL syringe with the luer tip removed. The sample was transferred to a 12 mL serum vial containing 3 mL NaOH (2.5 %). After sampling the vial was immediately closed with a Teflon-coated crimp-cap septum. The samples were taken to GEUS for methane analysis. The scattered methane versus depth obtained from last year's cruise indicated a methane loss in the course of sub-sampling the entire gravity core. Therefore, time was noted regularly while sub-sampling for methane (Table 4a-n).

3.8.2 Sediment Sampling

Twenty cc of sediment was sampled using a 20 mL syringe with the luer tip cut off (Fig. 4). The sample was transferred to a 30 mL plastic vial and capped with a tight lid. The sediment sub-samples were taken to GEUS for analysis of water content and organic matter content.

3.8.3 Pore Water Sampling

Pore water samples were obtained using the Rhizon method. Rhizons are prepared by soaking for 2 hours in 10% HCl solution, followed two deionized water rinses. Rhizons are connected to 10 ml disposable plastic syringes.

The Rhizon was carefully inserted in through the pre-drilled hole into the side of the gravity core. Care was observed to ensure that the entire porous tip was in the zone where pore water was to be obtained (not along the rim). A vacuum was applied by pulling out the syringe piston and holding it in place. The first mL or so of pore water was ejected from the syringe.

After the completion of pore water extraction (0.5 to 3 hours) the syringe was detached from the Rhizon and the volume of water was noted. Any gas in the syringe was pushed out and the syringe and the pore water distributed according to the scheme below.

3.8.4 Pore Water Distribution

Aliquots of pore water are injected directly into a vial (with or without fixative) for various types of analyses to be performed onshore.

Example Pore Water Distribution Scheme :

Sulfate/Dissolved Sulfide: 1.0 mL of pore water was injected into a 1.5 mL Eppendorf vial containing 100 µl of 5% Zn(Ac)2 solution and shaken.
The rest of the pore water was transferred to a 6 mL Exetainer vial, capped and stored in the cold until further analysis.

4. Results

Data acquisition took place in three areas, i.e. on the shelf off Aasiaat, in the central and western Vaigat and in the southern Uummaanaq Fjord (Fig. 1).
The seismic lines were planned to pass over sites sampled during the 2011 Paamiut cruise (GEUS report 2011/105), as well as new sites selected on the basis of pre-cruise analysis of existing seismic and acoustic data in combination with results from previous seabed sampling surveys (the "Sampling Catalogue"). The actual coring sites were chosen on the basis of onboard interpretation of the acquired seismic profiles. In addition, the sampling sites were studied on the ships echo sounder before the coring took place.

The seismic lines were named PA12_xx (stands for Paamiut 2012), starting with number 01. The gravity and Rumohrlot cores were labelled with pre-fix PG2012 (stands for Permagas 2012 survey) and numbered in chronological order with reference to the site number, i.e. PG2012-*01*GC (gravity core at site *01*) and PG2012-*01*RC (corresponding Rumohrlot core at site *01*), etc. When more than one of the same type of corer was taken at the approximately same location, they were sub-numbered, i.e. PG2012-01GC*1* (*1st* gravity core at site 01) and PG2012-01RC*1* (corresponding Rumohrlot core). A list of all seismic lines is found in Table 1 and a list of all cores is shown in Tables 2 and 3.

4.1 Seismic lines

The seismic survey started in the Aassiat area. In addition to find new sampling sites, another purpose of doing seismic profiling here was to investigate the reasons for the difference in gas content of the three relatively closely spaced 2011 gravity cores. Following a test line (PA12_runin01), three regular seismic profiles were acquired. The lines scanned the area and correlated the existing coring sites (Fig.1). Three new sampling sites were chosen based on these new seismic lines.

In the Vaigat, the seismic profiling started at the western outlet of the sound and continued eastwards to pass over two pre-appointed possible sampling sites ('Vaigat-A' and 'Vaigat-B' in the Sampling Catalogue). A total of six lines were acquired. Following a 'run-in' line (to tune the equipment), the proceeding three lines followed the central outline of the sound while the remaining two lines were run respectively perpendicular and parallel hereto (Fig. 1). Based on these seismic profiles, three sampling sites were pointed out and subsequently sampled, i.e. the two pre-appointed sites and a newfound one in the western end of Vaigat, off the Auvfarssuaq vally (Figs. 1 and 6).

In the Uummanaaq fjord, one seismic line was acquired running parallel to the coast of the Naassuaaq Peninsula, to transverse a pre-appointed sampling site. Several large icebergs made it necessary to deviated from the planned line transect, but the purpose of the seismic profiling was achieved, and two sampling site was pointed out and subsequently sampled.

Overall, the quality of the seismic data was fair to good and useable for our purpose. Unfortunately, a band of noise was repeating at every ca 10 minutes, blurring the primary reflection. The source of the noise was not found.

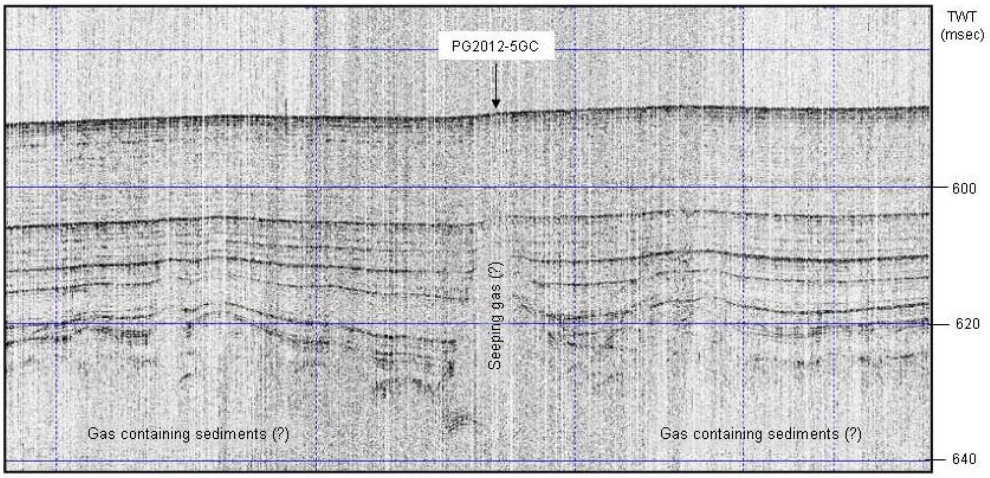

Figure 6 Part of seismic line PA12_06 from the northern Vaigat showing position of sampling site PG2012-5GC (Fig. 1), where gas and sediments were seeping out of holes in the core liner and caps (see Fig. 8 and Tables 1 & 2).

4.2 Echo sounding

The study of the ships echo sounding imageries during the entire cruise, gave some interesting information on hereinto un-reported flare formation in the water column within the surveyed areas (Fig. 7). The nature of the flares is still unknown, but the positions have been noted. Thus, these observations will likely form part of the planning of a future cruise.

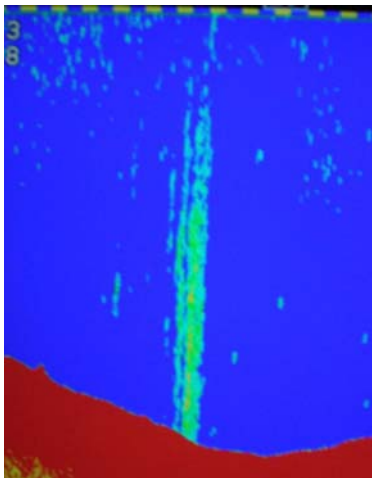

Figure 7 Flare observation on echo sounder imagery

4.3 Gravity cores

Generally, the sampled sediments were fine grained and thus penetration of the gravity corer was high. It is possible that over-penetration occurred at some sites where the entire system was covered by mud when retrieved on deck. However, only one gravity core showed clear sign of over-penetration with sediments being extruded at the top of the corer system. A total of 14 gravity cores were collected from 8 different sites, with a sum recovery of more than 65 m of sediments (Table 2).

Figure 8 A ca. 6 cm long Ikaite crystal was found in the core catcher of gravity core PG2012-05GC2, and sediments and gas was seeping out of the holes in the end caps of core sections 1 and 2

A preliminary investigation of the content of the cores was made by inspection of the sediments in the core catcher and at either ends of the core sections.
The cores taken in the Aasiaat area (Fig. 1) (PG2012-01GC to -03GC) contained green to grey, stiff silty clay with occasional smell of hydrogen sulphide. After sealing, some core caps started to bulge out, indicating presents of gas.
In the Vaigat area (Fig. 1), the easternmost core (PG2012-04GC) contained greenish-greyish sandy clay with layers of coarse sand, gravel and stones in the upper part and yellow-greyish stiff clay with sand, gravel and shells in the lower part. The core taken further to the west in the Vaigat (PG2012-05GC) contained olive-black silty clay with shell and snail fragments in the upper part grading downwards into gassy clayey mud with bioturbation. A ca. 6 cm long Ikaite crystal was found in the core catcher, and gas and sediments seeped out of holes in the liner and caps indicating presents of gas (Fig. 8). At the northwestern outlet of Vaigat, the core (PG2012-06GC) showed light-olive-grey sandy clay with IRD and dropstones in the top, getting darker and more silty downwards.
The cores taken in Uummaanaq area (Fig. 1) (PG2012-07GC & -08GC) contained homogenous grey sandy clay.

4.4 Rumohrlot cores

17 Rumohrlot cores were recovered from 8 different sites (Table 3). These cores were taken in order to obtain undisturbed samples of the upper 1 to 2 m below the seabed for geochemical investigations and for sediment surface samples for recent fauna studies.

Generally, the surface sediment in the cores consisted of unconsolidated mud with some content of organic matter. Below this, the cores contained mixed sediment of brownish-green clay with a downward increase in consolidation

4.5 Geochemical samples

The geo-chemical sub-samples were numbered in chronological order irrespectively of the type of sample. The numbers were listed in a table identifying the type of sample and its exact position with respect to core number and section number including the distance in cm below top of the section. Given the information regarding the length of each core (Tables 2-3) the depth below seafloor was calculated for each sample. Finally the table was re-ordered with respect to core number and type. List of all samples are presented in Tables 4a-n. A total of 185 pore water samples, 160 sediment samples and 140 sediment/gas samples were taken for further analysis onshore.

Figure 9 Selection of sediment sub-samples for geochemical analyses.

5. Summary and concluding remarks

From the early morning of July 9th to early morning of July 17th 2012, the Geological Survey of Denmark and Greenland (GEUS), together with the University of Tromsø, carried out a scientific cruise to the Disko Bugt region off West Greenland onboard the Greenlandic research wessel R/V Paamiut.

The goal of the cruise was to map pre-selected areas by shallow seismic surveying and collect sediment samples by means of gravity- and Rumohrlot coring, all to investigate possible presents of gas hydrates in these areas (Fig 1). The cruise was a follow up on a preceding pilot cruise in 2011 (see GEUS report 2011/105) and formed part of two research projects dealing with marine gashydrates, respectively a Danish and a Norwegian project.

Three areas were selected for investigations, i.e. the 'Aasiaat area', the Vaigat area' and the 'Uummanaaq. In total, 10 seismic lines, 14 gravity cores and 18 Rumohrlot cores were acquired during the 7 days cruise (Fig. 1). Sediment and geochemical sub-sampling were executed immediately after retrieval of the cores on deck.

The cooperation onboard went smoothly, and skipper and crew of Paamiut showed great skill and helpfulness. Owing to this, and fine sea and weather conditions throughout the period, the cruise was very successful. The Danish Centre for Marine Research is sincerely thanked for the financial support to the MAGAS cruise, which otherwise would not have been possible.

6. Tables

Table 1 - Seismic lines

Line name	Date	Location	Time (local) - Latitude ; Longitude	Comments
PA12_01	10-07-12	Aassiat area	SOL: 17:20 - 68°18,373 ; 55°51,767 EOL: 21:14 - 68°29,040 ; 55°46,552	Passed old coring sites PA2011-02GC & -04GC
PA12_02	10-07-12	Aassiat area	SOL: 21:14 - 68°29,040 ; 55°46,552 EOL: 23:36 - 68°24,586 ; 56°06,609	Passed old coring site PA2011-03GC
PA12_03	11-07-12	Aassiat area	SOL: 23:36 - 68°24,586 ; 56°06,609 EOL: 03:00 - 68°23,208 ; 56°09,666	Passed old coring site PA2011-02GC
PA12_04	12-07-12	Vaigat area	SOL: 09:14 - 70°37,015 ; 54°50,826 EOL: 10:20 - 70°37,010 ; 54°38,380	S-N run-in to line PA12_05
PA12_05	12-07-12	Vaigat area	SOL: 10:20 - 70°37,010 ; 54°38,380 EOL: 14:04 - 70°19,833 ; 53°55,223	Many, large icebergs
PA12_06	12-07-12	Vaigat area	SOL: 14:04 - 70°19,833 ; 53°55,223 EOL: 18:20 - 70°16,053 ; 53°09,656	Many, large icebergs
PA12_07	12-07-12	Vaigat area	SOL: 18:21 - 70°16,017 ; 53°09,494 EOL: 22:58 - 69°59,895 ; 52°32,924	Many, large icebergs
PA12_08	12-07-12	Vaigat area	SOL: 22:58 - 69°59,895 ; 52°32,924 EOL: 23:36 - 69°59,557 ; 52°40,707	N-S (ca) run-in to line PA12_09
PA12_09	12-07-12	Vaigat area	SOL: 23:36 - 69°59,557 ; 52°40,707 EOL: 23:56 - 70°00,892 ; 52°41,599	Many icebergs
PA12_10	13-07-12	Uummannaq area	SOL: 19:21 - 70°50,026 ; 53°30,770 EOL: 21:54 - 70°50,323 ; 52°55,056	Many large icebergs

Table 2 - Gravity cores

Station	Date	Time (local)	Location (see fig 1)	Latitude [N] Longitude [W]	Water depth [m]	Pene-tration [m]	Re-covery [cm]	No. of sec-tions (#)	Comment
PG2012-01GC1	11-07-12	05:40	Aasiaat area	68°27,838 55°46,901	489	~6	562	6	Core catcher: stiff, grey clay w. IRD stones. Geochemical sub-sampling
PG2012-01GC2	11-07-12	----	Aasiaat area	68°27,851 55°47,119	490	~6	566	6	#3 – core caps bulged out shortly after retrieval. Same site as -01GC1.
PG2012-02GC1	11-07-12	10:25	Aasiaat area	68°22,685 55°49,510	510	~6	482	5	Green mud on top, grey clay at bottom. Geochemical sub-sampling
PG2012-02GC2	11-07-12	11:44	Aasiaat area	68°22,837 55°49,748	567	~6	515	6	Same site as -02GC1.

(continue on next page)

Table 2 - Gravity cores (continued)

Station	Date	Time (local)	Location (see fig 1)	Latitude [N] Longitude [W]	Water depth [m]	Pene-tration [m]	Re-covery [cm]	No. of sec-tions (#)	Comment
PG2012-03GC1	11-07-12	14:27	Aasiaat area	68°24,148 55°43,383	557	~6	516	6	Green mud on top (smell of hydrogen sulphide), grey clay at bottom. Geochemical sub-sampling.
PG2012-03GC2	11-07-12	15:45	Aasiaat area	68°24,159 55°43,364	558	~6	346	4	Same site as 03GC1.
PG2012-04GC1	13-07-12	00:53	Central Vaigat	70°00,434 52°41,485	404	~6	380	4	Sampled in pockmark. Greenish-greyish sandy clay with layers of coarse sand, gravel and stones in upper part, and clay in the lower part. Cc damaged by stone. Geochemical sub-sampling.
PG2012-04GC2	13-07-12	00:53	Central Vaigat	70°00,434 52°41,485	404	~6	380	4	Same site as -04GC1. In lower part yellow-greyish stiff clay with sand, gravel and shells
PG2012-05GC1	13-07-12	07:02	Western Vaigat	70°18,561 53°33,837	587	~6	446	5	Olive-black silty clay w. shell and snail fragments in upper part (seabed disturbed). Becomes gassy clayey mud w. bioturbation downwards. A ca. 6 cm long Ikaite crystal found in cc. Gas and sediments seeping out of holes in liner and caps, but no smell (Fig. 8). Geochemical sub-sampling.
PG2012-05GC2	13-07-12	08:11	Western Vaigat	70°18,472 53°33,735	588	~6	453	5	Same site as -05GC1. Same sediments + dropstones. Seabed un-disturbed. Again gas and sediment was seeping out of holes in liner and caps, but no smell.
PG2012-06GC1	13-07-12	12:58	N-Western outlet of Vaigat	70°28,989 54°18,249	416	~6	455	5	Light-olive-grey sandy clay w. forams, getting darker and more silty downward. IRD and dropstones. Geochemical sub-sampling.
PG2012-06GC2	13-07-12	32:58	N-W outlet of Vaigat	70°28,976 54°18,210	415	~6	400	4	Same site as -06GTC1.
PG2012-07GC1	13-07-12	23:05	Uum-manaq fjord	70°50,202 53°12,263	566	~6	510	5 + 1 bag	Homogenous sandy grey clay; top ca. 10 cm brownish mud w. forams/sand (#6 in bag). Geochemical sub-sampling
PG2012-08GC1	14-07-12	00:48	Uum-manaq fjord	70°50,201 55°13,315	557	~6	561	6	Close to -07GC1. Same lithology

Table 3 - Rumohrlot cores

Station	Date	Time (local)	Location (see fig 1)	Latitude [N] Longitude [W]	Water depth [m]	Recov-ery [cm]	Comment
PG2012-01RC2	11-07-12	08:39	Aasiaat area	68°27,914 54°46,814	489	93	Correspond to PG2012-01GC. Sub-sampled for forams analysis. On-board mag. sus.
PG2012-01RC3	11-07-12	09:08	Aasiaat area	68°27,867 54°47,083	491	63	Correspond to PG2012-01GC. Geochemical sub-sampling
PG2012-02RC1	11-07-12	12:54	Aasiaat area	68°22,719 55°49,610	511	82	Correspond to PG2012-02GC. Sub-sampled for foraminifera analysis. Onboard mag. sus.
PG2012-02RC2	11-07-12	13:20	Aasiaat area	68°22,653 55°49,641	508	150	Correspond to PG2012-02GC. Geochemical sub-sampling
PG2012-02RC3	11-07-12	13:40	Aasiaat area	68°22,619 55°49,632	509	143	Correspond to PG2012-02GC. Taken for another project. Onboard mag. sus.
PG2012-03RC1	11-07-12	16:15	Aasiaat area	68°24,159 55°43,472	557	75	Correspond to PG2012-03GC. Sub-sampled for forams analysis. On-board mag. sus.
PG2012-03RC2	11-07-12	16:36	Aasiaat area	68°24,078 55°43,435	556	63	Correspond to PG2012-03GC. Geochemical sub-sampling
PG2012-04RC1	13-07-12	03:13	Vaigat area	70°00,410 52°41,559	404	71	Correspond to PG2012-04GC. Sub-sampled for forams analysis. On-board mag. sus.
PG2012-04RC2	13-07-12	03:31	Vaigat area	70°00,393 52°41,544	403	-----	Correspond to PG2012-04GC. Geochemical sub-sampling
PG2012-05RC2	13-07-12	09:26	Vaigat area	70°18,448 53°34,185	589	76	Correspond to PG2012-05GC. Sub-sampled for forams analysis. On-board mag. sus.
PG2012-05RC3	13-07-12	---	Vaigat area	70°18,424 53°33,579	589	-----	Correspond to PG2012-05GC. Geochemical sub-sampling
PG2012-06RC1	13-07-12	14:23	Vaigat area	70°28,960 54°18,293	416	67	Correspond to PG2012-06GC. Sub-sampled for forams analysis. On-board mag. sus.
PG2012-06RC2	13-07-12	14:40	Vaigat area	70°28,956 54°18,324	417	-----	Correspond to PG2012-06GC. Geochemical sub-sampling
PG2012-07RC1	13-07-12	23:53	Uummannaq area	70°50,197 53°11,582	566	15	Correspond to PG2012-07GC. Sub-sampled for forams analysis
PG2012-07RC2	14-07-12	00:16	Uummannaq area	70°50,187 53°12,180	566	----	Correspond to PG2012-07GC. Geochemical sub-sampling
PG2012-08RC1	14-07-12	01:02	Uummannaq area	70°50,182 53°13,307	557	114	Corr. to PG2012-08GC. Taken for another project. Onboard mag. sus.
PG2012-08RC2	14-07-12	01:24	Uummannaq area	70°50,190 53°13,186	557	----	Correspond to PG2012-08GC. Sub-sampled for forams analysis. On-board mag. sus.

Table 4a-n Geochemicel samples

Table 4a List of subsamples by ID No. from Gravity Core 1, Aasiaat, station 1

Core	cm b sfl	G	S	PW	mL	Section	cm be-low top	time
01GC1	0		15			6	0	07:01
01GC1	12			112	10.0	6	12	
01GC1	37		46	111	10.5	6	37	
01GC1	62	13	14	110	10.0	6	62	06:56
01GC1	87	30	45	109	10.5	5	25	07:52
01GC1	112	29	44	108	10.5	5	50	
01GC1	137	28	43	107	10.0	5	75	07:43
01GC1	162	11	12	106	10.0	5	100	06:52
01GC1	187	27	42	105	10.5	4	25	07:41
01GC1	212	26	41	104	10.5	4	50	
01GC1	237	25	40	103	10.5	4	75	07:37
01GC1	262	9	10	102	10.0	4	100	06:48
01GC1	287	24	39	101	10.5	3	25	07:34
01GC1	312	23	38	100	10.5	3	50	
01GC1	337	22	37	99	10.0	3	75	
01GC1	362	7	8	98	10.5	3	100	06:43
01GC1	387	21	36	97	9.5	2	25	07:27
01GC1	412	20	35	96	9.5	2	50	07:25
01GC1	437	19	34	95	10.5	2	75	07:24
01GC1	462	5	6	94	9.0	2	100	06:36
01GC1	487	18	33	93	10.0	1	25	07:19
01GC1	512	17	32	92	9.0	1	50	07:16
01GC1	537	16	31	91	9.0	1	75	07:14
01GC1	562	3	4	90	9.0	1	100	06:30
01GC1	572	1	2			cc	110	06:16

GC on seafloor 06:04

Table 4b List of subsamples by ID No. from Rumohr Core 3, Aasiaat, station 1

Core	cm b sfl	G	S	PW	mL
01RC3	5		213	113	10.5
01RC3	15		214	114	10.0
01RC3	25		215	115	10.5
01RC3	35			116	10.5
01RC3	45			117	10.5
01RC3	55			118	10.5

Table 4c List of subsamples by ID No. from Gravity Core 1, Aasiaat, station 2

Core	cm b sfl	G	S	PW	mL	Section	cm below top	time
02GC1	3		59			6	0-5	
02GC1	35	74	89	155	10.0	5	25	11:54
02GC1	60	73	88	156	10.5	5	50	
02GC1	85	72	87	157	10.5	5	75	
02GC1	110	57	58	158	10.5	5	100	11:15
02GC1	135	71	86	159	10.5	4	25	
02GC1	160	70	85	160	10.5	4	50	
02GC1	185	69	84	161	10.5	4	75	
02GC1	210	55	56	162	9.5	4	100	
02GC1	235	68	83	163	10.0	3	25	
02GC1	260	67	82	164	10.5	3	50	
02GC1	285	66	81	165	10.0	3	75	
02GC1	310	53	54	166	10.5	3	100	
02GC1	335	65	80	167	10.0	2	25	
02GC1	360	64	79	168	10.5	2	50	
02GC1	385	63	78	169	9.5	2	75	
02GC1	410	51	52	170	7.5	2	100	
02GC1	435	62	77	171	7.0	1	25	
02GC1	460	61	76	172	7.5	1	50	
02GC1	485	60	75	173	9.5	1	75	11:27
02GC1	510	49	50	174	6.0	1	100	10:58
02GC1	520	47	48			cc	110	10:52

GC on seafloor 10:25

Table 4d List of subsamples by ID No. from Rumohr Core 3, Aasiaat, station 2,

Core	cm b sfl	G	S	PW	mL
02RC3	10		216	175	7.0
02RC3	20		217	176	10.0
02RC3	30		218	177	10.0
02RC3	40			178	10.0
02RC3	50			179	10.0
02RC3	60			180	8.5
02RC3	70			181	10.0
02RC3	80			182	10.0
02RC3	90			183	8.5
02RC3	100			184	9.5
02RC3	120			185	8.0
02RC3	140			186	7.5

Table 4e List of subsamples by ID No. from Gravity Core 1, Aasiaat, station 3

Core	cm b sfl	G	S	PW	mL	Section	cm below top	time
03GC1	16	129	130			6	16	15:20
03GC1	41			187	10.5	5	25	
03GC1	66			188	10.5	5	50	
03GC1	91			189	9.5	5	75	
03GC1	116	127	128			5	98	
03GC1	141	142	154	191	8.0	4	25	16:01
03GC1	166	141	153	192	10.0	4	50	15:58
03GC1	191	140	152	193	9.0	4	75	
03GC1	216	125	126	194	8.0	4	104	
03GC1	241	139	151	195	10.0	3	25	
03GC1	266	138	150	196	8.0	3	50	
03GC1	291	137	149	197	9.5	3	75	15:50
03GC1	316	123	124	198	9.5	3	100	
03GC1	341	136	148	199	5.5	2	25	
03GC1	366	135	147	200	7.5	2	50	
03GC1	391	134	146	201	7.5	2	75	
03GC1	422	121	122	202	7.5	2	100	
03GC1	441	133	145	203	6.5	1	25	
03GC1	466	132	144	204	6.5	1	50	15:33
03GC1	491	131	143	205	7.0	1	75	
03GC1	516	119	120	206	7.5	1	100	14:50

GC on seafloor 14:27

Table 4f List of subsamples by ID No. from Rumohr Core 2, Aasiaat, station 3,

Core	cm b sfl	G	S	PW	mL
03RC2	5		219	212	10.5
03RC2	15		220	208	10.0
03RC2	25		221	209	10.5
03RC2	35			210	10.0
03RC2	45			211	10.0
03RC2	55			207	10.0

Table 4g List of subsamples by ID No. from Gravity Core 1, central Vaigat, station 4

Core	cm b sfl	G	S	PW	mL	Section	cm below top	time
04GC1	5	241	253	254	9.5	4	5	
04GC1	30	240	252	255	8.0	4	30	02:15
04GC1	55	239	251	256	8.0	4	55	
04GC1	80	228	229	257	10.0	4	80	01:45
04GC1	105	238	250	258	10.0	3	25	02:10
04GC1	130	237	249	259	7.5	3	50	
04GC1	155	236	248	260	7.0	3	75	02:05
04GC1	180	226	227	261	9.5	3	100	01:40
04GC1	205	235	247	262	9.5	2	25	
04GC1	230	234	246	263	9.0	2	50	02:02
04GC1	255	233	245	264	10.5	2	75	
04GC1	280	224	225	265	10.0	2	100	01:30
04GC1	305	232	244	266	9.5	1	25	01:57
04GC1	330	231	243	267	9.0	1	50	01:55
04GC1	355	230	242	268	9.0	1	75	01:52
04GC1	380	222	223	269	9.0	1	100	01:20

GC on seafloor 00:53

Table 4h List of subsamples by ID No. from Rumohr Core 2, central Vaigat, station 4

Core	cm b sfl	G	S	PW	mL
04RC2	5		475	270	10.5
04RC2	15		476	271	10.5
04RC2	25		477	272	10.0
04RC2	35			273	9.0
04RC2	45			274	7.5
04RC2	55			275	7.0
04RC2	65			276	8.5
04RC2	75			277	8.5

Table 4i List of subsamples by ID No. from Gravity Core 1, western Vaigat, station 5

Core	cm b sfl	G	S	PW	mL	Section	cm below top	time
05GC1	0		290			5	0	
05GC1	25			328	10.0	5	25	
05GC1	46	288	289	329	9.0	5	46	07:42
05GC1	71	314	315	330	9.0	4	25	09:05
05GC1	96	312	313	331	8.0	4	50	09:02
05GC1	121	310	311	332	5.5	4	75	
05GC1	146	286	287	333	8.0	4	100	07:40
05GC1	171	308	309	334	10.0	3	25	08:55
05GC1	196	306	307	335	10.0	3	50	
05GC1	216	320				3	70	
05GC1	221	304	305	336	10.0	3	75	
05GC1	246	284	285	337	10.0	3	100	
05GC1	271	302	303	338	9.5	2	25	
05GC1	296	300	301	339	8.5	2	50	
05GC1	316	319				2	70	
05GC1	321	298	299	340	10.5	2	75	
05GC1	346	282	283	341	9.5	2	100	
05GC1	351	318				1	5	
05GC1	371	296	297	342	6.5	1	25	08:25
05GC1	386	317				1	40	
05GC1	396	294	295	343	9.5	1	50	
05GC1	416	316				1	70	
05GC1	421	292	293	344	8.0	1	75	
05GC1	446	280	281	345	6.5	1	100	
05GC1	456	278	279			cc		

GC on seafloor 07:04

Table 4j List of subsamples by ID No. from Rumohr Core 3, western Vaigat, station 5

Core	cm b sfl	G	S	PW	mL
05RC3	8		478	321	10.0
05RC3	18		479	322	10.0
05RC3	28		480	323	10.0
05RC3	38			324	9.5
05RC3	48			325	9.5
05RC3	58			326	9.0
05RC3	68			327	8.0

Table 4k List of subsamples by ID No. from Gravity Core 1, NW outlet of Vaigat, station 6

Core	cm b sfl	G	S	PW	mL	Section	cm below top	time
06GC1	8	382	383	392	10.0	5	8	
06GC1	33	380	381	393	9.5	5	33	
06GC1	55	354	355			5	100	
06GC1	80	378	379	394	6.0	4	25	
06GC1	105	376	377	395	10.0	4	50	
06GC1	130	374	375	396	10.0	4	75	
06GC1	155	352	353			4	100	
06GC1	180	372	373	397	10.5	3	25	
06GC1	205	370	371	398	10.0	3	50	
06GC1	230	368	369	399	7.5	3	75	
06GC1	255	350	351	400	6.0	3	100	
06GC1	280	366	367	401	8.0	2	25	
06GC1	305	364	365	402	8.0	2	50	
06GC1	330	362	363	403	8.0	2	75	
06GC1	355	348	349	404	7.5	2	100	
06GC1	380	360	361	405	9.5	1	25	
06GC1	405	358	359	406	7.5	1	50	
06GC1	430	356	357	407	4.0	1	75	
06GC1	455	346	347	408	6.0	1	100	

GC on seafloor 12:58

Table 4l List of subsamples by ID No. from Rumohr Core 2, NW outlet of Vaigat, station 6

Core	cm b sfl	G	S	PW	mL
06RC2	0			384	10.0
06RC2	10		481	385	10.0
06RC2	20		482	386	10.5
06RC2	30		483	387	10.0
06RC2	40			388	10.0
06RC2	50			389	10.5
06RC2	60			390	9.0
06RC2	70			391	9.0

Table 4m List of subsamples by ID No. from Gravity Core 1, Uummaq Fjord, station 7

Core	cm b sfl	G	S	PW	mL	Section	cm below top	time
07GC1	10	419	420			5	10	23:54
07GC1	35	445	446	463	10.0	5	25	
07GC1	60	447	448	464	10.0	5	50	
07GC1	85	449	450	465	10.0	5	75	01:35
07GC1	110	417	418			5	100	23:50
07GC1	135	439	440	460	10.0	4	25	
07GC1	160	441	442	461	10.0	4	50	
07GC1	185	443	444	462	10.0	4	75	
07GC1	210	415	416			4	100	23:45
07GC1	235	433	434	457	10.0	3	25	
07GC1	260	435	436	458	6.0	3	50	
07GC1	285	437	438	459	10.0	3	75	
07GC1	310	413	414			3	100	
07GC1	335	427	428	454	10.0	2	25	
07GC1	360	429	430	455	6.0	2	50	
07GC1	385	431	432	456	10.0	2	75	
07GC1	410	411	412			2	100	
07GC1	435	421	422	451	9.5	1	25	
07GC1	460	423	424	452	10.0	1	50	00:10
07GC1	485	425	426	453	10.0	1	75	
07GC1	510	409	410			1	100	

GC on seafloor 23:05

Table 4n List of subsamples by ID No. from Rumohr Core 2, Uummaq Fjord, station 7

Core	cm b sfl	G	S	PW	mL
07RC2	7		484	466	10.0
07RC2	17		485	467	10.0
07RC2	27		486	468	9.0
07RC2	37			469	10.0
07RC2	47			470	8.5
07RC2	57			471	8.0
07RC2	67			472	8.5
07RC2	77			473	8.5