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The Expedition of the Research Vessel "Polarstern" to the Arctic in 2007 (ARK-XXII/1a-c)

Edited by
Michael Klages & Jörn Thiede
with contributions of the participants

HELMHOLTZ | GEMEINSCHAFT

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In Erinnerung an Jan Hendrik Wegner. Ein Kollege, der viel zu früh verstarb

In memory to Jan Hendrik Wegner. A colleaque who died much too early

ARK-XXII/1a–c

29. May - 25. July 2007

BREMERHAVEN - TROMSØ – LONGYEARBYEN - TROMSØ

1a Chief Scientist
Jörn Thiede

1b + 1c Chief Scientist
Michael Klages

Coordinator
Eberhard Fahrbach

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1. ZUSAMMENFASSUNG UND FAHRTVERLAUF

Jörn Thiede, Michael Klages

Alfred-Wegener-Institut

Die *Polarstern*-Expedition ARK-XXII/1a-c vom 29.05. - 25.07.2007 (Bremerhaven - Tromsø - Longyearbyen - Tromsø) stellte einen Beitrag zu dem von der EU geförderten Integrated Project HERMES (Hotspot Ecosystem Research on the Margins of European Seas) dar, in dem marine Ökosysteme der Tiefsee entlang des europäischen Kontinentalrandes erforscht werden. Dabei werden ausgewählte, verschiedenartige Ökosysteme von Spitzbergen im Norden entlang des norwegischen Kontinentalrandes, über das Mittelmeer bis in das Schwarze Meer studiert. Der erste Arktisfahrtabschnitt der “Polarstern” zu Beginn des IPY (International Polar Year) war in drei Unterabschnitte gegliedert, um so Untersuchungen an vier Ökosystemtypen entlang des nördlichen europäischen Kontinentalrandes durchzuführen. Ein besonderer Schwerpunkt lag dabei auf sogenannten “hot spots”, stark physikalisch kontrollierten Systemen, die zudem durch vergleichsweise dynamische geologische und/oder hydrologische Randbedingungen, wie zum Beispiel instabile Kontinentalhänge, Tiefseegräben, Tiefwasserkorallen, kalte Sickerstellen oder sauerstofffreie, von Bakterien besiedelten Lebensgemeinschaften geprägt sind. Auf die drei Unterabschnitte waren insgesamt 138 Teilnehmer aus 14 Nationen verteilt.

Für die Durchführung des Expeditionsprogrammes war auf dem ersten Unterabschnitt der Reise (29.05. -21.06.07) das bemannte Tauchboot JAGO des IFM-GEOMAR aus Kiel an Bord, um damit an Kaltwasserkorallenriffen vor der norwegischen Küste zu arbeiten. Begünstigt durch überwiegend gute Wetter- und Seegangsverhältnisse konnten 20 erfolgreiche Tauchgänge in den ersten drei Wochen auf See durchgeführt werden. Während des ersten Hafenaufenthaltes in Tromsø verließen fast alle wissenschaftlichen Fahrtteilnehmer das Schiff, JAGO wurde von Bord gegeben, und das ferngelenkte Unterwasserfahrzeug QUEST des MARUM der Universität Bremen an Bord installiert. Sowohl JAGO als auch QUEST wurden während dieser Expedition erstmalig auf *Polarstern* eingesetzt. Mit QUEST wurden am Håkon Mosby Schlammvulkan, einer untermeerischen Methanaustrittsquelle in 1250 m Wassertiefe nordwestlich von Norwegen (siehe Abb. Fahrtverlauf), während 10 erfolgreicher Tauchgänge gezielt Proben genommen. In Kombination mit einem am Max-Planck-Institut für marine Mikrobiologie in Bremen entwickelten Liftsystem konnten zudem *in-situ*- Experimente mit autonomen Messinstrumenten durchgeführt werden. Nach dem Wechsel der meisten wissenschaftlichen Fahrtteilnehmer am 9. Juli in Longyearbyen (Spitzbergen), hat *Polarstern* bis zum 22. Juli am “HAUSGARTEN“, einem von zehn Tiefseeobservatorien des von der EU geförderten Exzellenznetzwerkes ESONET (European Seas Observatory NETwork), operiert. Neben einem Standardprobennahmeprogramm (Aufnehmen und Ausbringen von

Verankerungen, Freifall-Landern) wurde "QUEST" genutzt, um unter natürlichen Umgebungsbedingungen in der Tiefsee verschiedene Experimente durchzuführen, aber auch um gezielt Sediment- und andere Proben aufzunehmen. Der Fahrtabschnitt PS ARK-XXII/1 endete nach 5289 nautischen Meilen am Morgen des 25. Juli im Hafen von Tromsø in Norwegen.

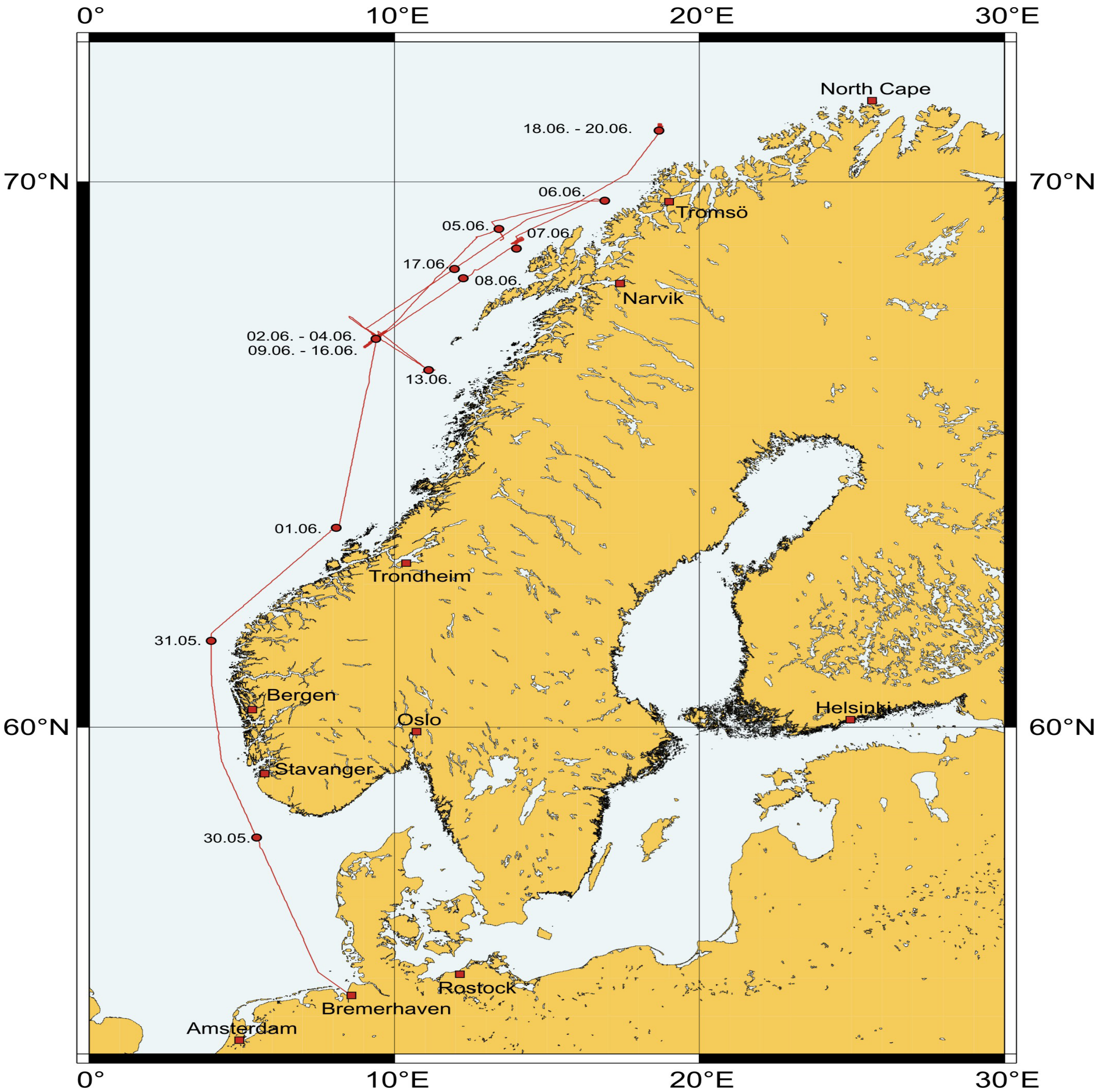

Fig. 1a: Fahrtverlauf der Polarstern während des Abschnitts ARK-XXII/1a

Cruise track of Polarstern during the expedition ARK-XXII/1a

CRUISE NARRATIVE AND SUMMARY ARK-XXII/1A-C

The *Polarstern* cruise ARK-XXII/1a-c (29.05.2007 - 25.07.2007; Bremerhaven -Tromsø - Longyearbyen - Tromsø) was a major contribution to the EU funded Integrated Project HERMES (Hotspot Ecosystem Research on the Margins of European Seas), aiming at research on ecosystems lying in the deeper ocean section. HERMES aims to compare and contrast selected environments around the European margin from the Svalbard continental margin, Norwegian margins, the Mediterranean to the Black Sea. The project is designed to gain new insights into the biodiversity, structure, function and dynamics of ecosystems along Europe's deep-ocean margin to underpin the future development of a comprehensive European Ocean and Seas Integrated Governance Policy. ARK-XXII/1 of RV "Polarstern" during the first year of IPY (International Polar Year) activities was subdivided into three sub-legs to allow studies on four different ecosystem types along the Nordic Margins within HERMES. In particular, cold-water corals, cold seeps, anoxic microbial systems, and open slope systems. A total of 138 participants from 14 countries were distributed over the cruise legs ARK-XXII/1a-c.

The work plan was based on the manned submersible JAGO (owned by IFM-GEOMAR, Kiel) during the first sub-leg (29.05 - 21.06.07) for studies on cold-water corals along the Norwegian continental margin. Favoured by exceptional good weather conditions 20 successful dives were performed during the first three weeks at sea. During the next port call in Tromsø, almost all scientists disembarked, JAGO was unloaded and the Remotely Operated Vehicle (ROV) "QUEST" of MARUM at Bremen University was installed onboard *Polarstern*. It is noteworthy that for the first time the installation and operation of both underwater vehicles was done onboard *Polarstern*. The ROV was necessary for detailed studies at the Håkon Mosby Mud Volcano northwest of Norway at 1,250 m water depth (see cruise plot), an exceptional cold seep with anoxic microbial systems at high latitudes where 10 successful dives in combination with a modified lift system developed at the Max-Planck Institute for marine Microbiology (Bremen) allowed intense sampling at the seafloor and deployment of *in-situ* experiments with pre-programmed instruments. After exchange of scientific personnel in Longyearbyen (Svalbard) on 9 July, *Polarstern* worked at the "HAUSGARTEN" deep-sea observatory, one node within the European Seas Observatory NETwork (ESONET) until 22 July. Among a standard sampling programme including exchange of moorings and free falling landers, here the ROV was used during 5 successful dives for various *in-situ* experiments at the central experimental site of "HAUSGARTEN" at about 2,600 m water depth. The cruise leg ARK-XXII/1a-c ended in the morning of 25 July at the port of Tromsø in Norway after 5,289 nautical miles.

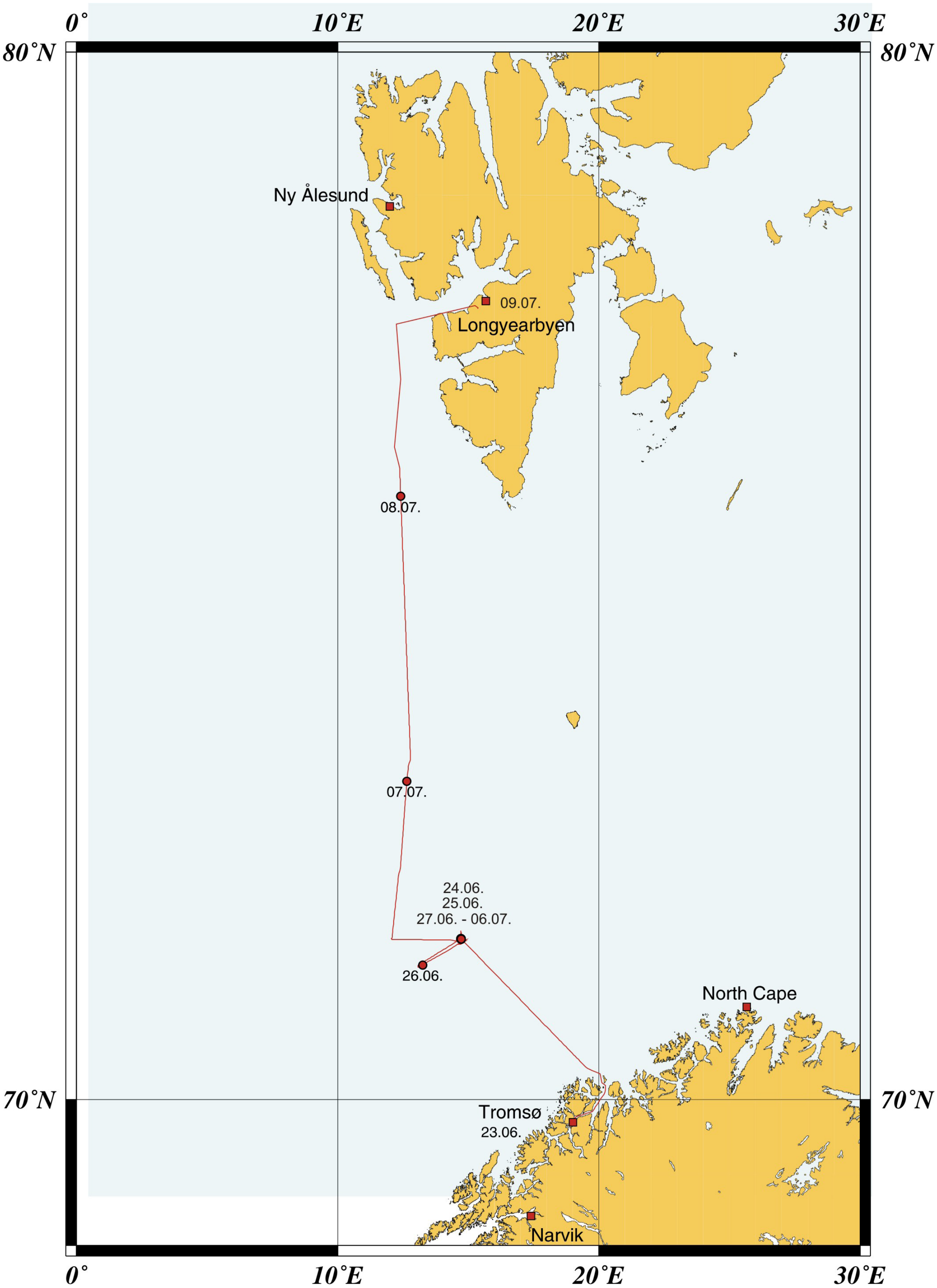

Fig. 1b: Fahrtverlauf der Polarstern während des Abschnitts ARK-XXII/1b

Cruise track of Polarstern during the expedition ARK-XXII/1b

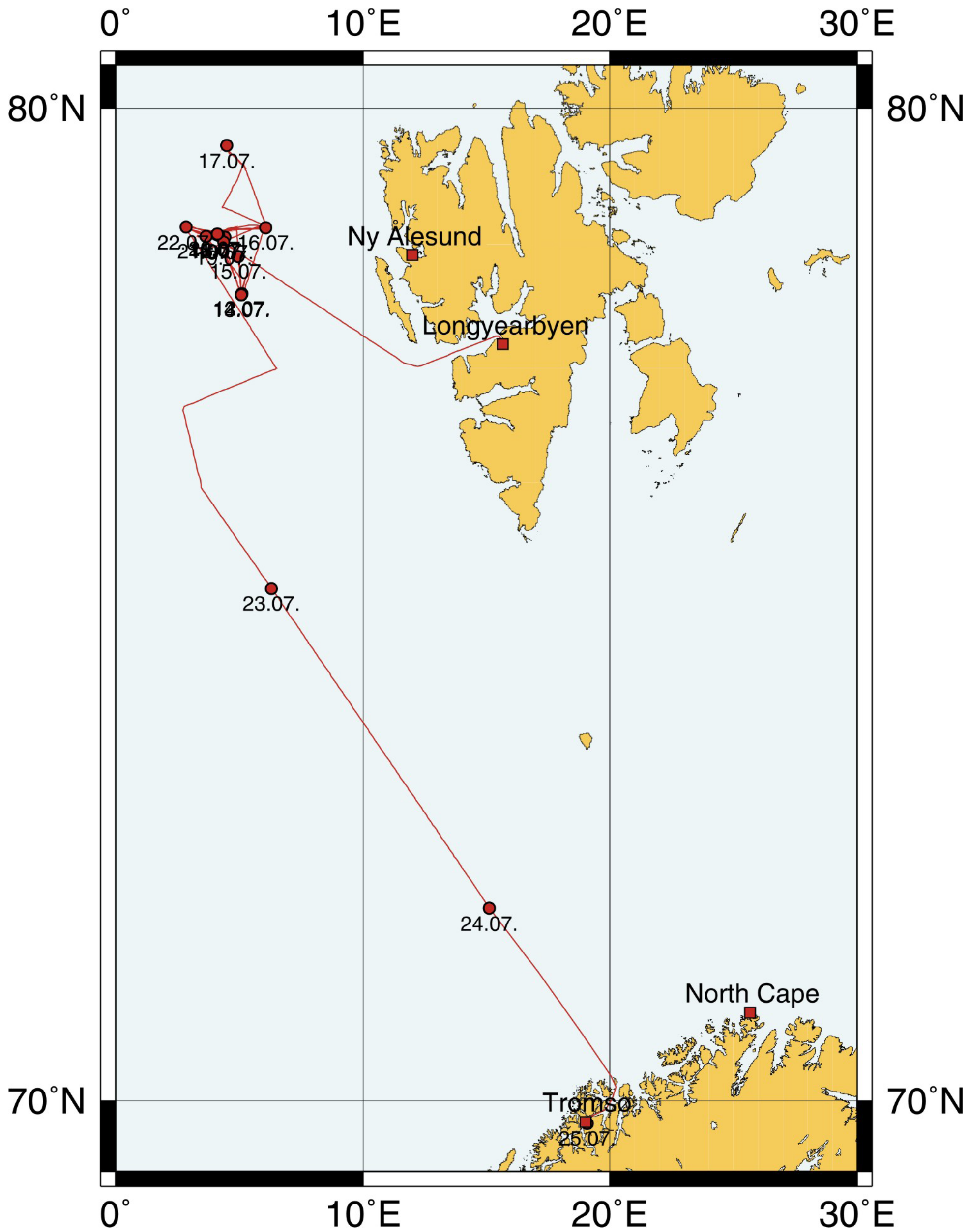

Fig. 1c: Fahrtverlauf der Polarstern während des Abschnitts ARK-XXII/1c

Cruise track of Polarstern during the expedition ARK-XXII/1c

2. WEATHER CONDITIONS

Eugen Müller
DWD Deutscher Wetterdienst

Weather situation during the cruise leg ARK-XXII/1a (Bremerhaven-Tromsø)

On May 29 when *Polarstern* started its cruise in Bremerhaven, a low pressure system over east Germany caused rain and northwesterly, later in the North Sea westerly winds of Bft 5 - 6. On the transit to the research area along the norwegian coast a ridge built up over the North sea, followed by a strong high, that became stationary over Scandinavia. The winds decreased rapidly to Bft 4 and Bft 2 - 3 later. The first working area, Røst Riff, was reached on June 2 and in the following night fog came up in the increasing moist air. On June 3 the diving operations with JAGO could be started after the fog dissolved in the evening. While the Scandinavian high decayed, a new high developed over the Northern Sea. It became stationary and dominated the weather for the following days until June 10. Because of the small pressure gradients, mostly weak winds of around Bft 3 prevailed. Sometimes it was even calm and the sea was smooth, except of a flat swell of 1 - 1,5 m.

During June 5 the Parasound system was tested and on June 6 the transfers by helicopters to Tromsø were done. The helicopter flights could be managed at sometimes difficult meteorological conditions because of the low stratus clouds and batches of fog over the sea. After these operations *Polarstern* sailed back to the Røst Riff.
The weather changed on June 11 when a cold front passed the Northern Sea to the south. Northwesterly winds of Bft 5 - 6 forced waves of 2,5 - 3 m. The dominating low pressure system became stationary over Scandinavia, and in the northerly current of unstable polar air over the relatively warm sea surface (11°C) many showers of rain were triggered. The changeable weather continued, but the northerly winds decreased to Bft 4.

From June 13 to 15 *Polarstern* operated in the Traena Riff area. A flat low over the Barents Sea caused only weak northerly winds of Bft 2 - 3. Initially a swell of 2 m still resisted, but it decreased slowly to 1 m. On June 16, back in the Røst Riff area again, a passing upper level trough was accompanied by showers of rain and northwesterly winds of Bft 4 - 5. From June 18 on *Polarstern* worked in the Sotbakken riff area off the coast of Tromsø. A high pressure system over Jan Mayen extended to west Norway and became more and more flat. Northwesterly winds decreased from Bft 4 to Bft 2 and the sea became smooth. These calm conditions persisted until the end of the subleg ARK-XXII/1a in Tromsø on June 21.

Weather situation during the cruise leg ARK-XXII/1b (Tromsø-Longyearbyen)

The second subleg ARK-XXII/1b began in the afternoon of June 23, when *Polarstern* left Tromsø accompanied by fair weather, a temperature of 19°C and easterly winds of Bft 3 - 4 in the fjords. Already in the next morning the working area Hakon Mosby Mud Volcano (HMMV) was reached. A flat decaying ridge caused only weak north-easterly winds and a relatively calm sea, what meant good conditions for the first ROV dive. On June 25 a low over Northwest Russia extended to the Barents sea and with the increasing pressure gradient also the north-easterly winds reinforced from Bft 4 to Bft 6 and the waves grew up to 3 m till the evening. Subsequently the low moved westward to Finland on June 26 , and as a consequence the winds over the Barents and Northern sea increased up to Bft 7 8. A pressure difference of 20 hPa existed between Spitsbergen and the North Cape. Waves of 4 m were observed. On the following two days the extensive low became stationary over Scandinavia and filled slowly up. The north-easterly winds in the working area decreased gradually to Bft 5 and the waves to 2.5 m.

On June 29 a secondary cyclone developed south of Spitsbergen and the wind shifted to northwest in the working area. On the next day the low was over Spitsbergen and caused a northwest storm over the Greenland Sea. Its swell could reach even the *Polarstern*. With a high pressure system that developed over the Northern Sea, the wind decreased rapidly to Bft 2, but the swell of 3 m from northwest remained until the evening. The centre of the flat high moved to the Barents Sea and on July 1 it was almost calm with a further decaying swell of 1 m. The high determined the weather also on the following days. A north-easterly current of Bft 3 - 4 dominated the wind conditions in the HMMV area. It increased slowly from day to day up to Bft 6 on July 6, when the last ROV-dive took place. The weather situation didn´t change on the following transit to Longyearbyen (Spitsbergen) from July 7 to 9. But the wind decreased rapidly when *Polarstern* steamed northwards and finally shifted to the west. On the anchorage of Longyearbyen a northwesterly wind existed, slightly strengthened by the orography up to Bft 4.

Weather situation during the cruise leg ARK-XXII/1c (Longyearbyen-Tromsø)

Polarstern left Longyearbyen already in the afternoon of July 9. There was still a stationary high pressure system over the Greenland- and Barents Sea with only small pressure gradients. Therefore weak westerly winds or calm conditions in the Isfjorden, followed by northwesterly winds of Bft 3 - 4 when entering the open sea. This weather situation persisted until July 16. North to northeasterly winds with windspeeds of Bft 4 - 5 dominated. Sometimes ice fields smoothed down the sea, whereas in the open water waves of 1 - 1,5 m were observed. The ice situation during ARK-XXII/1c is documented in the satellite image illustrated in Fig. 2.1.

On July 17 a deepening cyclone moved from Finland to the Barents Sea. So the northerly current between this low and a high over Jan Mayen continued. The northern most station of this leg (79,7°N 4,5°E) was in a partly ice-covered region.

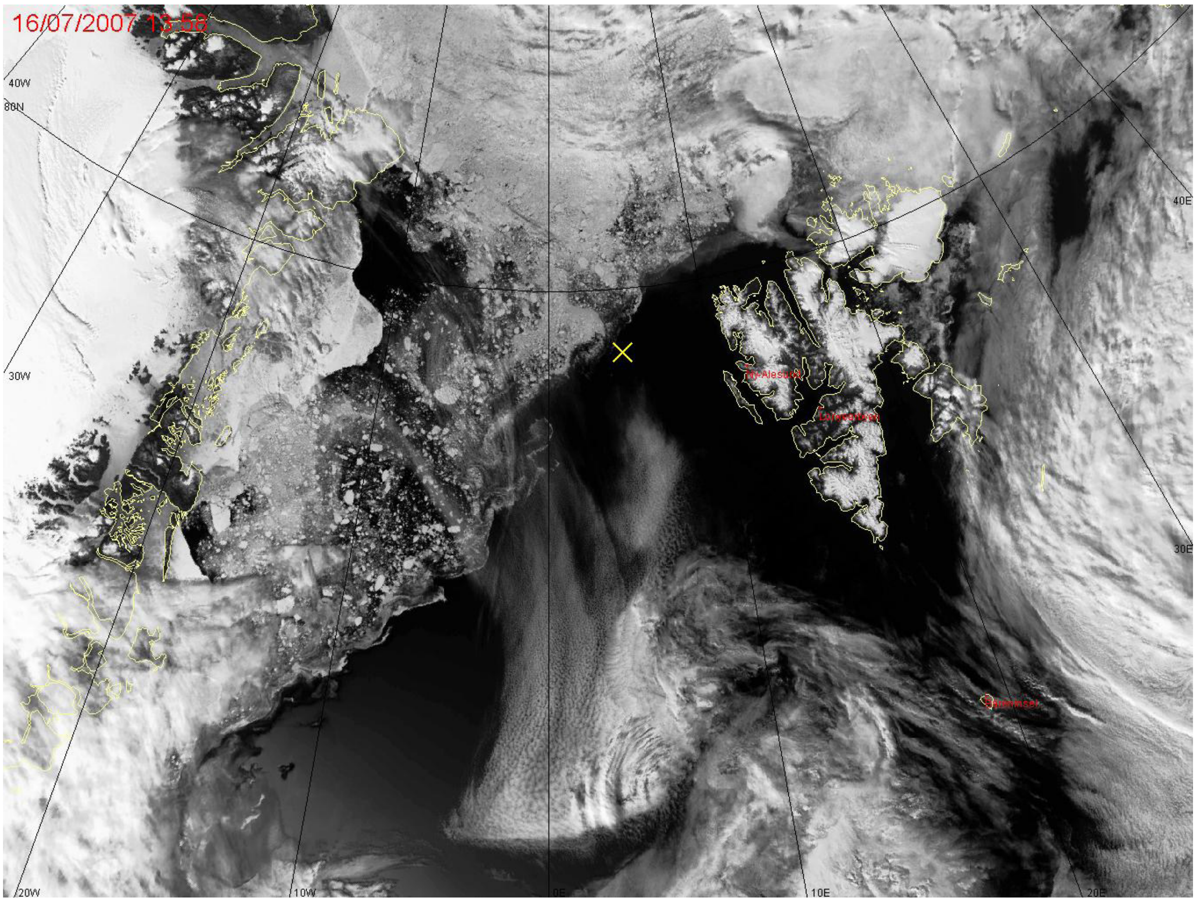

Fig. 2.1: Sea ice situation at 16 of July in Fram Strait

On July 18 the low over the Barents Sea moved westwards to Spitsbergen and started to fill up. A northerly-northeasterly current of Bft 5, sometimes up to Bft 6, dominated the following days, and waves of 1,5 - 3 m were observed. On July 21 the low pressure system moved southward to the Bear Island, where it became stationary (see satellite image in Fig 2.2). The northerly winds of Bft 5 still persisted until July 22. There were often fog banks in the vicinity of the ice edge. On the afternoon of July 22 the transit to Tromsø began, and while steaming southwards the wind decreased to Bft 4. On July 23 the low over the Bear Island was completely filled up. The resulting small pressure gradients over the Nordic Sea persisted until the last transit day July 24. Fair weather, weak winds and a calm sea characterized these last two days.

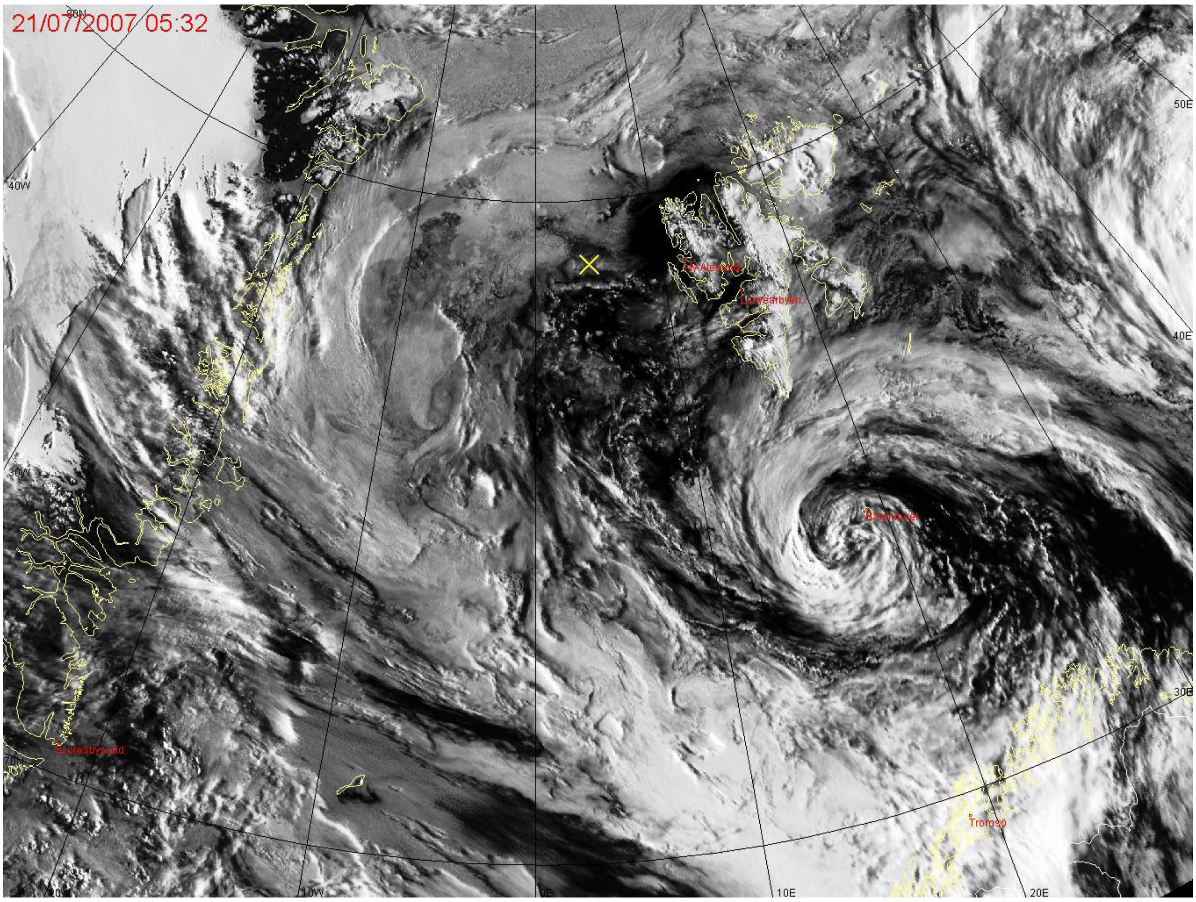

Fig. 2.2: Satellite image of the low pressure system prevailing on 21 July in the Barents Sea which than became stationary around Bear Island

3. SEDIMENT ACOUSTICS: ATLAS PARASOUND SYSTEM UPGRADE DS-2 TO DS-3 (P70)

Saad El Naggar[1] Gerhard Kuhn[1], Frank Niessen[1], Thomas Liebe[2], Peter Gerchow[3], Ulrich Lütticke[4,] Ralf Alfke[4]

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[2)]F. Laeisz
[3)]Fielax
[4)]Atlas Hydrographic

On the transit from Bremerhaven to Tromsø the first of two sea acceptance tests (SAT) were carried out for the newly installed Parasound system upgrade DS-3.

Tab. 3.1: Operation frequencies of the new ATLAS PARASOUND DS3 system (2007).

Frequency Band	Value(s)	Benefits of the Frequency Band
Primary High Frequency PHF1	ATLAS PARASOUND P70: - 18 kHz … 33 kHz (adjustable) ATLAS PARASOUND P35: - 18 kHz … 21 kHz (adjustable)	• Basis for the creation of the parametric signal • Acquisition of bathymetric data
Primary High Frequency PHF2	PHF2 = PHF1 + SLF	• Basis for the creation of the parametric signal
Secondary (Parametric) Low Frequency (SLF)	500 Hz … 6 kHz (adjustable)	• Deep sediment penetration • Additional bathymetric data channel
Secondary (Parametric) High Frequency (SHF)	36.5 kHz … approx. 40 kHz	• High-resolution water column analysis
Primary Low Frequency (PLF)	Approx. 6 kHz … 10 kHz (adjustable)	• Conventional (non-parametric) sub-bottom profiling

The second and final SAT is planned during the forthcoming cruise ANT-XXIV/1 in autumn 2007. With the DS-3 upgrade the hardware of the Parasound DS-1 system was replaced originally installed on *Polarstern* in 1989. DS-3 has totally renewed electronic components excluding the hull mount transducer array that still meets modern requirements including ice protection.

Objectives

The Atlas Parasound is a permanently installed system on *Polarstern*. It determines the water depth, and, with variable frequencies (Tab. 3.1), it provides high-resolution information of the sedimentary layers up to a depth of 200 meters below sea floor. With installation of the new hardware the control and data acquisition software packages Atlas Hydromap Control and Parastore and the local ATLAS echosounder network (Fig. 3.1) were updated as well. The entire update allows a lot more functions compared to the previous version DS-2. A description of the new DS-3 system will be presented in the report of the second phase of SAT on ANT-XXIV/1 in autumn 2007. The most important new functions include:

(i) Data acquisition of two additional and adjustable bands of transmission frequencies (SHF and PLF, Tab.1);
(ii) Beam steering to compensate for effects of sea floor topography such as dipping slopes;
(iii) User defined transmission-pulse shapes and modes (e.g. chirp);
(iv) Automatic sea-floor depth control in echogram windows;
(v) Additional data storage in SEG-Y format;
(vi) Adjustable output acoustic energy of PHF-1 (Tab.3.1) for marine mammal protection.

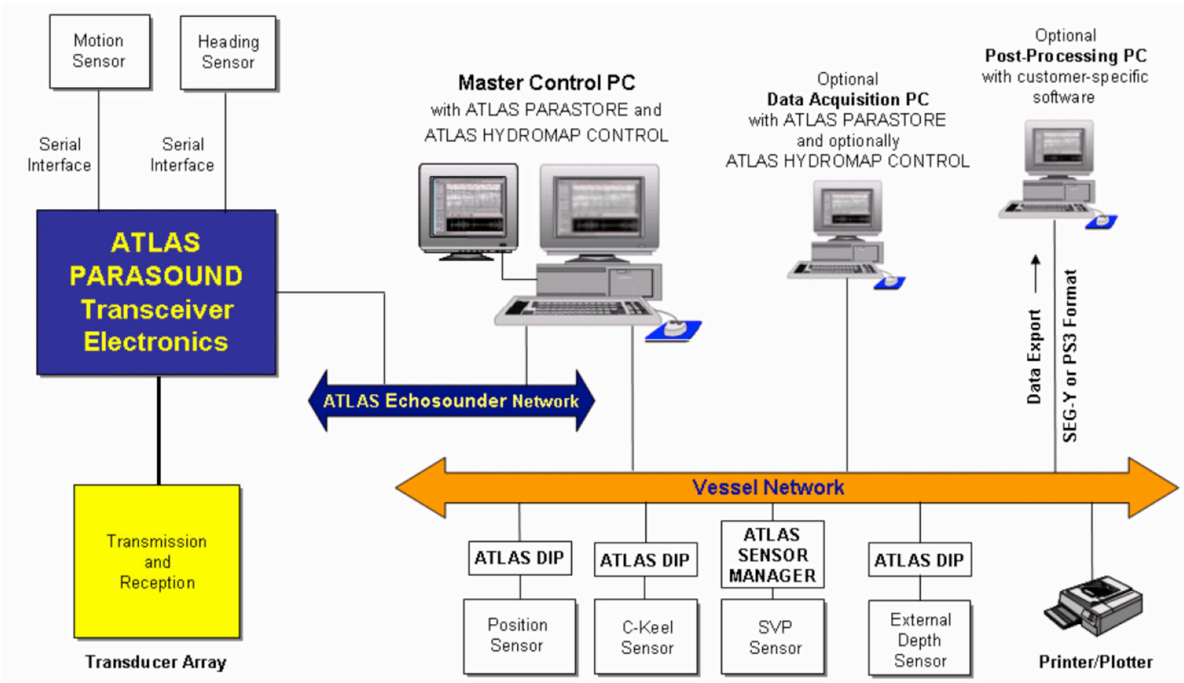

Fig. 3.1: System architecture of new ATLAS PARASOUND DS3 system (2007) with communication on 1GB local area network

Work at sea

System configuration and stability tests were carried out during the whole cruise. On 5 June a first deep-water test was carried out in an area (Fig. 3.2, Tab. 3.2) deep enough to allow pulse-train mode of operation and sediment penetration to 45 m below sea floor (Fig. 3.3). The results repeated similar penetration observed in the area during a previous cruise (ARK-XX/1). Also, we have successfully tested beam steering in on the Norwegian continental slope between waypoints 4 and 5 (Fig. 3.2). The adjustable output energy of PHF-1 (Tab. 3.1) could not be tested, because the level of sub-bottom acoustic penetration was not high enough along the entire cruise track. The sedimentary environments on the Norwegian continental shelf and slope have been affected by glaciations during the Quaternary and do not allow deep acoustic penetration.

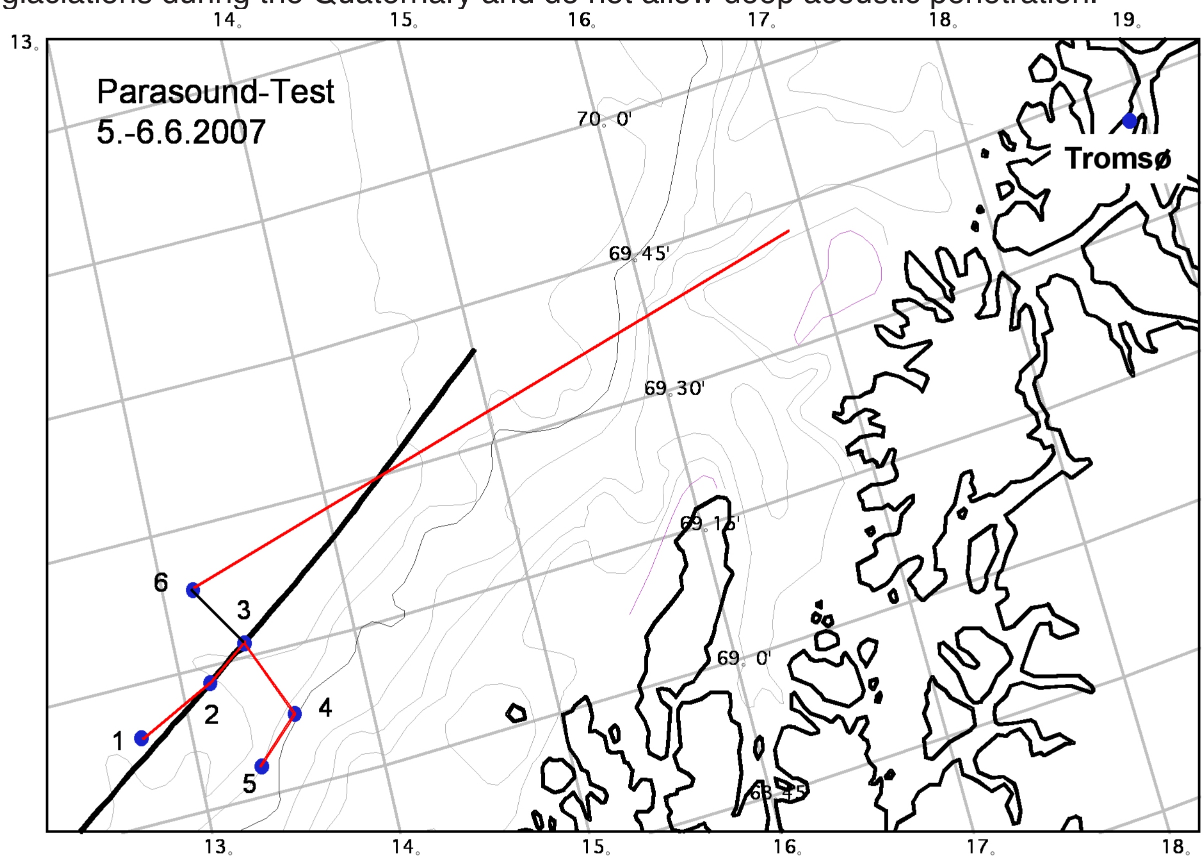

Fig. 3.2: Area of the preliminary deep-water test of Parasound DS-3 (for coordinates of way points 1 to 6 see Table 3.2)

Although basic testing was successful, the DS-3 system did not run stable during the test period and showed some evidence of insufficient transducer steering and ship-motion compensation. Therefore, one engineer of ATLAS Hydrographic further improved the system in terms of hard and software during the rest of the cruise leg 1a. Deep-water testing was only preliminary because this part of the SAT is left for the second test phase in the Bay of Biscay in autumn 2007. Except for the one engineer (U. Lütticke) the test crew left *Polarstern* to Tromsø by helicopter on 6 June 2007.

Tab. 3.2: Positions of waypoints of deep-water Parasound test (Fig. 3.2)

Position		Position		Way Points
Lat N	Long E	Lat N	Long E	No.
69°09.32	12°43.75	69.155	12.729	1
69°13.26	13°09.78	69.221	13.163	2
69°16.50	13°23.58	69.275	13.393	3
69°07.73	13°35.00	69.129	13.583	4
69°03.18	13°20.63	69.053	13.344	5
69°23.41	13°10.63	69.390	13.177	6

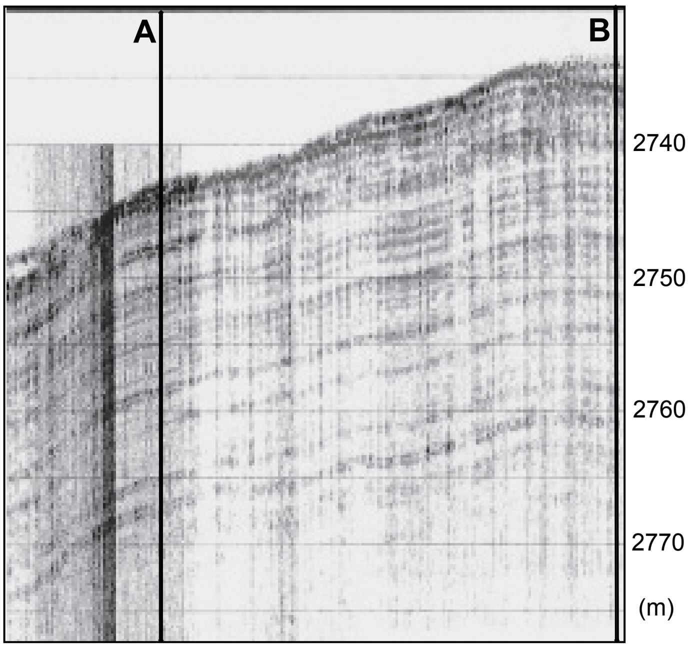

Fig. 3.3: Parasound DS-3 testprofile section near waypoint 3 (Fig. 3.2). Position at A: 69.258N, 13.319E. Position at B: 69.263N, 13.361E

4. THE RESEARCH SUBMERSIBLE "JAGO" AND SUMMARY OF DIVE OPERATIONS DURING ARK-XXII/1A

Jürgen Schauer, Karen Hissmann
IfM-GEOMAR

Objectives

JAGO is a manned submersible devoted primarily to research in the marine sciences. It allows researchers a personal view of the sea floor with the greatest degree of freedom. The underwater craft is certified to a maximum operating depth of 400 m and was designed and built according to the rules for classification and construction of the Germanischer Lloyd. The highly manoeuvrable vehicle can accommodate two persons, the pilot and a scientist/observer, at atmospheric pressure.

JAGO has two large acrylic dome ports that allow excellent visibility on the sea floor. The craft is electrically driven and able to move underwater autonomously within the reach of the navigation and communication systems of the surface vessel. The vehicle is equipped with fluxgate compass, USBL navigation and tracking system, underwater telephone, sonar, video and still cameras, oceanographic sensors and 8 function manipulator arm for handling various sampling devices from within the sub. Typical applications are benthic and/or mid-water observations and surveys, video/photo documentation, underwater sampling, environmental studies, search and location of objects, salvage work and support in emergency cases.

JAGO was built in 1989, and is maintained and operated by a small expert team. Since January 2006 the craft is stationed at the Leibniz Institute of Marine Sciences IfM-GEOMAR in Kiel. JAGO has made more than 1,000 dives throughout the World's Oceans and in deep lakes. It carried some hundred different observers to the sea floor, mainly scientists of various disciplines in the field of marine biology, microbiology, geology, palaeontology, sedimentology, biogeochemistry, oceanography and environmental conservation, film teams, photographers and marine engineers.

Because of its compact construction and small weight of 3 tons JAGO can be launched and recovered from nearly any larger boat and vessel with sufficient crane capacity. Over sea transportation is made with a single shippers own 20' standard sea freight container.

The submersible is regularly operated from board the German research vessels. The most important requirements for handling of the submersible are a deck crane or stern gantry with sufficient lifting capacity (minimum 5 tons) at an outreach of at least 3 meters from the ship's side, and sufficient deck space for save handling during deployment and recovery.

Work at sea

ARK-XXII/1a was the first *Polarstern* cruise with a submersible on board. JAGO has never been deployed from *Polarstern* before. The vessel has a main deck crane (HATLAPA) with a lifting capacity of 15 tons at 16 m outreach which was used for the deployment and recovery of the submersible over the ship's starboard side. The size of the vessel and its draft of 11 m makes *Polarstern* an extremely stable working platform even in wave heights of more than 2 m and wind speeds of 8 m/s. Communication from on board the ship turned out to be impossible. The underwater telephone (ORCATRON 10 kHz) was therefore transferred onto the workboat which kept position above the submersible during each dive. The minimum distance between ship and workboat for a more or less descent telephone contact with the submersible was 500 m. The workboat was operated by a crew member, the subphone by a member of the scientific party. The workboat team rotated every one to two hour. It kept close communication with the person at the navigation and positioning system on board the vessel. The submersible was tracked underwater with the help of a POSIDONIA USBL Underwater navigation and positioning system, part of the ship's equipment. The acoustic transponder which was used on the submersible was an IXSEA beacon (Model MT861S-HD-R, weight in air 6.5 kg) set to an interrogation frequency of 8.5 kHz. The POSIDONIA system provided very reliable positions during the entire cruise. The workboat (DSB inflatable with aluminium hull and Yanmar 36 HP Diesel outboard engine) was also used to pull JAGO away from the ship's side after deployment and for towing it back under crane position for its recovery.

During ARK-XXII/1a JAGO was used for ground truthing of the hydrosweep charts, which were produced during the cruise, detailed visual and video documentation of the coral reefs and surrounding areas, and for selective sampling of sponges, corals and their associated fauna with minimum impact on the ecosystem. Near-bottom water was collected directly above or at the reef by Niskin Bottles attached to the submersible in reach of the manipulator arm. Sediment samples were taken within the reefs during three dives in various water depths. A CTD attached to the lower part of the submersible continuously recorded depth, temperature and salinity during each dive. An ADCP at JAGO's stern measured near-bottom currents while resting at the bottom. A mobile oxygen sensor was placed with the manipulator arm into the living corals in order to compare oxygen values above and within the reef.

In total, 63 hours were spent underwater on 20 project dives (Tab. 4.1). Twenty different scientists had the chance for a personal view on the sea floor at 4 different dive locations. About 37 hours of video and dive tracks (Lat./Long. Positions, Tab. 4.2) for each dive to be plotted on the Hydrosweep charts are available.

Handling of the submersible from on board *Polarstern* went extremely smooth up to wind speeds of 8 m/s and wave heights of 2 m thanks to an excellent deck crew coordinated by the first officer Uwe Grundmann, crane operator Ekkehard Burzan, the work boat team bosun Burkhard Clasen and a rotating assistant, and the skilful hookmen Sascha Flögel and Andres Rüggeberg. Good weather conditions made it possible that the communication to the submersible was disconnected from the mothership – an extraordinary situation for a JAGO operation. Sascha Flögel, Andres Rüggeberg (JAGO-Team) and the bosun and his sailors spent all together 63 hours in the workboat to secure underwater communication during all dives. Their mutual support and enthusiasm made the JAGO operation possible under these extraordinary circumstances.

Research Submersible JAGO - General Specifications

Dimensions	Length 3.2 m, Beam 2.0 m, Height 2.5 m
Weight in air	3,000 kg
Operation depth	400 m
Cruising speed	approx. 1 knot
Crew	2 persons (1 pilot, 1 observer)

Pressure hull steel, 15 – 18 mm

Viewports bow-window (ø 700 mm), top dome / hatch (ø 450 mm) providing 360-degree view, both acrylic

Energy supply 3 battery sets, total capacity 540 AH – 24 Volt DC
Propulsion 4 reversible horizontal thrusters at stern, 2 rotational thrusters on starboard and port side, 1 bow and 1 aft thruster

Manipulator hydraulic, 8 functions and exchangeable claws, lifting capacity 5 kg

Navigation ORE LXT underwater positioning and navigation system (USBL), fluxgate compass, D-GPS satellite navigator, vertical and horizontal sonar, depth gauges, pinger positioning

Communication ultrasonic underwater telephone (subphone, ORCATRON), 10 kHz, VHF-radio

Emergency systems "Dead man" controlled ballast release system, manual ballast release, generation of >500 kg positive buoyancy at maximum diving depth, emergency buoy with rescue installation, life support 96 hours (2 persons)

Other Equipment 5 halogen-projectors, 2 flash-lights, digital video- and still cameras, physical instruments and sensors, sampling devices for organisms, gas, water, fluids, sediments, rocks, VEMCO ultrasonic transmitter receiver
Certified Germanischer Lloyd Hamburg

JAGO Dive #	Project Dive, Stat #	Date Time Sub-merged Time surfaced	Location	Total dive time (min)	Touch down position	Lift off position	Min-Max Depth (m)	Pilot	Observer	Video tapes #
986	1 / 6-1	03.06.07 18:07 21:52	Rost Reef	225	N 67.32.01 E 09.29.79	N 67.31.69 E 09.30.11	308-364	Schauer	Flögel	1, 2, 3
987	2 / 9-2	04.06.07 09:37 12:50	Rost Reef	193	N 67.30.59 E 09.25.44	N 67.30.39 E 09.25.56	303-350	Schauer	Hall-Spencer	4, 5
988	3 / 9-4	04.06.07 16:16 18:47	Rost Reef	151	N 67.30.23 E 09.25.36	N 67.30.63 E 09.25.85	280-340	Schauer	Thomsen	6
989	4 / 12-9	07.06.07 16:28 18:48	Floholmen	140	N 69.02.51 E 13.59.92	N 69.02.44 E 13.59.95	202-207	Schauer	Wehrmann	7
990	5 / 13-1	08.06.07 23:27 02:30	Rost Reef	183	N 67.30.07 E 09.24.48	N 67.30.131 E 09.24.54	293-317	Schauer	Viergutz	8, 9
991	6 / 14-4	09.06.07 10:46 13:51	Rost Reef	185	N 67.29.93 E 09.24.41	N 67.29.99 E 09.24.34	282-291	Schauer	Hoffmann	10, 11
992	7 / 15-1	09.06.07 18:32 22:14	Rost Reef	222	N 67.30.04 E 09.25.30	N 67.30.38 E 09.25.13	280-312	Schauer	Unnithan	12, 13, 14

JAGO Dive #	Project Dive, Stat #	Date Time Sub-merged Time surfaced	Location	Total dive time (min)	Touch down position	Lift off position	Min-Max Depth (m)	Pilot	Observer	Video tapes #
993	8 / 16-1	10.06.07 08:52 12:21	Rost Reef	209	N 67.30.86 E 09.26.57	N 67.30.70 E 09.26.48	306-353	Schauer	Purser	15, 16
994	9 / 17-1	10.06.07 16:30 20:32	Rost Reef	242	N 67.31.17 E 09.28.58	N 67.31.16 E 09.28.91	282-340	Schauer	Schöttner	17, 18
995	10 / 24-2	13.06.07 16:20 20:36	Traena Reef	256	N 66.58.09 E 11.08.49	N 66.58.13 E 11.07.29	297-319	Schauer	Fanguero	19, 20
996	11 / 26-1	14.06.07 09:23 12:35	Traena Reef	192	N 66.58.19 E 11.07.20	N 66.58.18 E 11.07.23	305-314	Schauer	Lessmann	21, 22
997	12 / 27-1	14.06.07 17:50 21:21	Traene Reef	211	N 66.58.34 E 11.07.65	N 66.58.48 E 11.06.42	287-302	Schauer	Cardenas	23, 24
998	13 / 29-1	15.06.07 09:08 11:30	Rost Reef	142	N 67.33.06 E 09.32.73	N 67.33.02 E 09.32.96	283-330	Schauer	Rüggeberg	25, 26
999	14 / 31-1	15.06.07 16:45 19:27	Rost Reef	162	N 67.31.34 E 09.28.02	N 67.31.31 E 09.28.23	358-388	Schauer	Wild	27, 28

JAGO Dive #	Project Dive, Stat #	Date Time Sub-merged Time surfaced	Location	Total dive time (min)	Touch down position	Lift off position	Min-Max Depth (m)	Pilot	Observer	Video tapes #
1000	15 / 34-1	16.06.07 08:45 11:44	Rost Reef	179	N 67.31.99 E 09.30.55	N 67.31.92 E 09.30.28	343-355	Schauer	Thiede	29, 30
1001	16 / 35-4	16.06.07 16:20 20:13	Rost Reef	233	N 67.30.31 E 09.24.73	- -	305-335	Schauer	Hissmann	31
1002	17 / 40-4	18.06.07 12:24 15:28	Sotbakken	184	N 70.45.30 E 18.39.72	N 70.45.38 E 18.39.95	247-269	Schauer	Todt	32, 33
1003	18 / 41-2	19.06.07 09:02 12:14	Sotbakken	192	N 70.45.14 E 18.39.60	N 70.45.36 E 18.39.76	246-280	Schauer	Knab	34, 35
1004	19 / 42-1	19.06.07 16:34 19:15	Sotbakken	161	N 70.45.37 E 18.40.70	N 70.45.41 E 18.40.21	256-284	Schauer	Moje	36
1005	20 / 43-1	20.06.07 08:22 10:20	Sotbakken	119	N 70.45.79 E 18.41.60	N 70.45.98 E 18.41.53	259-270	Schauer	Tornes	37
	20 dives	13 dive days	4 locations	3781 (63 h)			202-388		20 scientists	37 hours video

Fig.4.1a (left): Research Submersible JAGO and Polarstern during cruise PS ARK-XXII/1a (Foto Karen Hissmann / JAGO-Team)

Fig. 4.1b (right): Research Submersible JAGO during deployment from on board Polarstern

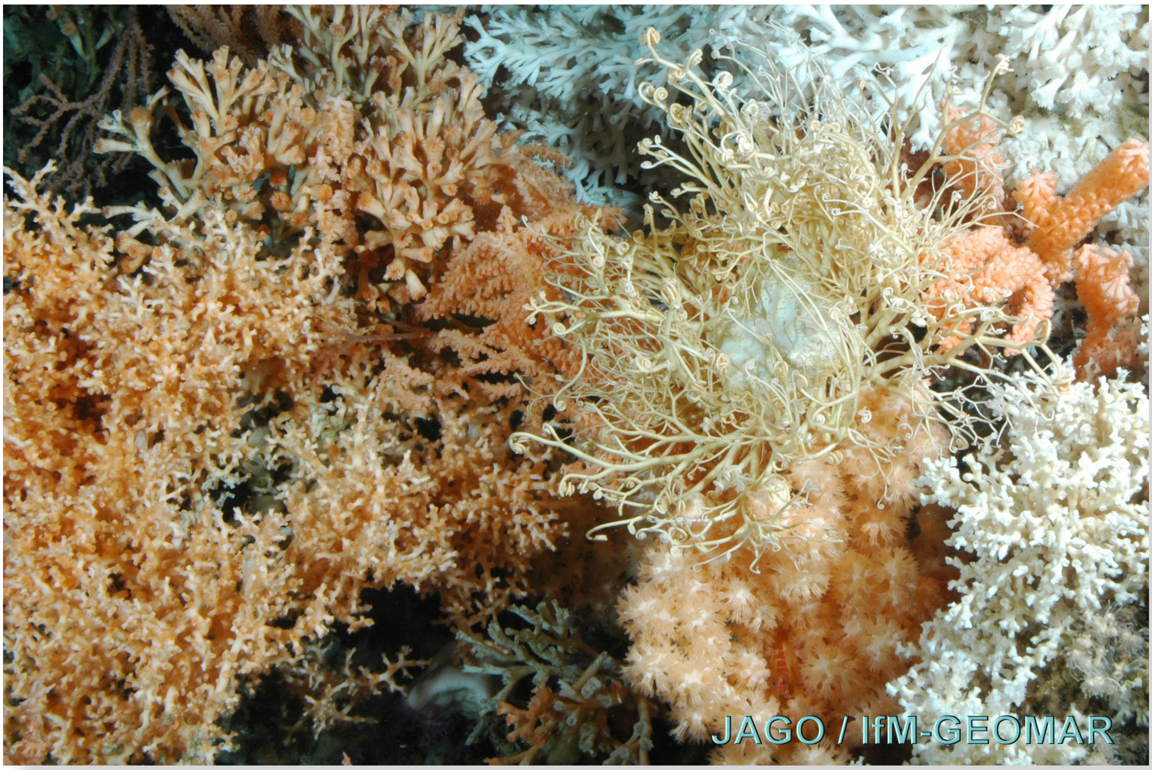

Fig.4.3: Underwater image taken by JAGO during a dive at the Røst Reef in 320 m depth (Foto K. Hissmann & J. Schauer)

5. DEEP-WATER CORALS ALONG THE NORWEGIAN CONTINENTAL MARGIN: MULTIDISCIPLINARY STUDIES ON SULA RIDGE, TRAENA REEF, RØST REEF, FLOHOLMEN AND SOTBAKKEN

Jason Hall-Spencer[1], Marta Karolina Söffker[1], Laurenz Thomsen[2], Vikram Unnithan[2]

1) University of Plymouth
2) Jacobs University Bremen

Objectives and work at sea

Despite our knowledge of the existence of cold-water corals since the times of Linnaeus, it is only in recent years that we have begun to unravel the geological and ecological complexities of the astonishing biogenic reefs formed by deep-water corals (Hovland & Mortensen, 1999; Freiwald et al., 2002; Hall-Spencer et al., 2002; Roberts et al., 2006; Lindberg et al., 2007). The present cruise surveyed cold-water coral reefs along the Norwegian coast, starting with a sidescan survey of Sula Ridge to examine backscatter data in detail on what is perhaps the best described cold-water reef complex (Freiwald et al., 2002). The expedition then continued north as a major target of the cruise was to study a system of Lophelia pertusa reefs which lie within the Arctic Circle off Røst in Lofoten. These reefs were discovered by the Norwegian Institute of Marine Research (IMR) in 2002 (Fosså et al., 2004; 2005) and comprise a complex of reefs that are 35 - 40 km long, up to 3 km wide and live at 300 400 m depth along the back wall of a giant submarine slide which took place on a steep and rugged part of the continental shelf break 4,000 years ago (Laberg et al. 2002). In the area mapped by IMR about 1500 potential Lophelia mounds were counted on the upper slope and around ice berg scars on the shelf. The IMR inspected selected parts of the reef with a tethered video camera and a ROV. They found no signs of coral damage due to fishing and on 4 January 2003 the Norwegian Government gave Røst Reef special protection against bottom trawling in an area 53 km long and 17 km wide. In July 2005 the Røst Reef was a target study area for a RV "Poseidon" cruise but poor weather conditions meant that only six grab stations and 10 CTDs were completed in the main reef area (Freiwald et al., 2005). On this trip we were blessed with good weather and so were able to extend our knowledge of the ecology and geology of Røst Reef considerably.

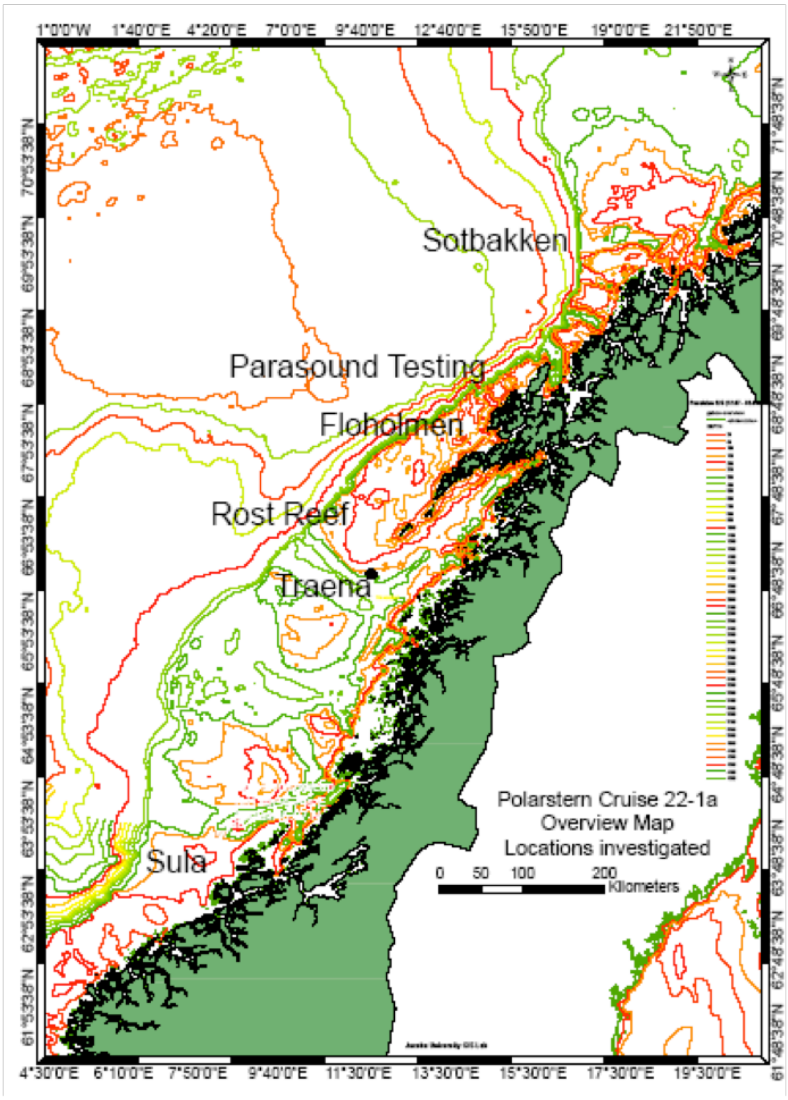

Fig. 5.1: Overview map of the areas investigated during ARK-XXII/1a

Our objectives were to:

1. Map the reef architecture and geometry using a multibeam system
2. Measure physical watermass properties with CTD and water sampler
3. Investigate particle dynamics and organic carbon cycling using ADCPs, particle sizers, sediment traps and water samples
4. Document sedimentary facies, biological habitats and species distributions within and adjacent to reef complexes using submersible, drop-down TV, scientific fish-finder, Van Veen grab and Box Core sampling
5. Thoroughly survey the Porifera and their associated microbiota
6. Characterise the microbial ecology of the living reef system
7. Analyse the postglacial geological evolution of the reefs by obtaining long sediment cores, with special emphasis on degredation and methanogenesis within the sediment

Concern has often been expressed that increased levels of turbidity and sedimentation could have negative effects on cold water coral habitats. To improve environmental risk assessment tools lab-experiments with different particle classes and corals were also carried out onboard. As HERMES deals with sustainable management of marine ecosystems the data from this cruise will be fed into the HERMES ecosystem modeling approach. This will provide means to predict and analyze potentially deleterious effects on coral ecosystems and moreover provide a platform to analyze scenarios to mitigate them. As will be seen in the remainder of this report, many of our ambitious targets were met, thanks in no small part to good weather which allowed us to make maximum use of the JAGO submersible, a first class research tool. In addition to the comprehensive surveys of Røst Reef, we also carried out similar surveys of poorly described coral reefs areas at Traeno and Sotbakken and looked for (but didn't find) reef systems at Floholmen.

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6. WATER MASS PROPERTIES ALONG THE NORTHERN NORWEGIAN MARGIN

Sascha Flögel 1, Andres Rüggeberg 1, Steffen Gauger 2

1) IFM-Geomar
2) FIELAX GmbH

A total of thirty-six CTD casts were carried out during *Polarstern* cruise ARK-XXII/1a (Fig. 6.1). The purpose of these measurements was to perform hydrographic transects across cold-water coral reef structures at Sula Reef, Røst Reef, Floholmen Reef, Traenadjupet, and Sotbakken. Bottom water samples were collected for stable isotope ($\delta^{18}O$, $\delta^{13}DIC$, $\delta^{88}Sr$) analyses. Another objective was to investigate the seasonal variability of the surface and deep-waters as well as the validation of the suggested control of seawater density (sigma-theta, kg/m³) on cold-water coral growth (Dullo et al., subm.).

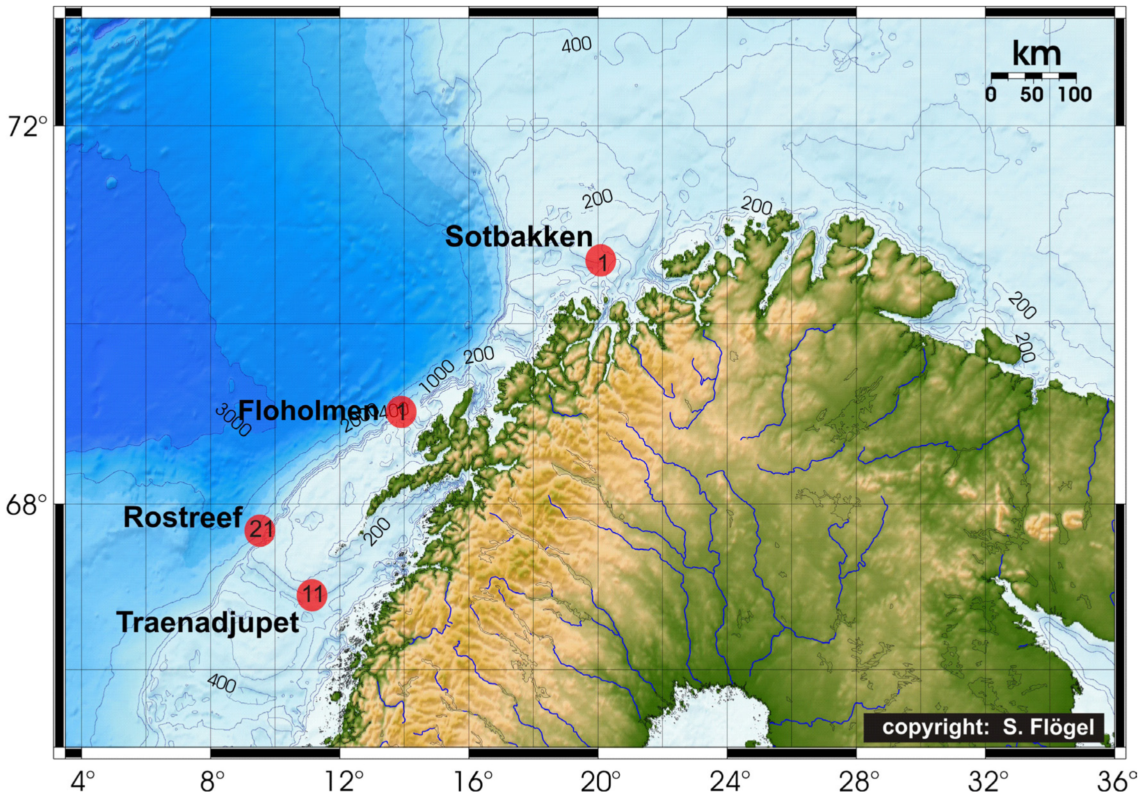

Fig. 6.1: Study areas during cruise leg PS ARK-XXII/1a. Numbers indicate CTD casts taken at each site. One CTD cast at Sula Reef is not included (64°08.2' N, 08°11.4' E)

The CTD system used was a SeaBird Electronics, model 911 plus type. The underwater unit was built into a rosette housing capable of holding 24 water sampler bottles. Pre-cruise laboratory calibrations of the temperature and pressure sensors were performed. Both yielded coefficients for a linear fit.

The main water masses along the Norwegian coast from 66°N to 71°N are of coastal and Atlantic origin. Norwegian Coastal Water (NCW) has salinities less than 35 PSU and stretches like a wedge out over the shelf edge merging with Atlantic Water (AW, Skardhamar & Svendsen 2005). The surface water regime is overlain by less saline freshwater discharge from the Norwegian landmass. The NCW, which originates primarily from the freshwater outflow from the Baltic and freshwater runoff from Norway flows northwards parallel along the coast and dominates the large-scale surface water circulation. In our study, an increase in thickness of the Norwegian Coastal Water from 50 m to 250 m corresponds with an increase in latitude from south to north. AW is characterised by salinities above 35 PSU and is present below the low-saline NCW in water depth of >50 – 250 m. Norwegian Sea Deep Water (NSDW), with salinities below 34.95 PSU and temperatures less than 0 °C, fills the deep basins below 800 m water depth (Fig. 6.2).

Cold-water coral reefs and coral assemblages occur along the Atlantic European continental margin in different water depths and water masses. This would allow the distribution of living corals over a wide bathymetric and hydrographical range, especially temperature, salinity and oxygen (Fig. 6.3).

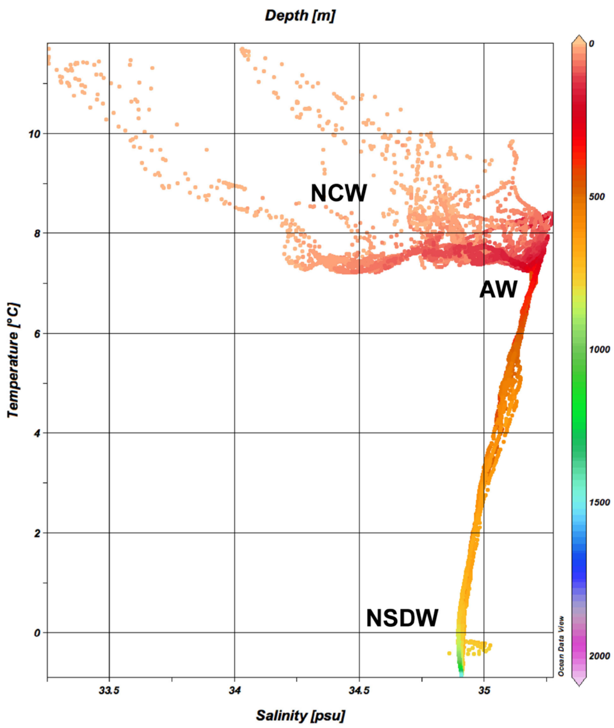

Fig. 6.2: TS-plot of all CTD cast of Polarstern cruise ARK-XXII/1a. Description of water masses are given in text

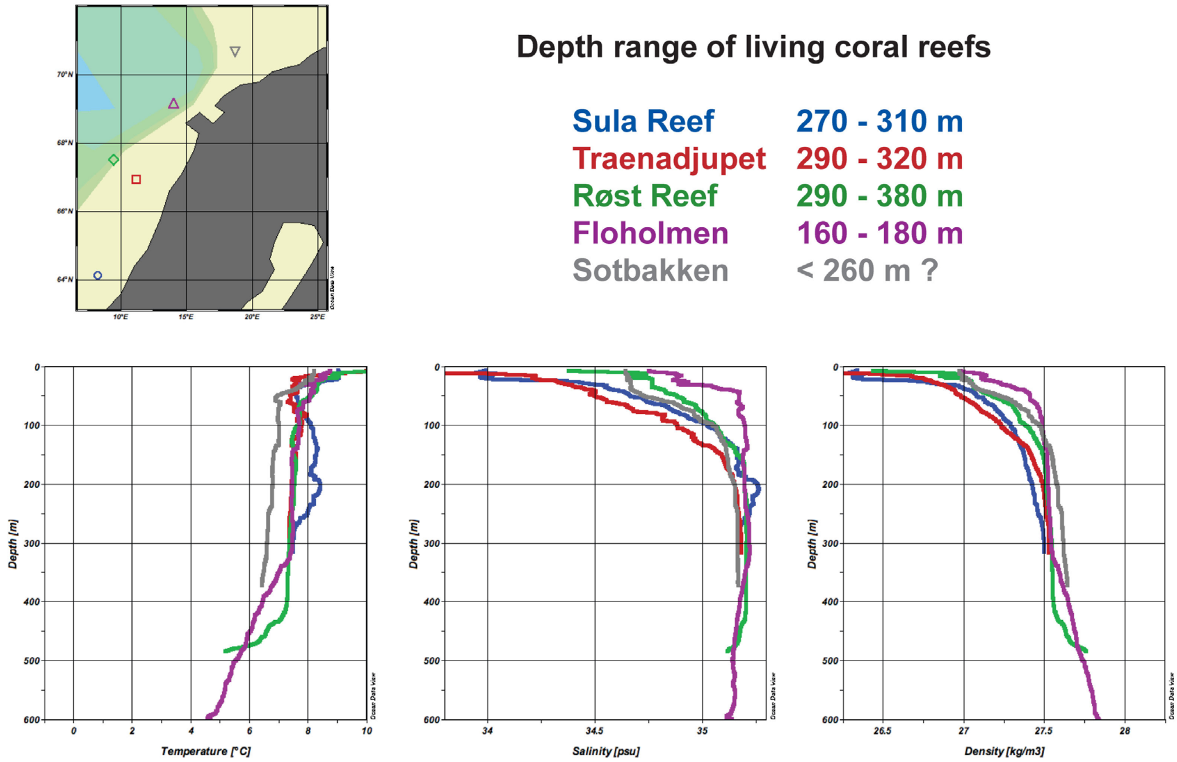

Fig. 6.3: Temperature, salinity and density (S_T) variations along the Norwegian continental margin

Focussing on the Norwegian margin, however, we found that the living cold-water corals at the investigated sites are characterised by a distinct density contrast of the water masses (Fig. 6.4). The habitat of living cold-water corals comprises a field within the Temperature-Salinity diagram of hydrographic data with its lower boundary being equivalent to the upper boundary of the Intermediate Salinity Maximum (ISM). The ISM along the Norwegian Margin is characterized by Atlantic Water. The upper boundary of this field corresponds to the Norwegian Coastal Water on the Norwegian Margin.

The new data of this cruise support the hypothesis that density of water masses bathing cold-water coral ecosystems is an important factor for the distribution of living cold-water corals. We speculate that this parameter controls nutrient availability and enrichment as well as spawning processes.

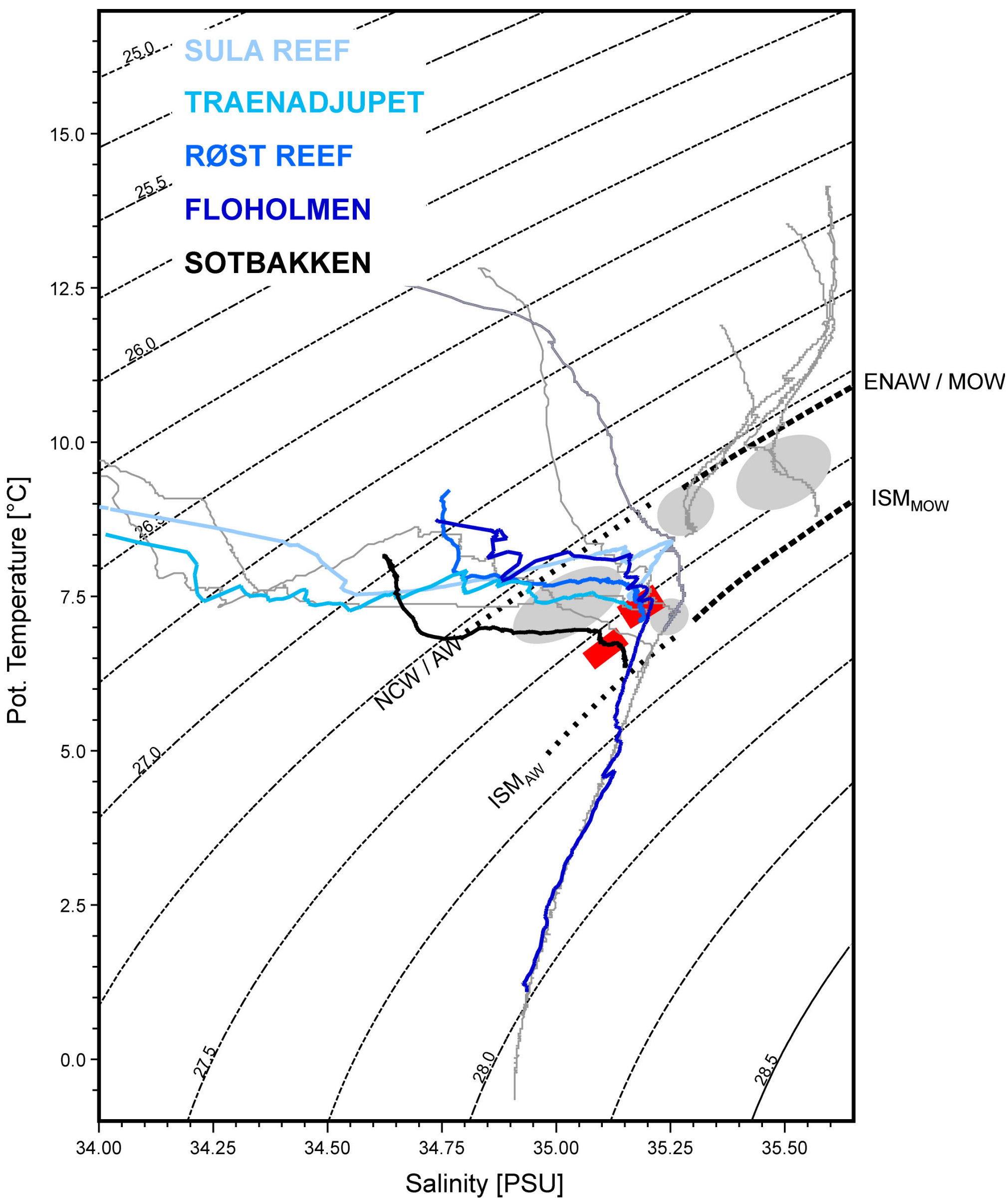

Fig. 6.4: TS-plot of all investigated sites. Thin dashed lines indicate levels of isodensity (S_T) in kg/m³. Grey patches (POS325, 2005) and red squares (PS ARK-XXII/1a, 2007) correspond to habitats of living cold-water corals. CTD data shown as grey lines were measured during various cruises along the NE Atlantic margin in 2004 - 2005. The lower limit is confined by the Intermediate Salinity Maximum (ISM) corresponding to Mediterranean Outflow Water (MOW) at the Celtic margin and to Atlantic Water (AW) at the Norwegian margin. The upper boundary is characterized by the water mass boundaries of Eastern North Atlantic Water (ENAW)/MOW (Celtic sites) and Norwegian Coastal Water (NCW)/AW (Norwegian sites).

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7. HYDRODYNAMICS AND CORAL COMMUNITIES

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Objectives

Effects of elevated levels of particulate matter and sedimentation on cold-water coral ecosystems are a matter of great general interest for HERMES. Concern has often been expressed that increased levels of turbidity and sedimentation could have negative effects, e.g. as a result of the re-suspension of sediments by trawling or other human activities close to CWC-habitats, or as a result of eutrophication of overlying surface waters. Aim of the cruise is to study the coral reefs off the Lofoten by using the PADYS (PArticleDYnamics Sensor system (sediment trap, particle sizer, ADCP, CTD, turbidity) and samples (near-bottom water, surface waters) to get detailed information on fluxes of particulate matter through several coral-reefs. Information on particle dynamics will be used to estimate the importance of particle-aggregation, (bio)deposition and (bio) erosion for the coral reefs off the Lofoten. Samples within the reef, from ambient soft bottom communities and from surface waters will be used to trace back the origin of the particles entering the reef-systems. A close collaboration with the MPI group onboard will allow the further investigation of the importance of coral-mucus in the material fluxes.

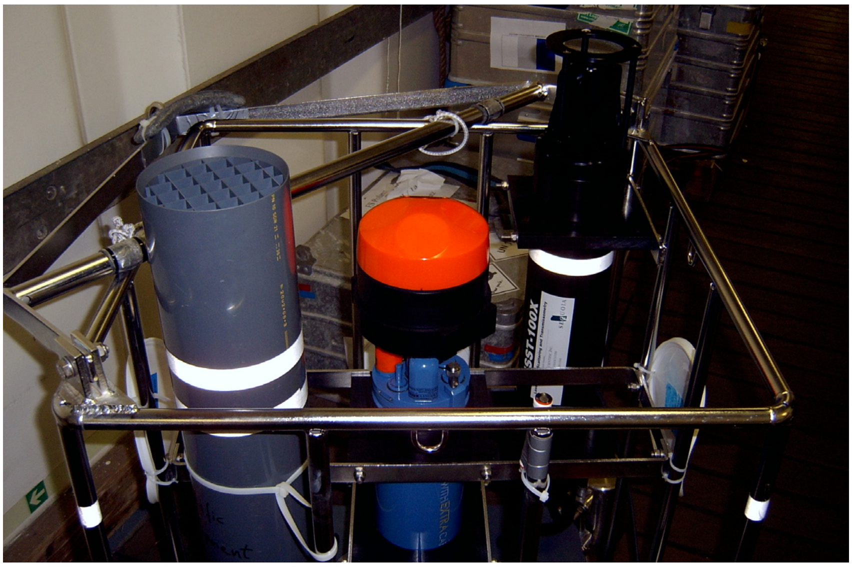

Fig. 7.1: The PADYS system to study particle dynamics. ADCP, turbidity, CTD, particle sizer, sediment trap

Work at sea

In total 30 CTD stations, 16 JAGO dives, 3 sensor deployments were used for the analyses. 110 water samples were/are analyzed for Chlorophyll *a*, turbidity, bioavailabilty and degradation index, particle size, flow direction and velocity, quality of particles (sediment trap), oxygen in near bottom waters. 14 experiments on particle dynamics and mucus production after contact with drill cuttings were carried out.

Preliminary results

The Røst Reef

The study area covered about 20 km^2 towards the continental slope from water depth of 250 – 750 m. Particle dynamics were studies around the steep, dissected ridges parallel to the shelf break, which were several tens of meters high and showed a characteristic community pattern (described in Hall-Spencer's report).

The PADYS was deployed twice at the shelf break in water depth of 320 m (18 and 24 hours at two different locations in the northern and southern part of the study site). Figure 7.3 shows the results of the two ADCP deployments. Flow velocities at 2 m height above seafloor varied during both deployments between 2 and 20 cm/s and directed towards the shelf break and the reef system. Thus, fluxes of particulate matter entered the reef system almost perpendicular and originated from the productive shelf seas. The progressive vectorplot of the water layers between 5 and 30 m above seafloor revealed that particles entering the reef-system traveled 5 - 10 km over 24 hours, thus passing through the whole reef system. This indicates that the reef community had access to a constant supply of labile organic material from the shelf.

Fig. 7.2: Camera snapshot of aggregates within the reef (copyright to IfM-Geomar)

Surface waters at the Røst Reef had Chl *a* concentrations of 0.1 – 1.3 μg/l and turbidity ranged from 0.4 - 2.7 NTU (calibrations to follow). Higher concentrations were found in surface and at Sigma 27.5 watermasses. However, the bottom water concentrations of chlorophyll *a* were highly diminished within the reef with maximum concentrations of 0.03 µg/l. The bottom waters in the reef were loaded with large transparent (organic rich) particles which indicate low settling velocities (to be confirmed in the lab). Average particle sizes ranged 2 to > 500 µm. First data interpretation of the size class distribution indicates a shift from fine to coarser particles with increasing proximity to the reef community. All results indicate that the reef community biodeposits most of the labile phytodetritus from the shelf and that the bottom waters within the reef mainly consist of larger particles which aggregated with the finer fraction of the water column. Analyses on the amino acid composition of the material and the determination of the degradation index will give further insight into the particle composition and carbon deposition in this hotspot ecosystem.

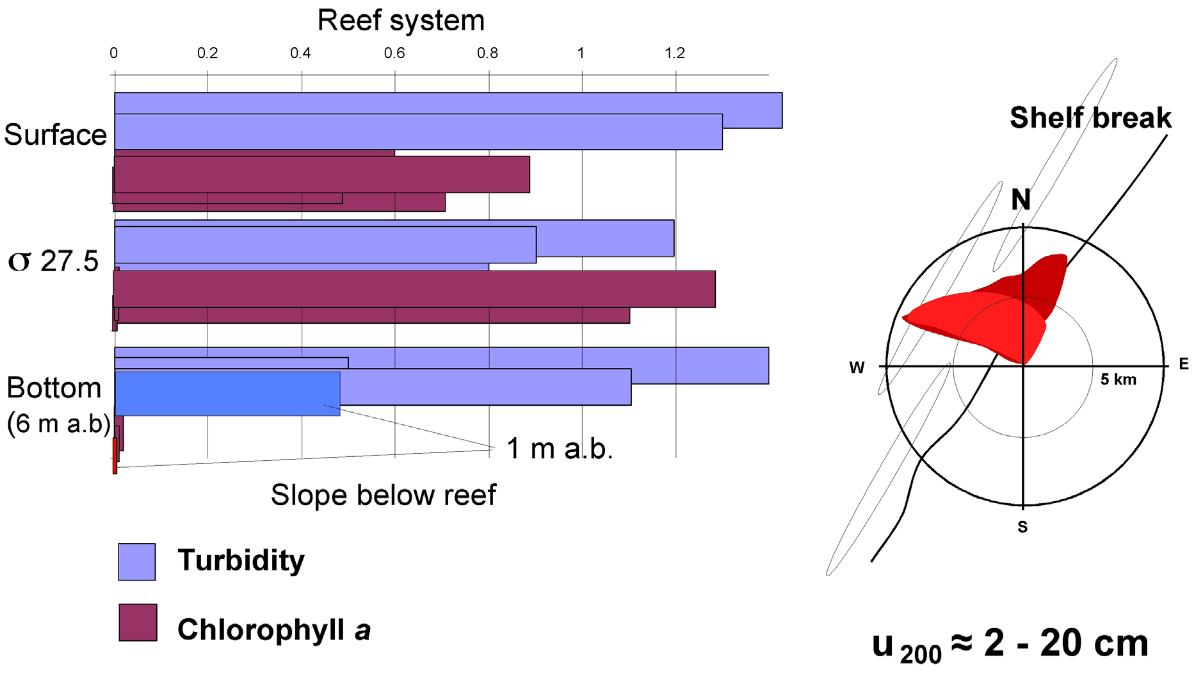

Fig. 7.3: Chlorophyl a and turbidity within the water column above the coral-reef. Low concentrations of Chl.a indicate massive biodeposition. The progessive vectorplot-diagram of bottom currents at the shelf edge indicate cross shelf transport of organic material towards the reef. Red: southern deployment, dark red: northern deployment

One special emphasis of the cruise was to carry out detailed oxygen measurements around and inside the reef. The results show a clear but not yet understood distribution of oxygen in the bottom waters of the reef. As biodeposition seems to be an important process of carbon accumulation at the reef site, oxygen consumption rates in the reef were expected to be very high. Therefore the JAGO submersible was equipped with an oxygen optode to measure variations of oxygen concentrations. Fig 7.4 shows a comparison between two concentration profiles during JAGO dives: one at the Vesteralen site with no coral reef (blue) with little variation in oxygen concentration was found; and one at the Røst Reef (pink) where there is a clear variation of oxygen concentration at different locations within the reef. The data and video-observations from 16 dives will allow us to estimate carbon mineralization rates at different benthic habitats within the reef.

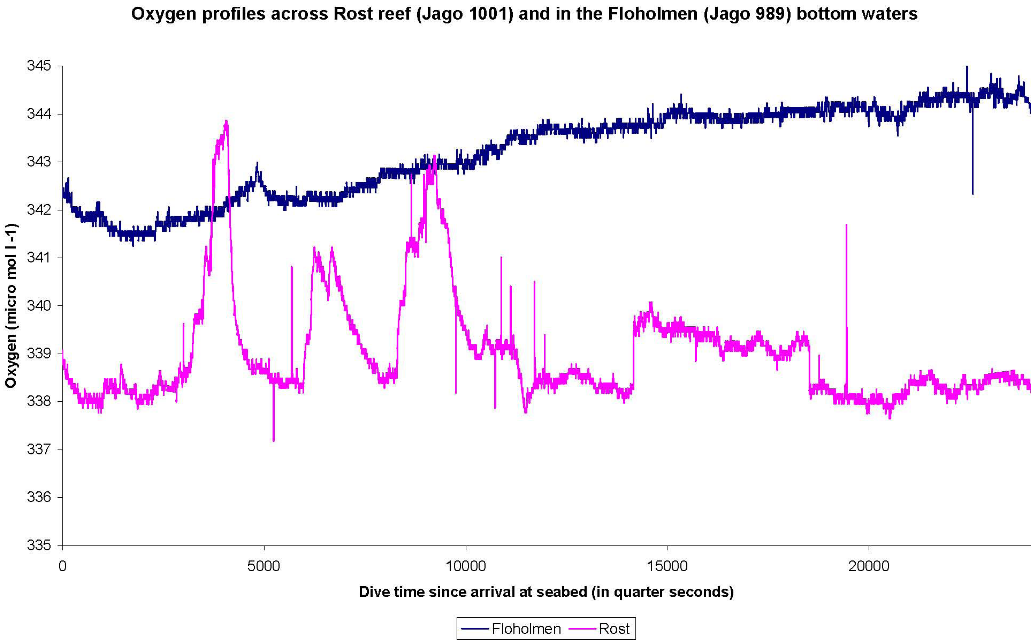

Fig. 7.4: Comparison between two oxygen concentration profiles during JAGO dives at a non-reef (blue) and reef site (pink)

The Traena Cigar Reefs

The study site covered about 4 km^2 at the northern end of a bowl-shaped seabed depression. Within this grid, we carried out 9 CTD/ bottom water sampling stations to determine changes of particle and Chl.*a* concentrations on down current direction. PADYS was deployed east of a large cigar reef with live corals to monitor the particle and flow dynamics within a period of 24 h. Flow velocities during the time of deployment varied between 5 and 30 cm/s and were directed towards West and Northwest. The progressive vectorplot of the water layers between 5 and 10 m above seafloor revealed that particles entering the reef-system traveled 5 - 7 km over the period of deployment. The CTD water sample casts showed decreasing Chl *a* concentrations of 0.03 – 0.01 µg/l in downstream direction. Turbidity ranged from 1 - 2 NTU and was generally higher than at the Røst site indicating the fluxes of more lithogenic material of fine particle size in the region.

The outer Vesteralen reef site

One JAGO dive at the outer shelf off Vesteralen did not confirm live corals on a hill-like subsea structure and thus could be used a reference station for the oxygen data from the Røst Reef. Fig. 7.4 above shows the oxygen concentrations of the bottom waters at the subsea structures. The oxygen concentrations at this site revealed significantly smaller variation than at the Røst site.

Drill cutting aggregation in Norwegian waters

For the IRCCM-CORAMM (Coral Risk Assessment Monitoring and Modelling) project 14 surface water samples with phytodetritus were aggregated with drill cuttings under typical surface waters shear conditions to determine the changes of particle size over time. Results indicate a shift of the size fractions towards larger particles and will be used to generate particle transport models for the Norwegian Sea around offshore installations to fine-tune the “zero-emission policy” of the Norwegian hydrocarbon industry.

8. SEDIMENT CARBONATES AND OCEAN ACIDITY AROUND ARCTIC CORAL REEFS

Jason Hall-Spencer[1], Andres Rueggeberg [2]
Laura Wehrmann [3]

1) University of Plymouth
2) IFM-Geomar
3) MPI MM

Objectives

Sometime in the middle to end of this century it is almost certain that the concentration of carbon dioxide (CO_2) in the atmosphere will have doubled, relative to its pre-industrial level, and will be considerably higher than at any time during the last million years. A major sink for this man-made CO_2 is the oceans where it dissolves in seawater to form carbonic acid. Although seawater is buffered by its carbonate chemistry, oceanic acidity is thought to have increased since the early 1900s, with a rise in H+ concentration of 30 %, i.e. a 0.1 decrease in pH. It has been estimated that with likely rates of burning fossil fuels the extra CO_2 dissolving in the oceans will lead to a drop in seawater pH of 0.5 by 2100. Discussion of the potential ramifications of this environmental change was published in a recent Royal Society Report, and the working party concluded that there was an urgent need for research in this area (The Royal Society, 2005).

Our understanding of how increased CO_2 and acidity may affect marine ecosystems is currently very limited, since investigations are few and recent. However, it is thought likely that calcified organisms living in high latitude and/or deep-water environments will be particularly at risk. Guinotte et al. (2006) suggest that the global distribution of deep-sea scleractinian corals could be limited by the depth of the aragonite saturation horizon (ASH) in the world's oceans since they use aragonite to build their skeletons and the ASH is the limit between saturated and undersaturated water. They found that > 95 % of deep-sea, bioherm-forming scleractinian corals occurred in waters that were saturated with aragonite during pre-industrial times and their projections indicate that about 70 % of these locations will be in undersaturated with aragonite by 2099. These authors highlighted the fact that baseline data on the carbonate chemistry of Arctic waters was lacking, despite the fact that the Arctic is currently one of the regions of the Earth that is showing the most marked climatic changes. The aim of our study was to characterise the carbonate chemistry of waters around Røst Reef, a high latitude reef complex described by Fosså et al. (2005), and to extend our observations on a transect out into waters of >2,000 m depth.

Work at sea

Røst Reef is the largest reef so far discovered in the North Atlantic and is found at 290 – 350 m depth southwest off the Lofoten Islands on the Norwegian shelf break (Fosså *et al*. 2005). We surveyed a transect line running from the main reef area at 300 m taking box cores and CTD casts at 600 m, 900 m, 1,200 m, 1,500 m, 1,800 m, and 2,100 m. At each site a surface sediment sample was taken for an analysis of calcium content and foraminifera. The remaining sediment was sieved and shells were retained for an assessment of their diversity, weight and thickness. Bottom water samples were taken for measurements of alkalinity, salinity, pH and dissolved inorganic carbon to calculate aragonite saturation levels.

Preliminary results

Box core sampling revealed a dramatic decrease in the abundance and diversity of calcified marine life with depth. Below 800 m water temperatures were <0 ˚C and at 2100 m the only calcified benthos present in a box core were foraminifera. In shallow water shells tended to be thicker and stronger. The full results of this study await detailed analyses.

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9. CORAL AND BIVALVE SAMPLING FOR SCLEROCHRONOLOGICAL STUDIES OF AGE, GROWTH AND WATER TEMPERATURE

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Objectives

Deep-water corals are generating strong interest in climate change research because zooxanthellate scleractinians have been shown to provide important archives of seasonal variations in temperature, salinity and productivity in shallow waters of the tropics (Tudhope et al*.,* 2001; Cohen et al., 2004; Roberts et al., 2006). It is hoped that analyses of deep-water corals and the remains of their associated biota will provide a detailed understanding of subsurface oceanic circulation patterns as this is the key to accurate predictions of future climate variability (Smith et al., 1997; Adkins et al., 1998; Thresher et al., 2004; López-Correa, 2005; Risk et al., 2005). The deep-water scleractinians examined for paleoclimate signals to date have complex internal banding patterns that makes extracting time-series of environmental change difficult (Risk et al., 2005; Sinclair et al., 2005). However, skeletons of the deep-water bivalve *Acesta excavata* Fabricius, 1779 together with gorgonian, antipatharian and zoanthid corals can show much clearer banding and this can be used to estimate age (Lopez-Correa et al., 2005, Sherwood et al., 2005). Growth band studies (sclerochronology) of this sort require validation using radiometric analyses whereby naturally occurring radioisotopes are used to determine an independent estimate of age or growth rate. Such studies have revealed that the oldest known deep-water coral to date is a zoanthid carbon dated to 1,800 years old (Druffel et al., 1995).

Deep-sea corals clearly have the potential to live for 1.000s of years (Andrews et al. 2005a), yet where food supply and water conditions are optimal some can grow quickly. For example the scleractinian *Lophelia pertusa* has rapidly colonised oil rigs and exhibited growth rates of up to 33 mm per year (Gass and Roberts 2006). Recent carbon dating work on isidid corals by Roark et al. (2005) revealed ages of 75 - 126 y confirming the longevity of certain deep-water corals, although lead-210 dating of an isidid (*Lepidisis* spp.) from 690 - 800 m off New Zealand by Tracy et al. (2005) showed that it was 38 - 48 years old, indicating a linear growth rate of ca. 30 mm per year.

Work at sea

In our study we aimed to collect living and dead specimens of the bivalve *Acesta excavata* and the gorgonian *Primnoa resedaeformis* together with other corals to determine their biodiversity, to age the specimens and estimate their growth rates and to study past water temperatures at the Norwegian shelf-break edge.

Preliminary Results

No live specimens of *Acesta excavata* were taken in any of the Van Veen or Box Core samples from Røst Reef, although two dead shells were obtained in sample PS70/23-3, four shells in PS70/13-4 and one dead shell on JAGO dive 2. These shells were heavily bioeroded and will be of no use for sclerochronology for reasons outlined by Lopez et al. (2005). We have not had time to conduct a quantitative analysis, but it is clear from a cursory examination of videos obtained during JAGO dives that *A. excavata* was a very rare inhabitant of the Røst Reef study area, with only 0 - 3 live specimens recorded per dive. These sparse animals were seen attached to overhanging surfaces of dead *Lophelia* reef and were too difficult to obtain without causing reef damage using JAGO. However, *A. excavata* was common at the start of Track 3 on Traena Reef (also known as Traenadjupet Reefs) using the drop-down video system. This site was then targeted using a box core (sample PS70/23-22) and yeilded four large and one small live specimen of *A. excavata* that grew bysally attached to the undersurface of *Lophelia*, together with the broken shells of a further 4 dead specimens. On a JAGO dive at the same site *A. excavata* was found to be common on vertical surfaces of dead coral. A number of dead shells of a variety of ages and sizes were collected that were in good condition for use in sclerochronology.

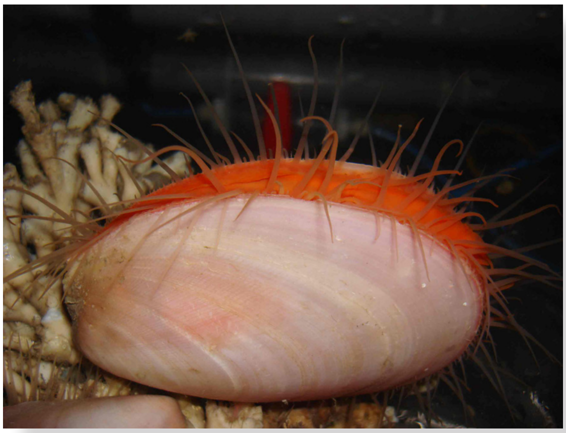

Fig. 9.1: One of five live Acesta excavata attached to dead Lophelia pertusa, collected in Box Core PS 70/23-22 at Traena Reef 13.6.07. The shell is 8 cm long.

Fig. 9.2: Numerous dead A excavata shells obtained using the manipulator arm of JAGO during dive PS70/23-22 at Traena Reef on 13.6.07

The corals that were recorded during this leg of the expedition are illustrated in Fig. 9.2. Only two species of scleratinian were found, with *Lophelia pertusa* being the dominant coral present at Traena and Røst reefs with small amounts of *Madrepora oculata* present at both sites. At Røst Reef, JAGO dives showed that wide butresses of coral flanked the upstream side of a series of 10 m high glacial till ridges that ran parallel to the abrupt shelf break contour at 300 - 350 m depth. These butresses appeared to be constructed by the continuous tabular growth of single colonies up to 3 m wide. The largest live *L. pertusa* colony collected had a 20 cm outer region of live polyps on a 40 cm long matrix of older dead skeleton. This specimen was obtained in Box Core PS70/14-6 from 330 m depth on Røst Reef (67˚30.48′N 9˚25.39′E) and was subsampled for radiometric dating by Andres Rüggeberg (IfM-GEOMAR) and will be deposited at the Public Museum in Plymouth, UK.

The gorgonians Primnoa resedaeformis and Paragorgia arborea were common at Røst and Traena Reefs, but at Røst Reef these were out-numbered by smaller, unidentified gorgonians. Two small gorgonians (which were not Primnoa resedaeformis or Paragorgia arborea) were taken in box cores (see Appendix) and appeared to be seperate species since one colony (sp. A) turned black in alcohol whilst the other (sp. B) remained white (collected in Van Veen grab 70/22-2 on 12.6.07). A 30 cm high entire Primnoa resedaeformis colony was collected at during JAGO Dive 2 and a 10 cm high fragment of a P. resedaeformis was collected in Box Core PS70/14-6 from 330 m depth on Røst Reef (67˚30.48′N 9˚25.39′E) which also contained a 25 cm high Paragorgia arborea colony fragment. One box core contained a subfossil specimen of P. resedaeformis burined under 30 cm of glacial till. Each of these three specimens were cut into two pieces, one for sclerochronological study at the University of Plymouth and the other for taxonomic reference by Manuela Ramos at the University of Seville. The sea pen Vigularia mirabilis was colleted at 198 m in a muddy sand grab sample (PS70/12-6) on 7.6.07 in the Floholmen area (68˚2.09N 13˚59.23′E). Three species of soft coral were recorded, Drifa glomeratum was abundant in back-reef habitats on stones, Anthothela grandiflora cf. was less common, but often seen on coral rubble whilst Gersemia sp. was inconspicuous and small, but often found in Box Core and Van Veen samples where cobbles and pebbles were present between reef ridges. Examples of the sea pens and soft corals were also taken for taxonomic reference by Manuela Ramos at the University of Seville. No antipatharians were found during this leg of the cruise.

Fig. 9.3: Corals recorded during leg 1a of the cruise, a) Lophelia pertusa, b) Madrepora oculata, c) Primnoa resedaeformis, d) Paragorgia arborea, e) Gorgonacea sp. A, f) Drifa glomeratum, g) Anthothela grandiflora cf., h) Gersemia sp.

Shallow-water Bivalvia have proven to be particularly useful in the reconstruction of past attributes of surface seawater (e.g., Jones et al. 1983; Richardson 2001; Owen et al. 2002). This has been attempted for subsurface water masses using shells of *Astarte* spp., but this was unsuccessful due to the small shell size and complex growth patterns of these species. *Acesta excavata* may be a more suitable environmental recorder of intermediate water masses since it is large and has a simple growth pattern with a margin-wide occurrence in intermediate waters of the NE Atlantic (Lopez-Correa et al., 2005). It is clear from our surveys that *A. excavata* is uncommon on Røst Reef where it approaches the known northern limit of the species at Stjernsund in West Finnmark at 70° (Freiwald et al. 1997). However, it was common at Traena Reef and occupied a similar habitat to that described by Hovland and Mortensen (1999) and Freiwald et al. (2002).

Lophelia pertusa was the main reef-building coral, as expected from previous reports from the area (Dons, 1944; Hovland & Mortensen 1999). The skeleton of a large sample obtained in Box Core PS70/14-6 will be dated radiometrically to help determine the age and growth-rate of Røst Reef. Live *Madrepora oculata* was not noted at Traena Reef (although not all of the JAGO dive videos have been analysed to check), but it was common at Røst Reef which may be a northern record for this species since it was not reported from Fugloy Reef at 70˚N (Lindberg et al., 2007) and is thought to be absent from Northern Norway (Freiwald et al. 2002). Only two other scleractinians are reported from deep-waters off Norway, *Desmophyllum cristagall and Stenocyathus vermiformis* (Fosshagen & Hoisæter, 1992; Freiwald & Mortensen, 2000), but both are very rare and were not found during our studies. The Wyville-Thompson ridge, which separates the warmer deep Atlantic waters from the much colder Norwegian Sea water, is responsible for a major faunal division on the Atlantic Frontier which may explain the relative paucity of scleractinian species off Norway as compared with the British Isles (Hall-Spencer et al., 2002). The lack of antipatharian and zooanthid corals recorded in our surveys of high latitude reefs is in stark contrast to cruise ARK-XIX/3a where a variety of these corals were found and collected from around *Lophelia pertusa* reefs off Ireland (Hall-Spencer & Brennan, 2004).

The gorgonian corals *Primnoa resedaeformis* and *Paragorgia arborea* were common on the reefs we studied and are charateristic inhabitants of *Lophelia* reefs throughout Norway (Hovland & Mortensen, 1999; Freiwald et al., 2002). The skeleton of *Primnoa resedaeformis* is well suited to schlerochronology with fossil specimens from Georges Bank dated as 320 y (Risk et al., 2002) and 700 +/- 100 y (Sherwood et al., 2006). Andrews et al. (2002) dated a 112 y old *P. resedaeformis* colony in the Gulf of Alaska and noted that larger colonies in the vicinity were probably older. Our subfossil sample of *P. resedaeformis* will be dated and aged, its death may have coincided with the a giant submarine slide which took place in the area 4.000 years ago (Laberg and Vorren 2000) since it was found under a 30 cm layer of glacial till.

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10. ANTHOZOAN DIVERSITY ASSOCIATED WITH COLD WATER CORAL COMMUNITIES

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Objectives

During ARK-XXII/1a leg cruise on board *Polarstern* samples were taken to collect Anthozoan specimens associated with the Deep Sea Coral Reefs from Northern Norway: Røst Reef, Traena Reef and Sotbakken respectively (between 66º32'N to 70°45'N Lat. and 9º30'E to 18°40'E Long.).

This preliminary report contains a list of the Hexa- and Octocorals achieved in these areas and at this first stage it was outlined what is described at the moment (revisited literature, in J.H.Fosså & P.B. Mortensen, 1998), why species descriptions are rather incomplete in terms of diagnostic characters and what needs further examination.

Work at sea

Three different types of gear were used for biological sampling; a Van Veen grab, a Box Corer and the submersible JAGO (see stations overview on Annex I, Fig. 10.1).

We recovered a variety of hardgrounds of the studied areas, characterized by a complex topography of carbonate substrates (coral rubble), coral reef properly "healthy", but not exclusively, also soft-bottom composed by mud and silt deposits characterised by high sedimentation rates. For each sample a photograph was taken of the contents together with a description of the sediment or coral surface and fauna. Macrofauna was sampled and the Anthozoans were selected. As some actiniarians get stressed with capture techniques and handling, especially out of their natural habitat, they usually arrive at the deck strongly contracted. In that cases, specimens were maintained in cold sea water with menthol during the sufficient time to reach anaesthesia, in the manner that when it is obtained the relaxed state it is possible the observation of the expanded tentacles and oral disc. Pictures were taken when the material was alive or nearly dead to reveal natural colouration before the traditional fixation methods. Each specimen was fixed on board using 4 % formalin and (depending on the quantity of material) on 99 % ethanol for molecular analysis (DNA extraction). All the specimens were stored in bottles and jars and properly labelled.

The collected material was also included in a database (of 142 labels) with all the stations and all the species names, numbers of individuals/fragments or colonies (each bottle numbered with ARK-XX/1a, to facilitate access for further analysis). This file can be requested at the author for any consult or interest.

Preliminary results

The Anthozoans from the Norwegian coral reefs (Røst, Traena and Sotbakken) and other different types of habitats of the surrounding or deeper areas (sediments, coral rubble) were sorted at species level, resulting in more than 100 lots, belonging to 18 different species of Hexacoral and Octocorals. Some of them were identified at species level, other remain at genus level waiting further work on laboratory and consults from different literature sources or type specimens deposited in several museums.

Tab. 10.1: Preliminary Family/Genera/Species check-list of ARK-XXII/1a material: at least 21 species from the samples assessment of each station, nearly 150 specimens to be examined in laboratory (BEIM, Uni. Seville)

Class	Order	*Species*
Hexacoralliia	Actiniaria	*Cf. Fagesia loveni*
Hexacoralliia	Actiniaria	Edwardsiidae *sp.1*
Hexacoralliia	Actiniaria	Edwardsiidae *sp.2*
Hexacoralliia	Actiniaria	*Protanthea simplex*
Hexacoralliia	Actiniaria	*Bolocera tuediae*
Hexacoralliia	Actiniaria	Actinostolidae *sp.1*
Hexacoralliia	Actiniaria	Actinostolidae *sp.2*
Hexacoralliia	Actiniaria	Actinostolidae *sp.3*
Hexacoralliia	Actiniaria	*Amphianthus sp.*
Hexacoralliia	Actiniaria	*indet. sp.*
Hexacoralliia	Ceriantharia	*Cerianthus sp.*
Hexacoralliia	Zoantharia	*Epizoanthus sp.*
Octocoralliia	Alcyonacea	*Drifa sp.*
Octocoralliia	Alcyonacea	*Gersemia indet. sp.*
Octocoralliia	Alcyonacea	Alcyoniidae *sp.*
Octocoralliia	Alcyonacea*	*Paramuricea sp.*
Octocoralliia	Alcyonacea*	*indet. sp.*
Octocoralliia	Alcyonacea*	*Anthothela grandiflora*
Octocoralliia	Alcyonacea*	*Paragorgia arborea*
Octocoralliia	Alcyonacea*	*Primnoa resedaeformis*
Octocoralliia	Pennatulacea	Pennatulidae *sp.*

* According to Bayer (1981), the classification followed in this report, and in the possible publications resulting from the study of the present ARK-XXII/1a material, differs slightly from the traditional one, were the long time considered, orders Stolonifera, Telestacea, Alcyonacea and Gorgonacea are fused in a single order namely Alcyonacea. Thus, only three orders should be considered in Octocorallia: Helioporacea, Alcyonacea, and Pennatulacea. In the ARK-XXII/1a collection, only the orders Alcyonacea and Pennatulacea are represented, with 10 and 1 species, respectively.

One of the most interesting groups founded associated to the Coral Reefs is the family Edwardsiidae. At least three species (Cf. Fagesia loveni, sp1 and sp2) were observed living in the coral rubble. Fagesia loveni (Carlgren, 1893) (see Annex II, Fig. 10.3) is a small anemone that lives attached in the dead calcareous structures of

Lophelia pertusa, has a long body, but retracts suddenly when perturbed. This species was described on Sula Ridge, that revealed an intense infestation of the coral frame (Freiwald et al. 2002 in Zibrowius and Taviani, 2005), although it is now reported at more north especially in Røst and Traena Reefs. After the first impression, according Carlgren (1949) description, it seems that this species requires a revision or improved considerations of the prognostic characters. Other species of the family Edwardsiidae (indet. sp1) were also found attached in the dead branches of Lophelia (Fig. 10.4). The third species (Edwarsiidae sp.2) that lives completely inside the tubes of Lophelia (Fig. 10.5), has a vermiform shape and when retracted is very difficult to take off and the coral has to be broken.

Another most common anemones found is *Bolocera tuediae* (Johnston, 1832), Fam. Actiniidae. This actinia is immediately recognisable for their numerous long tentacles (see Fig. 10.6) and the non retractable oral disc cause has a weak endodermal sphincter, nevertheless when stressed “mutilate” their tentacles out and inverse the pharynx. Lives adherent to any rocks and stones. Although being common and with a wide range of distribution, it still causes doubts about specific variability and synonymies, which only molecular analysis may help to determine. The specimens taken were especially considered for this purpose. One of the exemplar kept was maintained in the aquarium (Fig. 10.6.b) and revealed a particular reaction against the gorgonea *Primnoa resedaeformis*, because started to liberate considerable amounts of mucus. As a small note, this accidental episode may also prove the competition for space in the reef. It could be interesting make some inclusion/exclusion experiments on aquarium.

In the reef (living and dead coal), it is usual to find *Protanthea simplex* (Fig. 10.7). This species is not provided with sphincter, and their retractor muscles are very weak, so they are not capable of tentacles involution.

The submersible JAGO brought other interesting anemones, which at the moment are labelled as the generalist name of the family Actinostolidae (sp1, sp2). They possess a very strong retractable sphincter, mesogleal, the column has also a very thick mesoglea. Other morphotype (sp.2) could be only ontogenetic states of the same species, but this should be checked in Seville after the usual taxonomic procedures (histological sections and measurement of cnidocysts from different zones). Other interesting feature was the presence of juveniles inside the body of the “white” anemone (Fig. 10.8.e). They are at the first state of development, with only 12 tentacles, (Fig. 10.8.d) and it’s an opportunity to report some reproductive patterns of this species.

In one of the last dives on Sotbakken, JAGO brought other anemone (the only specimen) totally different from the others, with a striated column; shape and contraction of the oral disc also different (see Fig. 10.9). The presence of two siphonoglyphs is obvious. This species was labelled as Actinostolidae sp.3 as a distinctive label only, the family characters needs to be checked in Seville.

Also in the last dive, Sotbakken area, JAGO brought live *Lophelia* infested with lots of small anemones, apparently *Amphinathus sp* (Fig. 10.10). This species is not described for the reefs (Jason Hall Spencer, pers. comm.). In Fig. 10.10.b) and 10.10.c) some of the specimens show the oral disc opened and the tentacles out. It is also notable the asexual reproductive pattern of this species.

A small actinia, undetermined (sp.) was found in the Floholmen area, only one exemplar of this species was captured. In this conditions it will be almost impossible to identify this species due to it's very small size. However, it is important to report the presence of this species with photos for reconnaissance in future expeditions (Fig. 10.11). The presence of one species of zoanthids, Epizoanthus sp. was also rare (Fig. 10.12). This species has a cuticle recovered with fine grains and foraminiferans.

The class Octocorallia is dominated by Cf. Gersemia rubiformis (Ehrenberg, 1834) and Drifa sp. These two Alcyonaceans (Fig. 10.13 and 10.15) are very common on Røst Reef, and they appear in every type of hard subtract (rocks, coral, shells, etc), although it not exists (at least with the same abundance) in Traena Reef. Other Alcyonacean sp. (Fig. 10.14) with violet colour appeared, but in less abundance. Three species of gorgonians (Fig. 10.16) were found, Paramuricea sp. (Fig. 10.16.a), Anthothela grandiflora (Sars, 1856) (Fig. 10.16.b) and one unknown species of the Fam. Plexauridae (Fig. 10.16.c). The sclerits analyses will tell much more. The popular species Primnoa resedaeformis (Gunnerus, 1763) and Paragorgia arborea (Linnaeus, 1758), do not need presentation.

One species of the order Pennatulacea was found only in the Foholmen area.

In resume, this expedition permitted to acquire:

- Hexacorallians Actiniaria: 7 morphospecies; Zoantharia: 1sp.; Scleractinia: 2 sp.
- Octocorallia: Pennatulacea: 1 sp.; Alcyonacea: 6 sp.
- Video and photographic surveys of Anthozoans diversity in their natural habitat (available by JAGO team).
- Important "alive material": coloration and external shape; oral disc and tentacles; feed habits; substrate and associations.

Future work and preliminary results

It is expected to continue the work in our laboratory (BEIM, Uni. Sevilla). The actiniarians identification protocol depends on several fragments of parts of the body, sliced in transversal and longitudinal ways and embedded in paraffin to be proceeded by the microtome to obtain series of histological sections of 7-8 μm thickness. Also very important is the cnidae measurements in squash preparations at 1000x magnification with Normaski differential interference contrast optics. Mean and standard deviation of the size ranges of cnidae measurements will be provided always depending on the quantity of the material of each morphospecies. We hope to contribute to the list of species associated to the Deep Sea Coral Reefs of Northern Norway and to describe the "undetermined" species and species variability. These new data can also give more information about the distributional patterns of the reefs. Other important achievement can be the "note" about the reproductive patterns and first stages of life cycle of one of the dominant species. Also the achievement of representative samples usable for molecular taxonomic studies is very important to increment the bank of tissues in future work.

Annex I: Stations

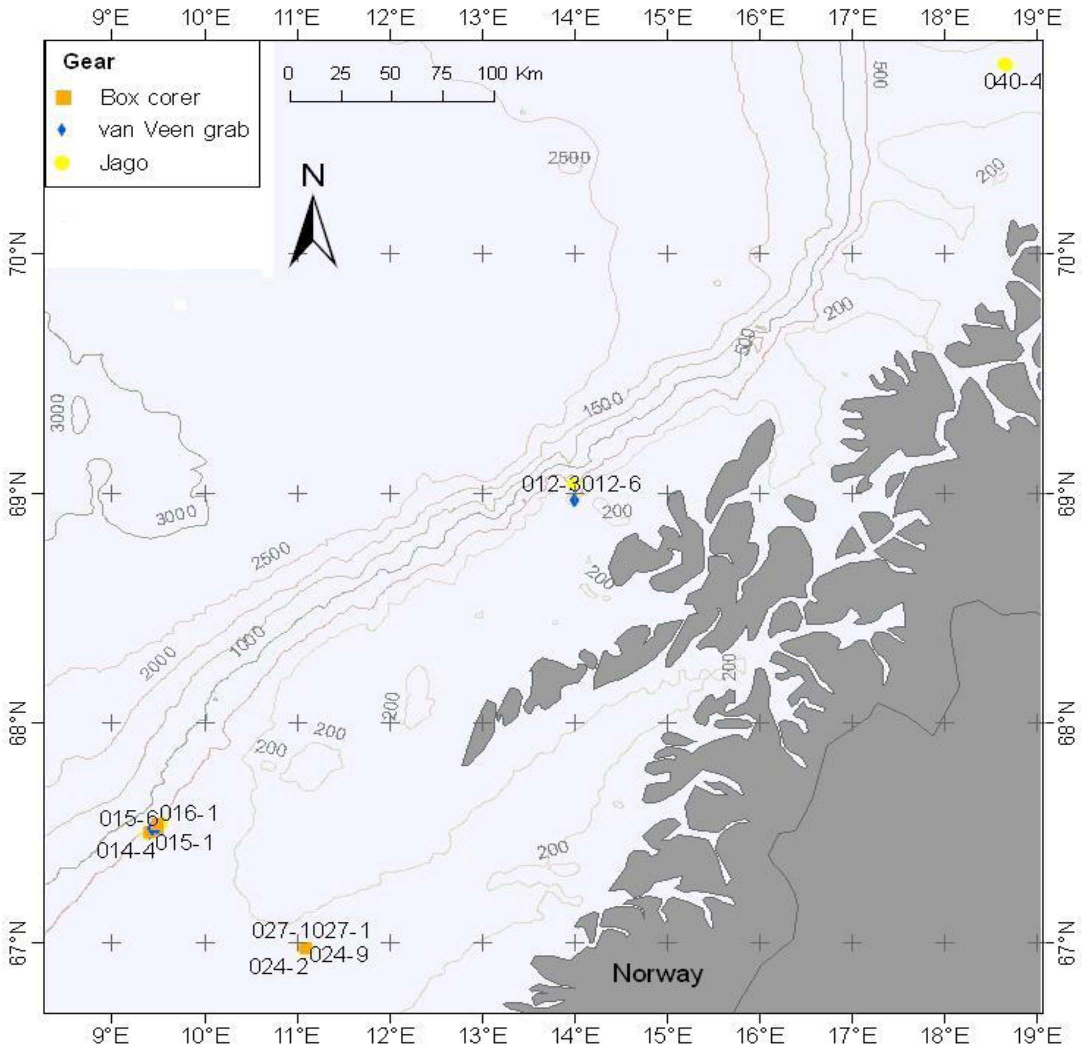


Fig. 10.1: Stations overview, only Anthozoans collection during ARK-XXII/1a cruise

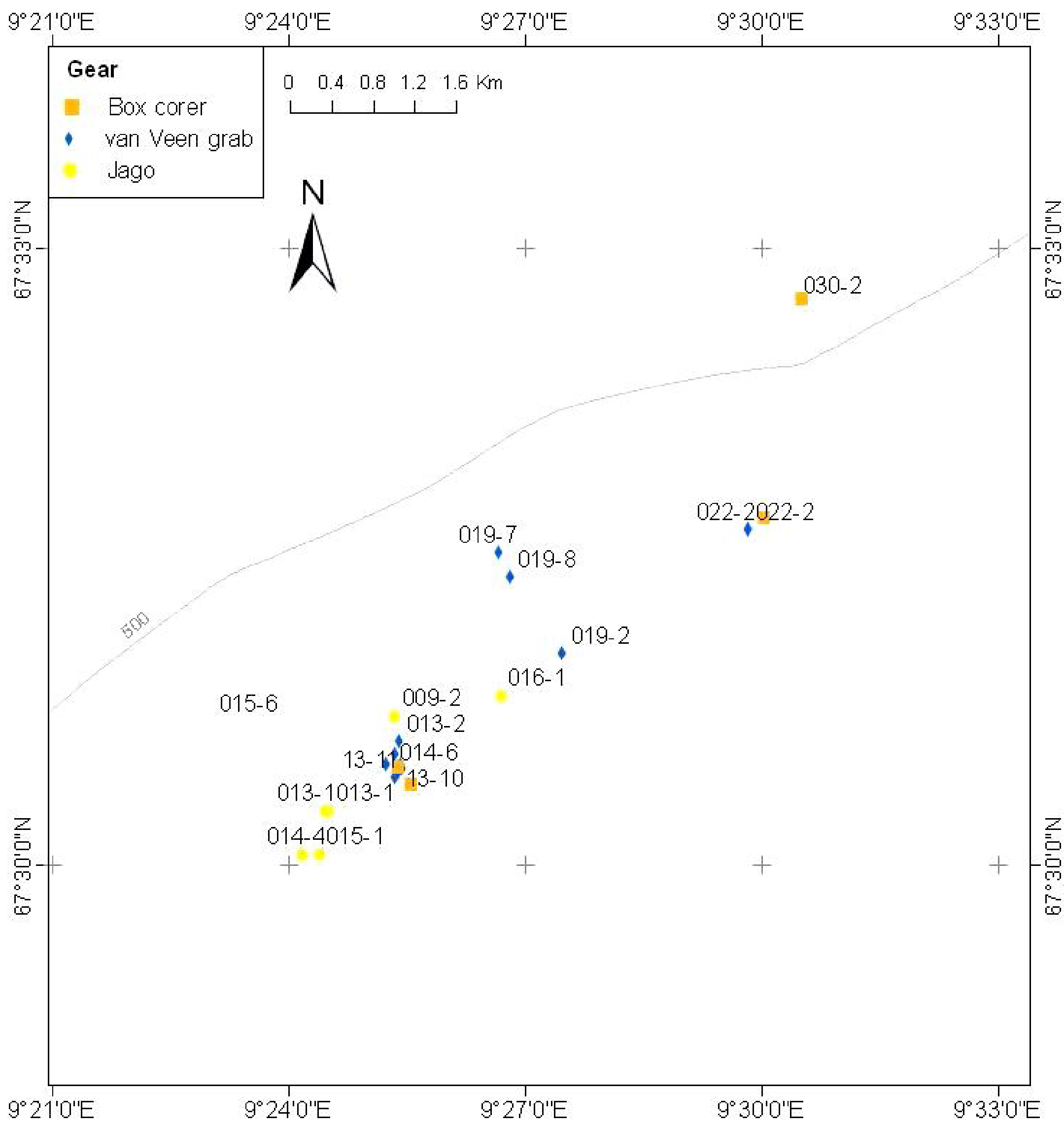


Fig. 10.2: Stations map of Røst Reef, the most intensively sampled area

Annex II: Photographic album

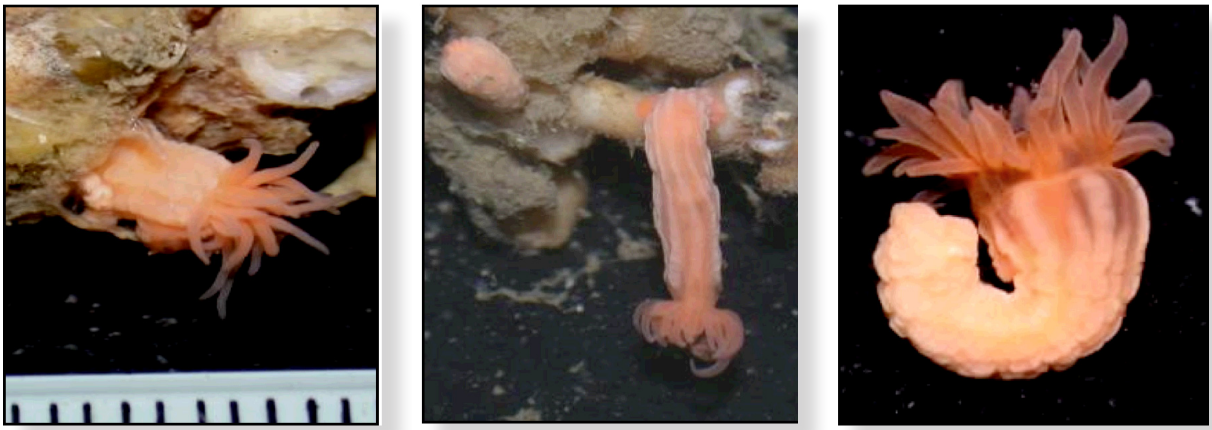
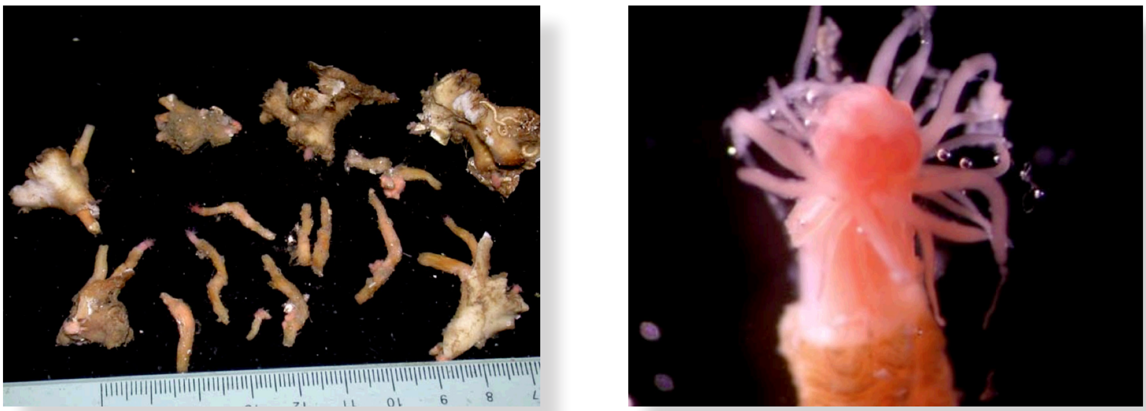


Fig. 10.3: Fagesia loveni, attached to dead branches of Lophelia pertusa (commonly named "coral rubble"), in different states of expansion showing the tentacles (after relaxation)

a) **b)**

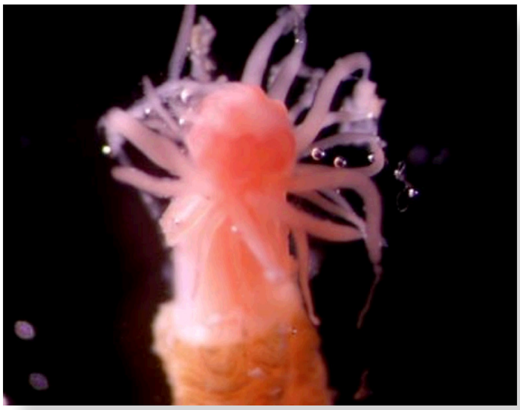
Fig. 10.4: Fam. Edwardsiidade, (indet. sp.1), a) attached in dead Lophelia; b) in relaxed state showing physa-like character.



a) **b)**

Fig. 10.5: Edwardsiidae sp.2, a) lives inside dead Lophelia tubes, strongly retractile, b) oral disc detail

a)



b)

Fig. 10.5: Edwardsiidae sp.2, a) lives inside dead Lophelia tubes, strongly retractile, b) oral disc detail

a)

Fig. 10.6: Bolocera tuediae, a) photo taken by JAGO team, b) specimen maintained in aquarium in controlled conditions

b)

a)

b)

c)

Fig. 10.7: Protanthea simplex, a) attached in coral, b) attached in old shell, c) oral disc detail

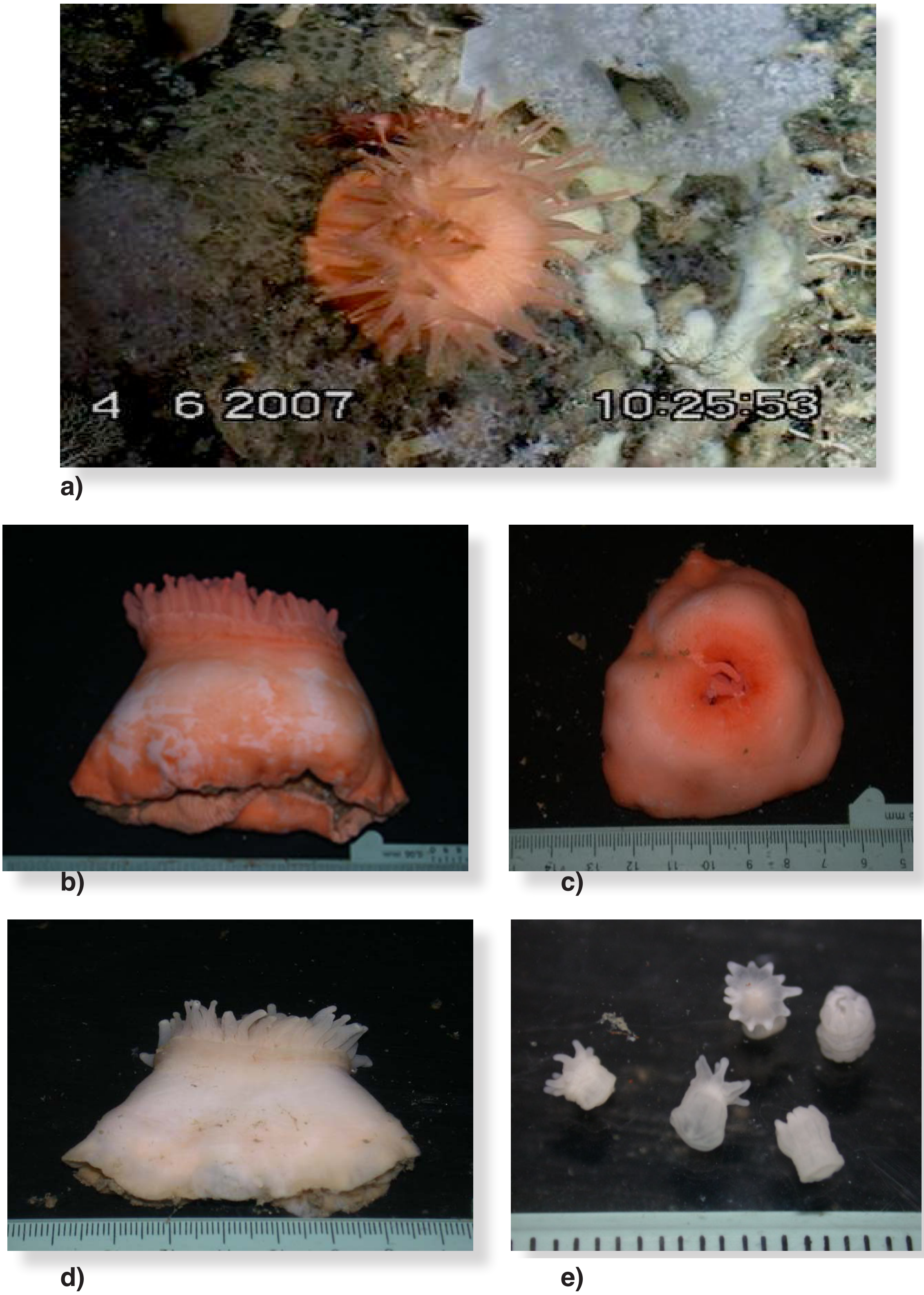


Fig. 10.8: Actiniaria (Actinostolidae?) indet. sp.1. a) photo taken in natural habitat by JAGO team, b) specimen (colour: salmon) with body relaxed, b) specimen with body almost fully contracted, c) specimen in white coloration (sp2 ?), e) juveniles

a)

b)

c)

Fig. 10.9: Actiniaria (Actinostolidae?) indet. sp.3.

a) contracted state

b) relaxed state after 12hours,

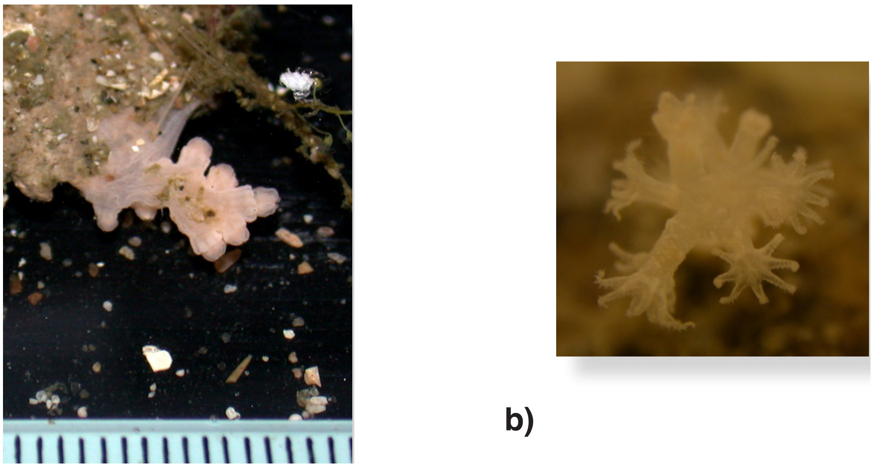
c) column and broad pedal disc

a) **b)** **c)**

Fig. 10.10: a) Amphianthus sp. infestation of branches of live Lophelia pertusa. b) evidence of asexual reproduction c) details of the oral disc and tentacles opened.

Fig. 10.11: Actiniaria (indet.) sp.

Fig. 10.12: Colonies of Cf. Epizoanthus sp. adhering to dead branches of Lophelia



a) b)

Fig. 10.13: Cf. Gersemia rubiformis, a) attached detritic shell, b) detail of their polips open

Fig. 10.14: Alcyoniidae (indet.) sp.1, attached to dead branches of Lophelia

a)

b)

c)

Fig. 10.15: Cf. Drifa glomerata, a) photo taken by JAGO team, b) in contracted form, c) details of some polypes open

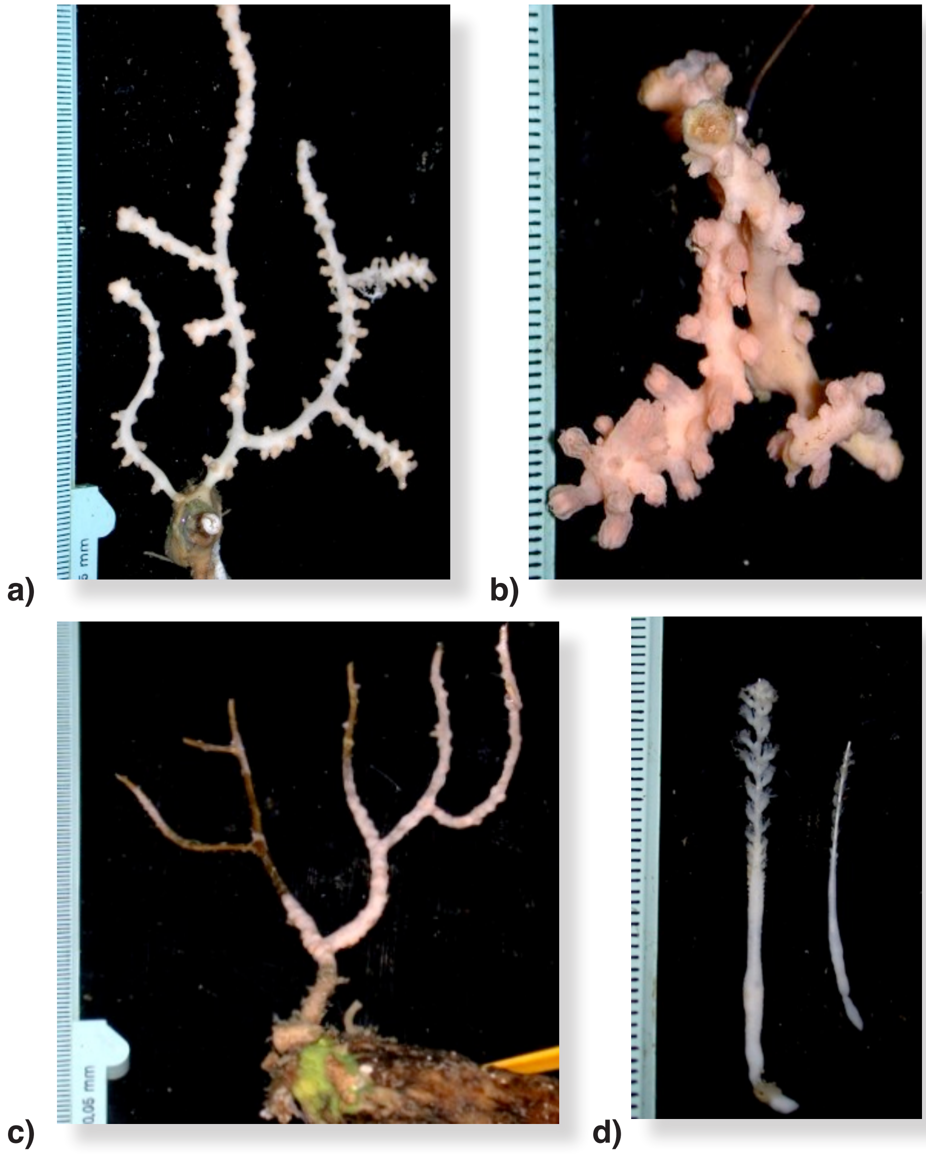


Fig. 10.16: a) Cf. Paramuricea sp.1; b) Cf. Anthothela grandiflora; c) indet. sp. d) Pennatulacean

References

Fosså J. H. and P. Mortensen, 1998. Artsmangfollett på Lophelia-korallev og metoder for kartlegging og overvåkning. 95pp.

Zibrowius H. and M. Taviani 2005. Remarkable sessile fauna associated with deep coral and other calcareous substractes in the Strait of Sicily, Mediterranean Sea. In: Freiwald A., Roberts J.M. (eds). 2005, Colde water Corals and Ecosystems, Springer-Verlag. Berlin Heidelberg, pp 807-819.

11. BIODIVERSITY OF MICROBES, SPONGES AND OTHER MACROFAUNA ASSOCIATED TO COLD WATER CORAL REEFS

Friederike Hoffmann [1], Sandra Schöttner [1], Laura Wehrmann [1], Nina Knab [1], Paca Cardenas [2], Christiane Todt[2]
Christian Wild [3],

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[2)]IMR Bergen
[3)]LMU München

Objectives

Microbes occur in every niche in the ocean and comprise a significant part of the global biomass. Recently also animal surfaces, tissues and exudates have been viewed as microbial habitats, which add microbial diversity to an ecosystem.

Biodiversity hot spots on continental margins like the deep water coral reefs and associated sponge accumulations have not yet been investigated for the nature of microbial niches in these settings. The microbial community structure and diversity of the different coral reef habitats (coral mucus, tissue and carbonate surface; sponge tissue; sea water; sediment) were investigated, as well as their role in biogeochemical processes and nutrient cycling of the reef systems.

12. SPONGES AND OTHER ASSOCIATED FAUNA

Paca Cardenas [1], Christiane Todt [1], Friederike Hoffmann [2], Magnus Tornes [1]

1) University Bergen
2) MPI MM

Objectives

1. Biodiversity of sponges and other macrofauna associated to cold water coral reefs
2. Biodiversity of microbes associated to sponge key species at cold water coral reefs

Work at sea

Sampling and video mapping in different reef zones at Røst Reef, Traenadjupet and Sotbakken by the manned submersible JAGO. Additional sampling with the giant box corer and the Van Veen grab.

Sample and data processing on board:

- Determination of sponges on board by macroscopic and microscopic analyses
- Samples for taxonomy
- Subsamples for DNA-based phylogenetic studies of sponges and associated microbes
- Subsamples for histological studies and microbial cell counts
- Removing of macrofauna (body length > 3mm) from all samples
- Identification and counting of total specimen numbers
- Photographs of live specimens and fixation of voucher specimens (4% formalin, 70% ethanol, or 98% ethanol)

Preliminary results

Sponges

The diversity of sponge species is extremely high at Røst Reef, and seems to be a bit lower at Traenadjupet. At Sotbakken, the highest number of sponge species was found on rocks next to the reefs rather than among *Lophelia* corals. Twelve different sponge species were found on a single rock from this area! In total, over 50 sponge species were found during this cruise, with all three classes of sponges represented:

Demospongia (46 species), Calcarea (7 species), Hexactinellida (3 species).

See Tab. 12.1 for details.

In the northern part of the Traenadjupet area at 300 m (66º58.5589 N, 11º06.3379 E), giant growth forms of astrophorid sponges were observed in high densities (Fig. 12.1). This is possibly a mass occurrence of large sponges, which have been described as "ostur" (cheese bottoms) from the shelf break off Iceland, Faroe Islands and Norway, but to our knowledge never so close to shore.

Tab. 12.1: Taxonomic overview of sponge species found during cruise *Polarstern* ARK-XXII/1a

Porifera Check-List

Order	**Family**	**Species**
DEMOSPONGIAE		
Astrophorida	Geodiidae	*Geodia barretti*
		Geodia atlantica
		Geodia macandrewi
		Geodia phlegraei
		Pachymatisma normani
	Ancorinidae	*Stryphnus fortis*
		Stelletta normani
	Pachastrellidae	*Pachastrella monilifera*
		Poecillastra compressa
		Thenea muricata/abyssorum cf.
Spirophorida	Tetillidae	*Craniella zetlandica*
Tetractinellida *incertae sedis*		*Alectona millari*
Halichondridae	Axinellidae	*Phakellia ventilabrum*
		Phakellia robusta
		Phakellia rugosa
		Axinella infindibuliformis
	?	*sp1*
	?	*sp2*
	?	*sp3*
	?	*sp4*
	Petrosiidae	*Petrosia crassa*
Homoscleromorphida	Plakinidae	*Plakortis simplex*
Poecilosclerida	Hamacanthidae	*Hamacantha sp.*
	Latrunculidae	*Sceptrella ?triloba*
	Crambidae	*Discorhabdella?*
	Esperiopsidae	*Amphilectus sp.*
		Esperiopsis sp.
	Coelosphaeridae	*Lissodendoryx (Lissodendoryx) sp.*
		Lissodendoryx (Ectyodoryx) sp.
		Forcepia sp.
		Coelosphora (Histodermon) sp.
	Mycalidae	*Mycale lingua*
	Raspailiidae	*sp1*
	Hymedesmiidae	*Hymedesmia paupertas*
		Hymedesmia (Stylopus) sp.

	Cladorhizidae	*Asbestopluma sp.*
	Microcionidae	*Antho dichotoma*
	Iotrochotidae	*Iotroata ?abyssi*
	Desmacellidae	*Desmacella sp.*
Hadromerida	Polymastiidae	*sp1*
		sp2
		Polymastia sp. 1
		Polymastia sp. 2
		Tentorium semisuberites
	Stylocordylidae	*Stylocordea borealis*
	Clionidae	*Cliona sp.*
Hadromerida?		*sp.1 (slimy)*
Haploscelerida	?	*sp1*
	?	*sp2*
Dendroceratida	Darwinillidae	*Aplysilla sulfurea*
		Aplysilla rosea
?	?	*?*
CALCAREA		*Leucoselenia sp.*
		Clathrina sp.
		Sycon sp1.
		Sycon sp2.
		Sycon sp3.
		Ute sp.
		sp1
		sp2
HEXACTINNELIDA	Rosselidae	*Sympagella sp.*
	?	*sp1 (purple)*
	?	*sp2 (small brown)*

Fig. 12.1: Mass occurence of large sponges in "sponge garden" at Traenadjupet, filmed by JAGO. The sponge at the front-left (Geodia sp.) is about 80 cm in diameter, the bright sponge at the right as well as the similar one at the left-back (both Geodia barretti) are about 50 cm in diameter each.

Preliminary results for other macrofauna

We collected about 150 species of benthic animals from 11 animal phyla (Cnidaria, Platyhelminthes, Nemertini, Echiurida, Sipunculida, Polychaeta, Arthropoda, Mollusca, Tentaculata, Echinodermata, Tunicata), and some planctonic/nectic species of the Ctenophora, Chaetognatha, and Vertebrata. Identification to the species level on board was possible only for about 50 % of species and will be continued at University of Bergen, based on photographs (available for 87 species) and preserved voucher specimens (for all species). Specimens of certain taxa (Polychaeta, Pycnogonida, Amphipoda, Isopoda, Bryozoa) will be handed on to specialists for identification. The material will finally be deposited at the Natural History Museum in Bergen to make it available to the scientific community.

The very localized sampling techniques allow for a precise assignment of species to the investigated habitats (living corals, dead corals and coral rubble, soft sediment close to the reefs, deep soft sediments) and the counts of specimens per sample give an estimate of abundance for each species in the respective habitats (see appendix "box core sheets and grab sheets" and Fig. 12.2). For example, the brachiopod *Terebratulina retusa* and the pectinid clam *Delectopecten vitreus* could be found in high numbers on living and dead *Lophelia pertusa* in all three reefs, while the brachiopod *Macandrewia* sp. and the pectinid clam *Chlamys sulcata* do not occur on living coral and are rare on dead coral, but numerous on stones in the coral rubble zone.

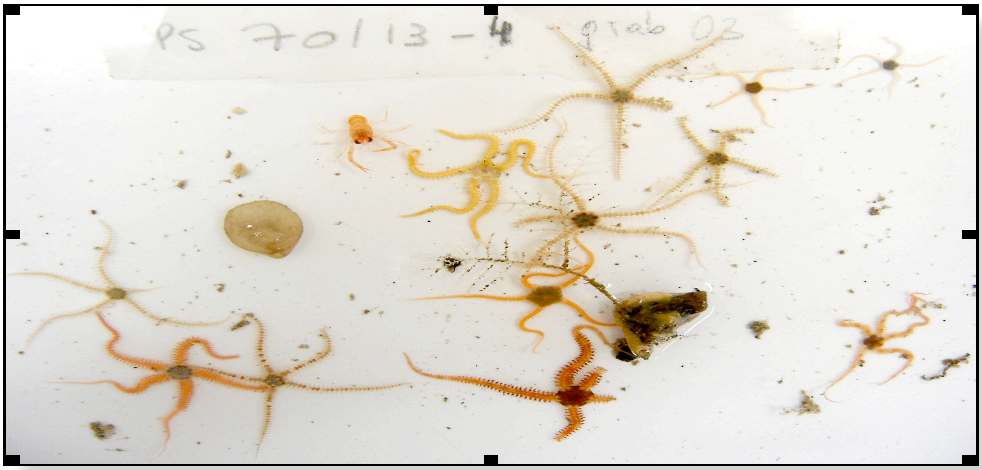

Fig. 12.2: Animals from one of the grab samples (position nr. PS70/13-4), including 5 species of brittle stars

A striking fact is the high abundance and diversity of brittle stars (Ophiuroidea) in all investigated habitats. A total of 15 species could be determined, whereby the habitat preference of most species is very distinct. The high numbers of specimens on dead coral and coral rubble, as well as on soft bottoms close to the reef point to an important role of Ophiuroidea for the reef ecosystem.

13. CORALS AS ECOSYSTEM ENGINEERS – CONSEQUENCES FOR MICROBIAL DIVERSITY AND ACTIVITY

Sandra Schöttner[1], [1)] MPI MM
Christian Wild [2] [2)] LMU München

Cold water coral reefs through their complex and 3-dimensional structure do generate a wide range of different habitats, which are known to facilitate high fauna diversity and potentially also microbial diversity. In addition, organic exudates are obviously released in high quantities by the corals, but nothing is known about the chemical composition, function and degradability of this important organic matter source. Thus, during this cruise we aimed to investigate how these two factors, habitat differenziation and organic matter relase, may influence microbial diversity and activity in the reef.

Objectives

1. Diversity of microbial communities associated with cold water coral reef habitats
2. Fauna-microbe interactions: The effect of coral exudates onto microbial activity in the reef

Work at sea

For subsequent molecular analyses (DNA fingerprinting, clone libraries, FISH)

- Sampling of coral fragments, surface sediments and bottom water along a horizontal transect (see Fig. 13.1) across Røst Reef (10 stations) and during one occasion at Traenadjupet Reef (2 stations) using the manned submersible JAGO
- Vertical transect water sampling from 8 different depths above Røst Reef (see Fig. 13.1) using a CTD-coupled multi- water sampling Rosette
- Sediment sampling in a high vertical resolution from gravity cores taken at various occasions by the collaborating sediment group (Laura Wehrmann and Nina Knab)
- For subsequent biogeochemical analyses (particulate and dissolved organic C and N concentrations, protein contents, stable isotope signatures)
- Coral exudates samples from freshly collected *Madrepora* spec. and *Lophelia* spec.
- Water samples in a horizontal and vertical resolution
- Sediment samples from various reef locations and used in experiments conducted by Autun Purser, Jacobs University Bremen

Ecological experiments on board:

- Incubation experiments with coral exudates to determine microbial carbon turnover
- Planktonic microbial oxygen consumption rates in a vertical resolution above Røst Reef

Preliminary results

Ecological experiments confirmed the hypothesis that cold water coral exudates act as an energy carrier from corals to planktonic microbes. Vertical oxygen consumption rate measurements indicate that cold water reefs may represent hotspots of microbial activity. Molecular analyses will show if cold water coral reefs also act as hotspots for microbial diversity.

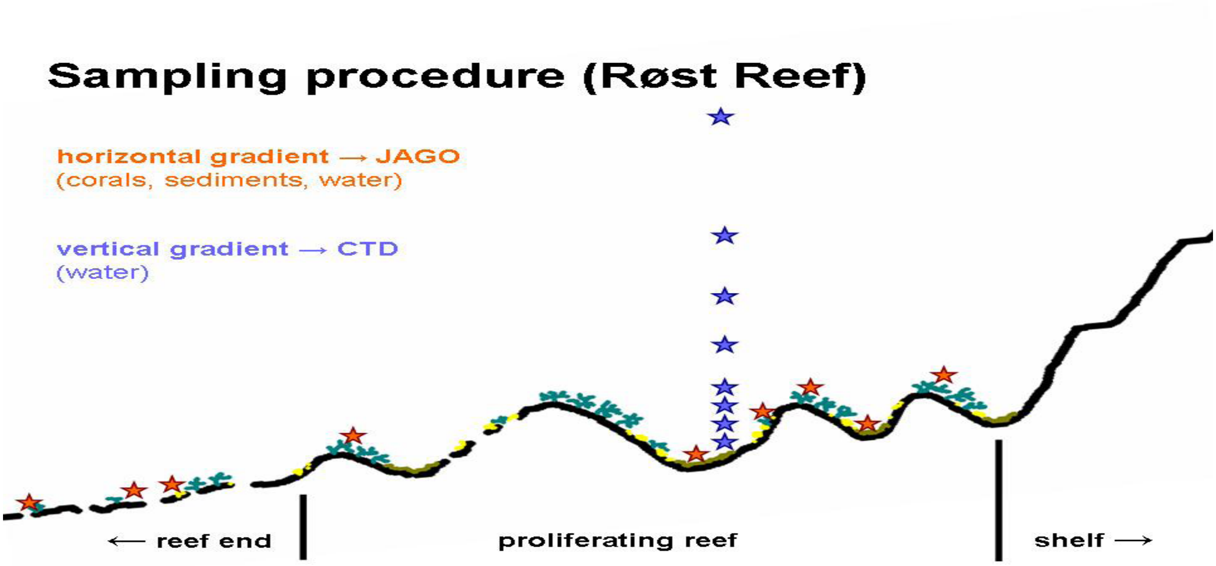

Fig. 13.1: Schematic drawing of horizontal (JAGO) and vertical (CTD-Rosette) samplings at Røst Reef

14. BIOGEOCHEMISTRY AND SEDIMENTOLOGY OF REEF-ASSOCIATED SEDIMENTS WITH A SPECIAL FOCUS ON THE SULFUR AND CARBON CYCLE

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Nina Knab[1]
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2) University of Gent

Objectives

Cold-water coral ecosystems are widespread along the north-eastern Atlantic continental margin and have been the subject of intensive research over the last ten years mainly focused on biological investigations and mapping of coral areas. Yet, little is known about the linkage between microbially driven geochemical processes and carbonate dynamics in these extreme sediments. Therefore this cruise aimed to gather samples for analyses of the porewater and solid phase of reef sediments to identify important biogeochemical processes.

Work at sea

Sampling was performed on a transect across a ridge of Røst Reef representing the three main zones: clay zone in the depression between the ridges, top of the ridge (living corals) and coral rubble-dominated facies on the lower slope.
In addition Traenadjupet reef was cored at different stations from the top of the reef towards the outer part of the reef area. Reference cores were taken away from the reef (Floholmen area and deeper part of Røst Reef).

Fig. 14.1: Gravity core used for sampling of reef sediments

Sampling was performed in different reef zones at Røst Reef, Traenadjupet and Sotbakken by the use of a gravity-corer with a 4 m barrel and a weight of 800 kg as well as a box-corer. In order to find suitable sites for coring Van-Veen-grab was deployed.

Tab. 14.1: Gravity corer station list

Station	**Area**	**Date**	**Coordinates**		**Depth**	**Recovery**
			Lat N	**Long E**		
7-1 GC	Røst Reef	03.06.07	67°32.64	9°28.05	527	42 cm
11-3 GC	Floholmen	06.06.07	69°44.21	16°33.27	926	200 cm
14-8 GC	Røst Reef	09.06.07	67°30.52	9°25.34	342	115 cm
14-10 GC	Røst Reef	09.06.07	67°30.48	9°25.40	330	53 cm
15-3 GC	Røst Reef	09.06.07	67°30.46	9°25.39	331	163 cm
23-15 GC	Traenadjupet	13.06.07	66°58.24	11°7.82	327	54 cm
23-17 GC	Traenadjupet	13.06.07	66°58.21	11°7.82	327	41 cm
23-18 GC	Traenadjupet	13.06.07	66°58.16	11°7.80	327	325 cm
23-19 GC	Traenadjupet	13.06.07	66°58.16	11°7.81	327	326 cm
23-23 GC	Traenadjupet	13.06.07	66°58.23	11°7.66	323	109 cm
25-1 GC	Traenadjupet	14.06.07	66°55.47	10°54.05	313	41 cm
35-1 GC	Røst Reef	16.06.07	67°30.46	9°25.38	334	200 cm
35-2 GC	Røst Reef	16.06.07	67°30.48	9°25.41	327	80 cm
35-3 GC	Røst Reef	16.06.07	67°30.53	9°25.35	344	143 cm
41-5 GC	Sotbakken	19.06.07	70°45.34	18°39.84	266	62 cm

Sample processing on board

The gravity cores were immediately cut into 1-m sections after retrieval and stored upright at *in-situ* temperature until further processing. Cores were either processed on board or remained unopened for CT-scanning and subsequent analyses. Geological description was conducted on the opened cores before the 1-m sections were subsampled in 5-cm intervals for porewater, solid phase and sedimentological analyses as well as microbial turnover rates.

- Geological description
- Sampling for sedimentological analyses: grain size, clay analyses, stable isotope
- Analyses, Neodymium isotopic ratio
- Porewater sampling for: DIC/alkalinity, sulfate/sulfide, nutrients, trace metals, Ca^{2+}/Mg^{2+}
  and methane

  - Solid phase sampling for: Fe/S/C/N geochemistry
  - Sulfate reduction rates (SRR)
  - Rates of anaerobic oxidation of methane (AOM)
  - Calcium precipitation rates

Preliminary results

During the cruise we recovered 15 gravity cores with a maximum length of 3,2 m. All reefs had in common that their base consists of blueish-gray, stiff clay most likely of glacial origin (Fig. 14.2). The coral framework in the cores was filled with light gray, sticky clay with a lot of biogenic debris and sponges spiculae. We observed alternations of zones with smaller coral rubble and zones with big coral chunks. Occasionally, the main framework builders, *Lophelia* and *Madrepora*, were replaced by brittle, calcified Gorgonians. Throughout the cores several stones were found of a size up to 8 cm.
The penetration depth of the gravity cores were limited by the occurence of the stiff and compact clay layer underneath the coral reefs. At Røst Reef the basal clay was reached after 1,6 m, whereas at Traenadjupet reef we did not reach the base at station 23-18 GC, therefore longer cores could be retrieved.

Fig. 14.2: Base of the reef sediment with the underlying blueish gray stiff clay

Presumably this difference in sediment cover can be attributed to different oceanographic conditions of the two sites. Røst Reef is situated on the outer part of the shelf exposed to strong shelf edge currents, in contrast Traenadjupet reef is located in a more sheltered embayment closer to the shore. These findings might indicate that the corals living at Traenadjupet reef are experiencing higher sediment stress. Pictures from the submersible JAGO showing a rather patchy coral distribution at this site confirms this hypothesis.

Subsequent geochemical analyses of the samples taken on this cruise are supposed to provide further insight into the geological record, geochemical processes and microbial pathways in these cold water coral reef sediments.

15. IMAGE ANALYSIS AND MOSAICKING

Vikraim Unnithan[1], Birgit Lessmann[2]

[1])Jacobs University Bremen
[2])University of Bielefeld

Objectives

For the development of monitoring systems in marine research it is essential to analyse the visual appearance of marine habitats. This can be done by taking photographs and video data, either with remotely operated vehicles (ROV), ocean floor observation systems (OFOS) or submersibles. The acquired footage is huge and the visual analysis of the raw data is labour-intensive and time-consuming. Thus it is important to develop new methods for an automatic analysis.

One of such techniques is video mosaicking. Video is essentially a sequence of images shown at such a fast rate that the human eye perceives it as a continuous, flowing animation. The number of images varies but is typically in the order of 25 images per second. Video mosaicking attempts to select few images from this sequence at creates a single photo mosaic image. The advantage lies in the fact that there are a large number of images to choose from and only those that are well suited are selected for processing. In terms of mapping and quantitative analysis, a single image covering a large area is extremely useful for quantitative studies of the distribution of biological fauna and geological sediment cover.

Automatic image analysis provides the possibility to process large quantities of data in order to assess the abundances of particular species. Of particular interest is the automatic object recognition and extraction of both the biology and geology of the reef habitats.

In this cruise video footage of the coral reefs along the Norwegian continental margin were acquired by the manned submersible JAGO and a hybrid OFOS system. The data will be used to map and develop video analysis techniques to evaluate health and structure of cold-water coral reefs. This work is part of the EU HERMES and CORAMM projects.

Work at sea

The submersible JAGO is equipped with a forward-looking HD Video camera collecting high quality video data. During all dives video footage was taken. During some of the dives, two video cameras were operated to obtain near stereo video sequences.

The OFOS was equipped with an HD video camera directed vertically, i.e. looking downwards. A rope with 3 m lengths and a hook (9 cm width) was attached to the OFOS. A second camera providing only black/white images was attached to the OFOS and connected to the surface. By using the black-and-white video signal it was possible to control the height of the OFOS above the ground. Footage of eight different transects was taken, both perpendicular and along the ridges. The video transects and JAGO dives located in the Røst, Traena and Sotbakken Reefs as shown in Figs. 15.1, 15.2, and 15.3.

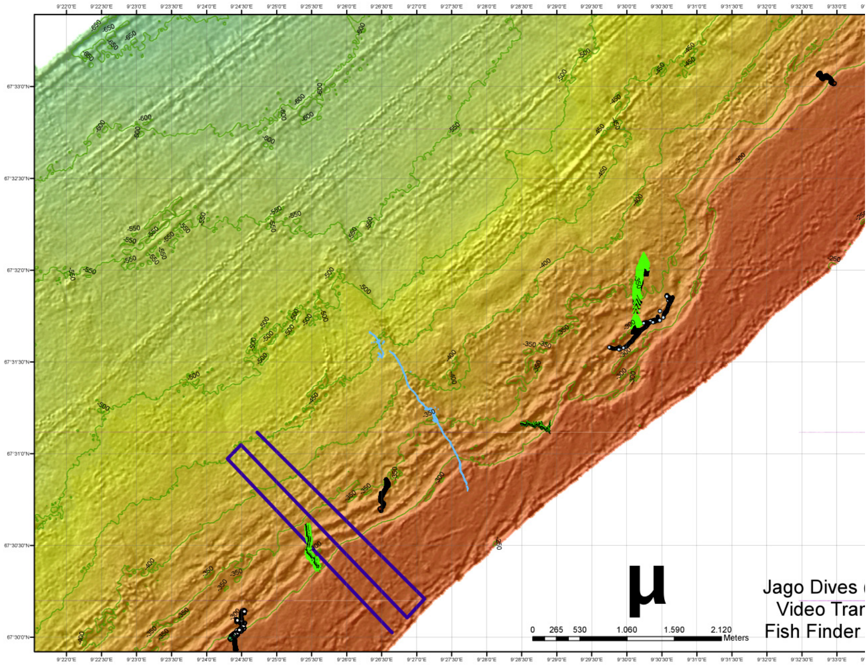

Fig.15.1: Video Survey transects and JAGO dives in the Røst Reef

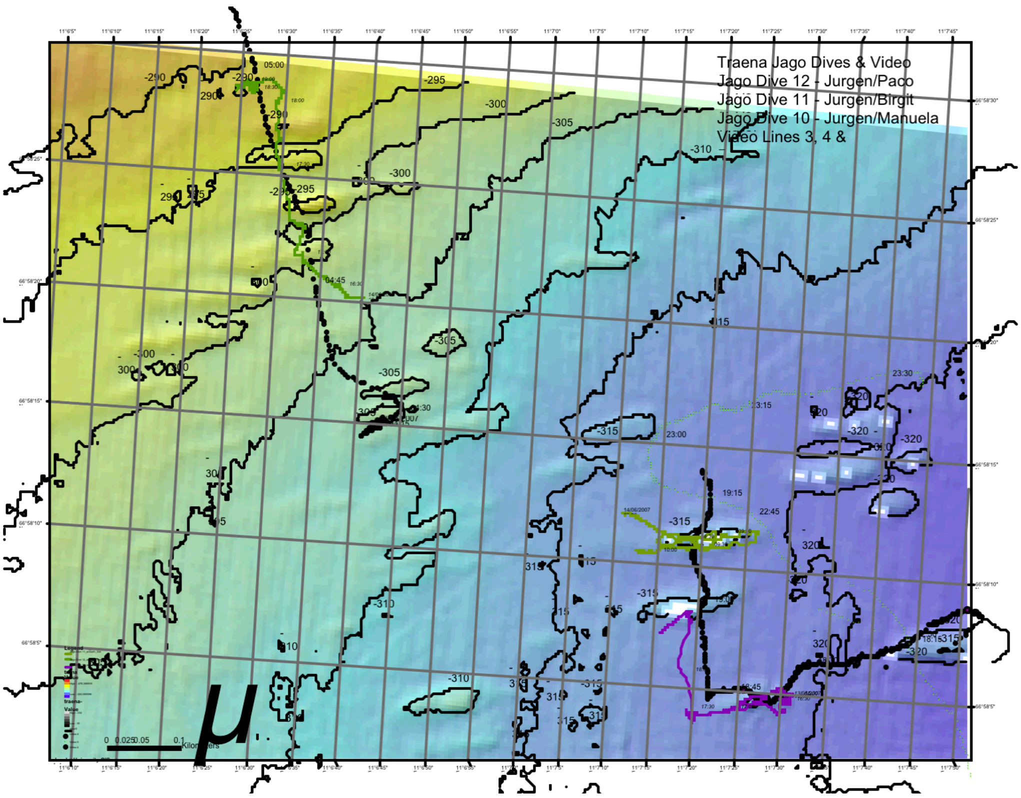

Fig. 15.2: Video Survey Transects and JAGO dives in the Traena Reef

The footage of the JAGO video camera is of excellent quality and provides very detailed image information. However, the camera is directed forwards resulting in strongly varying distances to objects and inhomogeneous light conditions.

The quality of the video footage acquired with the OFOS is strongly influenced by ship's heave during acquisition. Strong heave can cause strong variation of the system's speed and thus blurring effects in the video sequences. However, the main advantage of the OFOS video sequence is the vertical camera and the quite homogeneous light conditions, two very important aspects in the automatic analysis of video footage. Due to these properties, we consider the video footage of the OFOS to be more appropriate for the tasks of video mosaicking and automatic image analysis.

Stereo Video
Limited video footage was acquired in stereo mode during the JAGO dives. This test implementation consisted of two HD video cameras mounted together on a rigid plate. The horizontal distance between the cameras was approximately 9 cm, i.e. similar to human eye separation. The general aim was to try and extract additional information especially in 3D of viewed objects. The single camera footage generally lacks the depth perspective. Hence, hope is to bring the third dimension to scientists, especially those who have not had the good fortune to be able to experience the coral reefs in their full extent.

Analysis methods

Video Mosaicking
The basic techniques for video photo mosiacking are very simple, i.e. select images from a video sequence, correlate the images to extract motion vectors, and finally merge the sequence into one image. Practically there are, however, numerous problems starting with the various video formats, codecs and compressions used to store video on digital medium. Rapidly changing ambient condition such as light or speed of the video instrument has a very large negative impact on the quality of the video.
Various different tools were tested for the video mosaicking. Tests show that all tools (see Fig. 15.3) provide positive results.

Automatic image analysis
Within the CORAMM project new analysis methods will be developed to analyse video data of cold-water coral reefs automatically. The most important question is here to process large amount of data in order to monitor the health and structure of the reefs. The work will focus on methods for assessing the amount of corals within the image and for classification into dead and living corals. For this purpose machine learning algorithm will be used to classify image structures based on particular characteristic image features such as texture and colour.

Preliminary results

The amount of acquired video data is huge. To reduce the amount of image information to be processed the HD video sequences were captured using the programme IMovie HD. After capturing it was possible to export a certain amount of frames into still images for further analysis.

Two frames for each second were exported into still images.
The original HD footage has an image size of 1440x1080 pixels. To obtain a 16:9 format the pixels are not squared but provide an aspect ratio of 4:3. Using IMovie the original video data was exported into PNG-images with squared pixels. The resolution of the exported images is 1920x1080 to maintain the 16:9 format. The PNG-image format was selected since it provides a high quality lossless compression. One example image is shown in Fig. 15.3. The processing described above resulted in approximately 52000 images and a data amount of approximately 80GB.

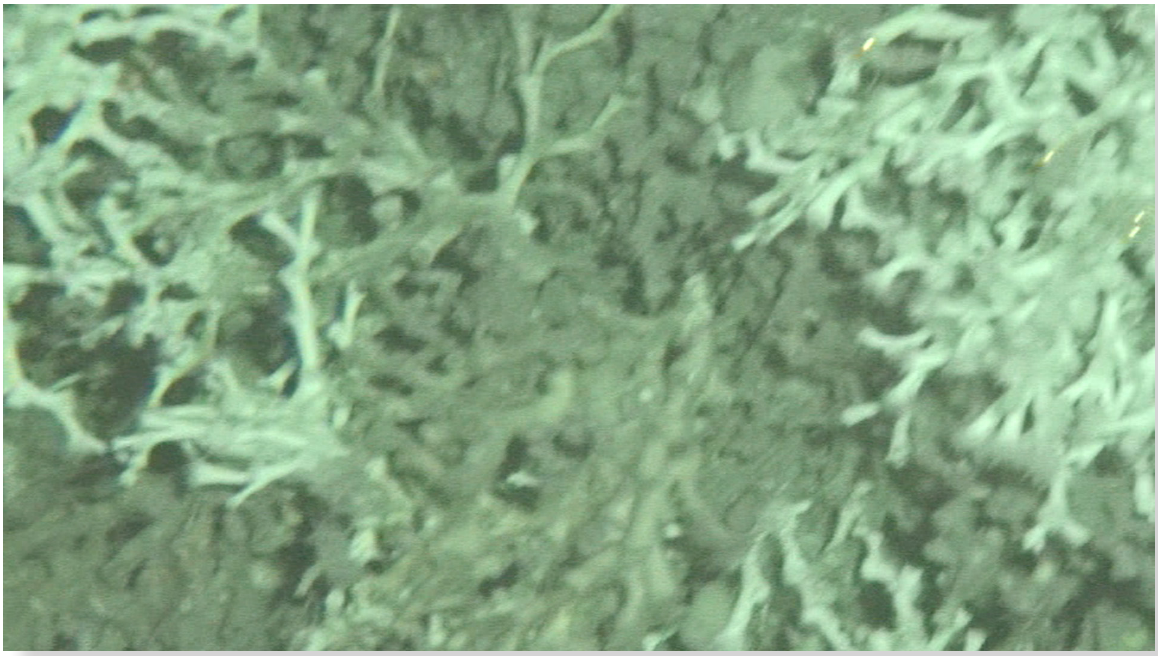

Fig. 15.3: Example Image acquired during a video survey in the Røst Reef

The exported images provide a strong overlap and are thus appropriate for image mosaicking applications.

The reduction of the data by exporting a small amount of single frames has the advantage that the originally high resolution can be preserved. This is especially important for the purpose of automatic image analysis, since a significant reduction of the image resolution would strongly affect characteristic image properties such as texture.

It is planned within the next months to establish a system that recognizes automatically cold-water corals within the images and distinguishes dead from living corals. This can most probably be done based on the colour and the texture of the different image structures. In this way it is possible to automatically process the large amount of footage and to compute the abundances and health conditions of particular species.

The bright dots in the image belong to shrimps. They can easily detected due to the high intensity as demonstrated in Fig. 15.4.

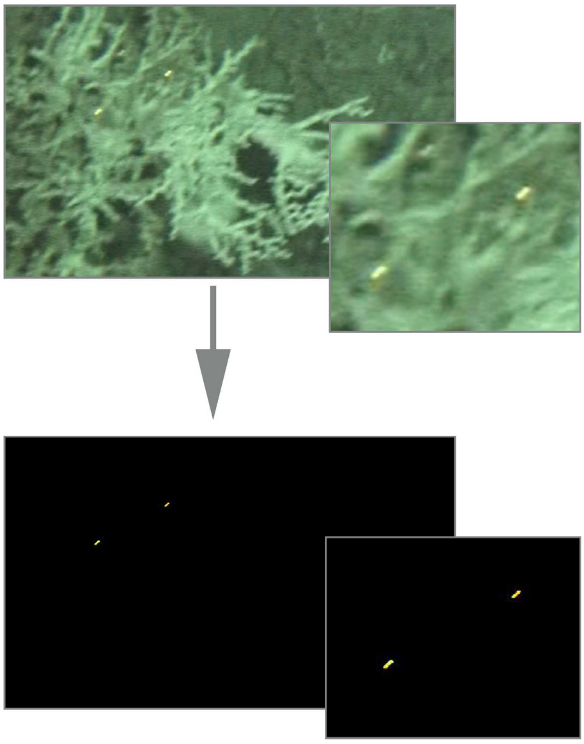

Fig.15.4: Detection of shrimp eyes

Some of the preliminary video mosaicking results are shown in the following figures. During this cruise a lot of data was acquired and it was impossible from the hardware and software point of view to process the data. In the next few months, video segments will be chosen and extracted for mosaic creation. Additional software code in matlab will be written to provide better motion analysis and algorithms to increase the efficiency of the mosaic creation.

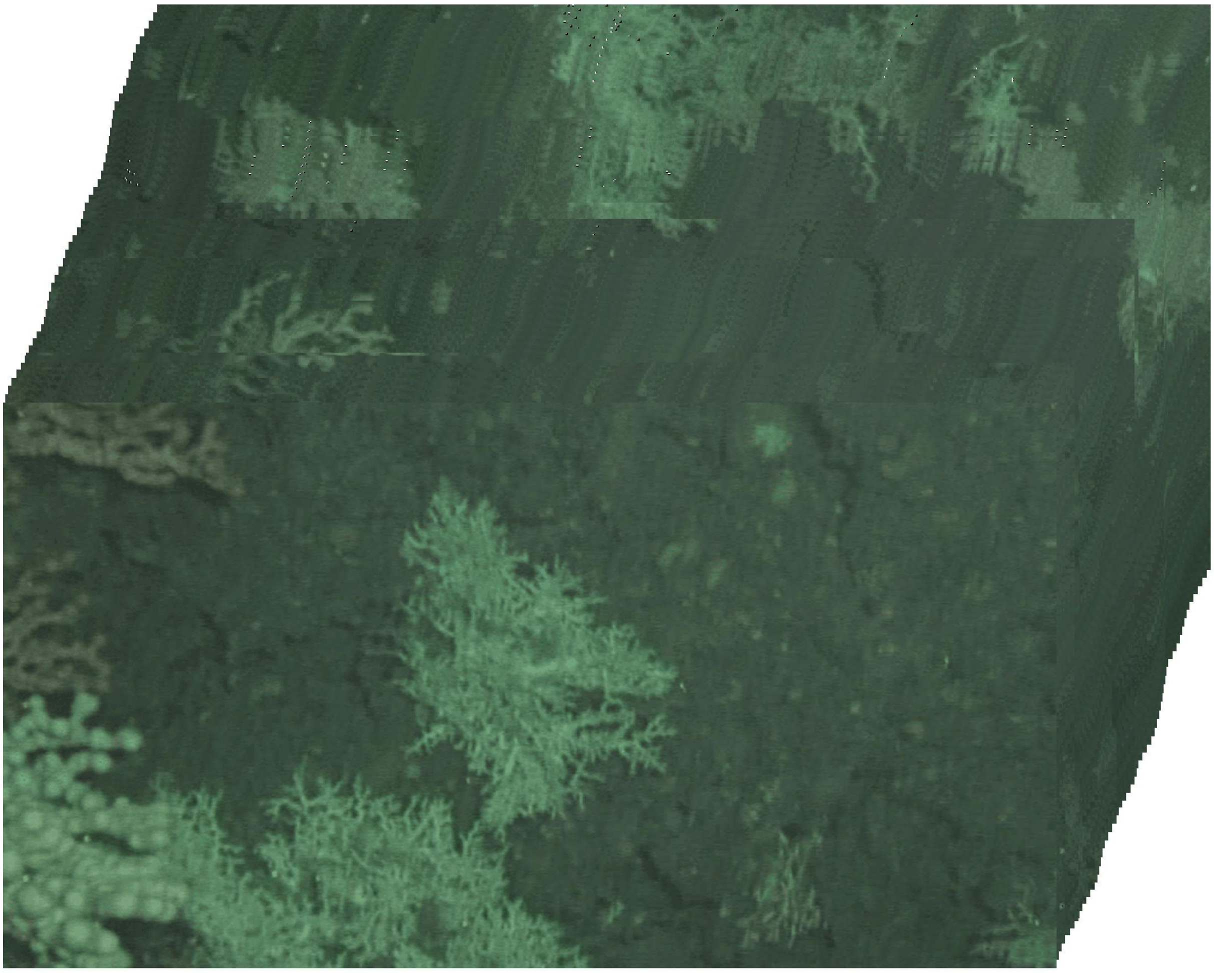

Fig. 15.5: Example mosaic from video survey

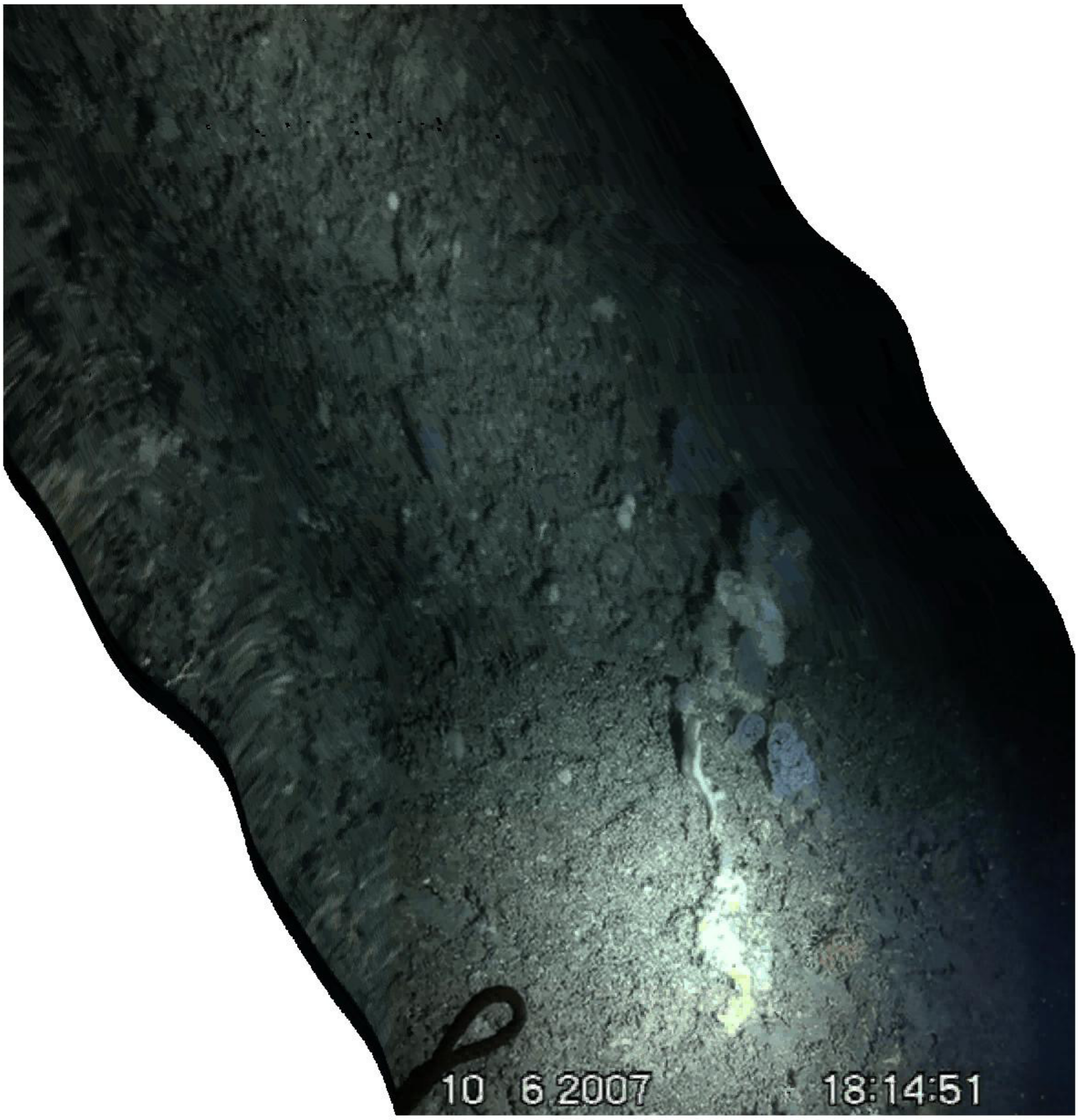

Fig. 15.6: Mosaic image using the JAGO sive video footage

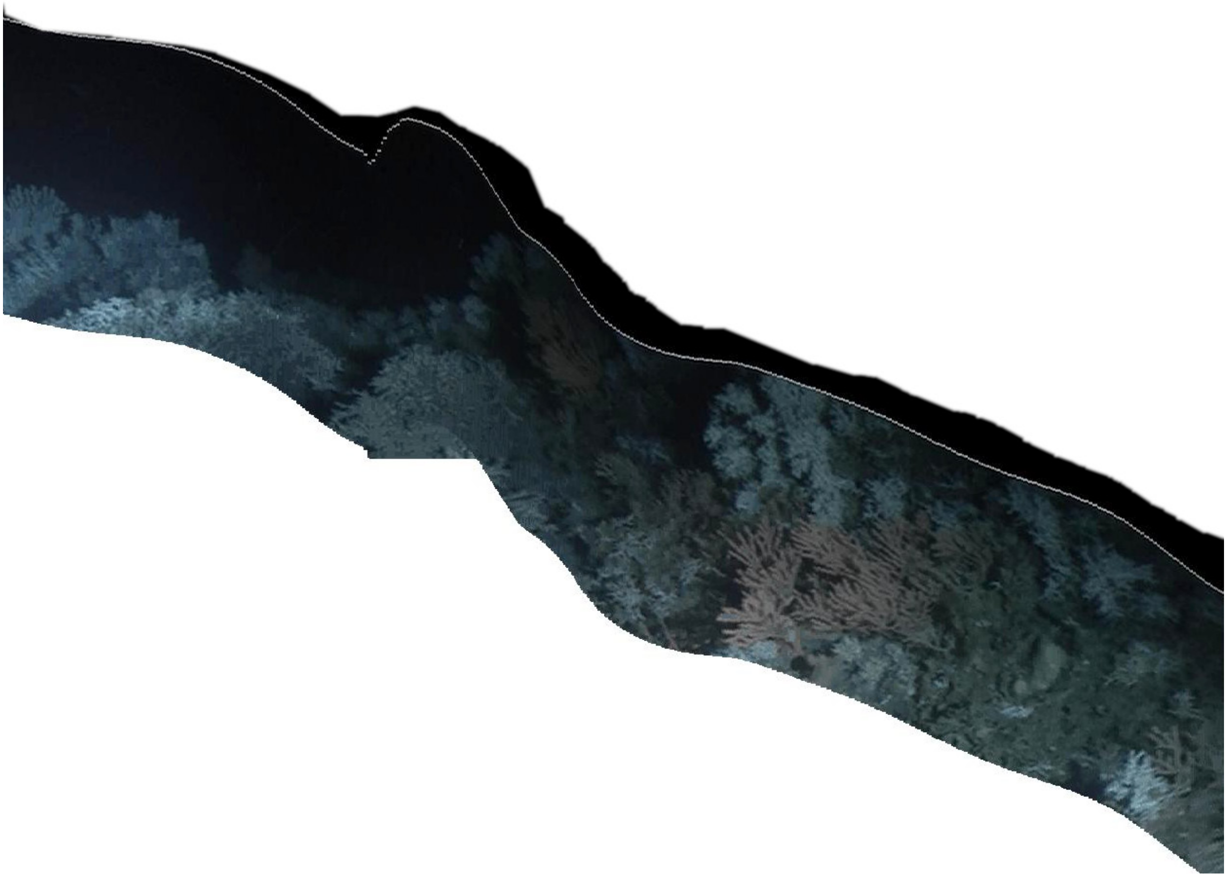

Fig. 15.7: Video mosaic created using the JAGO dive video (Røst Reef)

16. HERMES OUTREACH GROUP: "OUTREACH FOR SCHOOL PUPILS”

Rune Erlandsen, Gesche Funk, Nora Hanelt, Aline Munyaruguru, Steffen Wittek
Jacobs University Bremen

HERMES Outreach, in conjunction with the International Polar Year 2007/2008, AWI and Jacobs University Bremen did ‘host’ four school pupils from Norway and Germany on a research expedition onboard the research vessel *Polarstern*. The four school pupils carried out their own research projects and assisted the deep-sea researchers onboard *Polarstern*. The pupils also communicated to their school peers about their experiences, wrote expedition logs, conducted relevant scientific and investigative reporting, video-making and interviews that they put online. After the expedition, the pupils will continue their outreach efforts, for example by designing educational posters for distribution to schools, etc.

The four school pupils - Aline Munyaruguru (16 years) and Rune Erlandsen (17) together with their German counterparts Gesche Funk (18) and Steffen Wittek (19) - were part of a scientific expedition *Polarstern* ARK-XXII/1a to the Nordic Continental Margins. They had been onboard since May 29, when *Polarstern* set sail from Bremerhaven, Germany. Since then, they had been participating in a variety of hands-on learning experience onboard *Polarstern* not available during normal school classes, indeed a privileged opportunity.

All four school pupils had been actively participating in various activities onboard *Polarstern*. During the first week when the ship was sailing on its way to the first research site and the scientists were busy unpacking and setting up their laboratories, the pupils conducted interviews of the various crew onboard and were given “educational tours” of the various parts of the ship e.g. the Captain showed them the Bridge, the Chief Engineer showed the engine room areas, the ship Doctor showed them the medical equipment available onboard, the helicopter pilots gave them a chance to sit in the stationary helicopter while explaining about the helicopters, the team of the manned submersible JAGO explained about the submersible and allowed them to go into the submersible while it was dry on deck, the “Weathermen” demonstrated to them how the transmitters which were supposed to gather information about the weather were released into the atmosphere using a huge weather balloon, etc. These activities were to help keep their mind off their seasickness as well as to give them a thorough orientation of the large ship.

During the second week, they began their rotational training work with the various scientists’ groups such as the sponge taxonomy group, the mud group, the coral mucus group, the invertebrates group, etc. They also interviewed some of the scientists. Each pupil conducted video 'analysis' of one scientist's submersible dive in order to 'experience a dive' (albeit second-hand!) by recording the interesting things they see, etc. They then compared their own observations (dive logs) with the scientists' own dive logs. They were allocated their own aquaria in a cool room to maintain the corals and other animals they would like to keep for observations.

In the guise of a sponge spicule preparation session, the pupils were also shown how to write scientific reports in scientific format, in order to prepare them for the next phase: their own mini-projects. Of the various mini-projects offered or available, Aline and Rune were researching the effects of sediments on sponges under the supervision of A. Purser (Jacobs University Bremen) and Dr. F. Hoffman (Max Planck Institute Bremen). Gesche and Steffen opted to do research on effects of stress on coral mucus production under the supervision of Dr. C. Wild (LMU, Munich). Steffen Wittek learned from Prof. V. Unnithan (Jacobs University Bremen) more about the application of the 3-D software 'Fliedermaus' for visualization of the sea-bottom topography.

17. THE REMOTELY OPERATED VEHICLE (ROV) "QUEST" AND SUMMARY OF DIVE OPERATIONS DURING CRUISE LEG ARK-XXII/1B

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(MARUM, Center for Marine Environmental Sciences at the University of Bremen)

Objectives

The deepwater ROV (remotely operated vehicle) "QUEST 4000m" used during ARK-XXII legs 1b and 1c, is owned and operated by MARUM, Center for Marine Environmental Sciences at the University of Bremen, Germany. The QUEST ROV is based on a commercially available 4000 m rated deepwater robotic vehicle designed and built by Schilling Robotics, Davis, USA. Since installation at MARUM in May 2003, it was designed as a truly mobile system specially adapted to the requirements of scientific work aboard marine research vessels for worldwide operation. Today, QUEST has a total record of 173 dives during 14 cruises, including this expedition.

For ARK-XXII/1b, the QUEST system had to be installed for the first time aboard *Polarstern*. Following one day preparation work especially for adapting the vehicle's LARS (launch and recovery system) to the ship's A-Frame during docktime in Bremerhaven prior to the cruise, the mobilization in Tromsø took 2 days. Including installation of the 45 tons of system equipment, welding of rails on the aft deck and various electric and fibreoptic connections to ships data network and main electricity net, QUEST was ready for diving in the morning after departure. This efficiency was to a large extent due to most professional support by the ship's crew.

Work at sea

During ARK-XXII/1b, QUEST performed 10 dives to depths around 1,260 m. All dives with a total of 87 hours bottom time (113 hours total dive time) allowed successful scientific sampling and observation at different sites at Håkon Mosby Mud Volcano. QUEST was operated by a team of 8 pilots/technicians on a daily basis with a mean dive time of 12 hours as long as the weather conditions allowed deployment and recovery. Only 1 dive had to be interrupted after ¾ dive time for technical reasons due to a compensation leak within one circuit on the vehicle, which could be instantly repaired after recovery.

Close cooperation between ROV team and ship's crew on deck and bridge allowed a quick gain of experience for the handling procedures during deployment and recovery, which needed to prove even in higher seas up to 3 m wave height. During diving, this cooperation allowed precise positioning and navigation of both ship and ROV, which was essential for accurate sampling and intervention work such as instrument recovery and remote shuttle operation at depth. The ROV team is very grateful for this kind of steady support from the entire ships crew during the whole cruise.

QUEST System description

The total QUEST system weighs approx. 45 tons (including the vehicle, control van, workshop van, electric winch, 5,000-m umbilical, LARS and transportation vans) and can be transported in four standard ISO 20-foot vans. Using a MacArtney Cormac electric driven storage winch to manage the 5,000 m of 17.6 mm NSW umbilical, no additional hydraulic connections are necessary to host the handling system.

The QUEST uses a Doppler velocity log (DVL, 1,200 kHz) to perform dynamic positioning, displacement, and other auto control functions. Designed and operated as a free-flying vehicle, the combination of 60 kW propulsion power with DVL-based auto control functions provides exceptional positioning capabilities at depth. Withstanding cable drag and currents, the vehicle maintained relative positioning accuracy within decimeters. Absolute GPS-based positioning are performed using the shipboard IXSEA Posidonia acoustic USBL positioning system. Performance of the USBL system reached an absolute position accuracy of +/- 5 m.

The QUEST SeaNet telemetry and power system provides a convenient way to interface all types of scientific equipment, with a current total capacity of 16 video channels and 60 RS-232 data channels. The SeaNet connector design allows easy interface to third-party equipment, particularly to prototype sensor and sampling devices, by combining power-, data-, video-distribution plus compensation fluid transport all through one single cable/connector set-up. This ease of connection is especially important in scientific applications, where equipment suites and sensors must be quickly changed between dives. When devices are exchanged, existing cables can be kept in place, and are simply mapped to the new devices, which can consist of video, data, or power transmission equipment.

The empty space inside the QUEST toolskid frame allows installation of mission-specific marine science tools and sensors. The initial vehicle setup includes two manipulators (7-function and 5-function), 7 color video cameras, a digital still camera (Insite SCORPIO, 3.3 Megapixel), a lighting suite (with various high-intensity discharge lights, HMI lights, lasers, and dimmable incandescent lights), a CTD, a tool skid with exchangeable drawboxes, an acoustic beacon finder and a 675 kHz scanning sonar. Total lighting power is almost 3 kW, total additional auxiliary power capacity is 8 kW.

For extremely detailed video close-up filming, a near-bottom mounted broadcast quality (>1000 TVL) 3CCD HDTV video camera was used (Insite Zeus). Spatial Resolution of this camera is 2.2 MegaPixel at 59.94 Hz interlaced. Recording was performed on demand onto tapes in broadcast-standard digital Sony HDCAM format, using uncompressed 1.5 Gbit HD-SDI transmission protocol. Continuous PAL video footage was recorded on MiniDV tapes with two colour zoom cameras (Insite PEGASUS or DSPL Seacam 6500). In order to gain a fast overview of the dive without the need of watching hours of video, video is continuously frame-grabbed and digitized at 5sec intervals, covering both PAL and HD video material.

The QUEST control system provides transparent access to all RS-232 data and video channels. The scientific data system used at MARUM feeds all ROV- and ship-based science and logging channels into a commercially available, specially adapted real-time database system (DAVIS-ROV), which is compatible to the ships database system.

During operation, data and video including HD are distributed in realtime to minimize crowding in the control van. Using the existing ship's communications network, sensor data can be distributed by the real-time database via TCP/IP from the control van into various client laboratories, regardless of the original raw-data format and hardware interface. This allows topside processing equipment to perform data interpretation and sensor control from any location on the host ship.

Additionally, the pilot's eight-channel video display is distributed to client stations into the labs on the ship via simple CAT7 cable. This allows the simple setup of detailed, direct communication between the lab and the ROV control van. Thus, information from the pilot's display is distributed to a large number of scientists. During scientific dives where observed phenomena are often unpredictable, having scientists witness a "virtual dive" from a laboratory rather than from a crowded control van allows an efficient combination of scientific observation and vehicle control.

Post-cruise data archival will be hosted by the information system PANGAEA at the World Data Center for Marine Environmental Sciences (WDC-MARE), which is operated on a long-term base by MARUM and the Alfred Wegener Institute for Polar and Marine Research, Bremerhaven (AWI).

During ARK-XXII/1b, the following scientific equipment suite was handled with QUEST:

ROV based tools, installed on vehicle:
PC SAM 365 Pushcore (Geochemistry)
X SAM 408 InSinc (Geochemistry)
PCAWI SAM AWI Core (Geochemistry)
T-Stick MES 414 T-Stick (Continuous MES.: Temperature)
KIPS SAM KIPS discrete water sampler (Water)
Net SAM Net (Biology)
GM SAM Gas-Meister (Water)
SG SAM 127 Slurp gun (8 samples) (Biology)
AC SAM Autoclave Corer (Geochemistry)
BL SAM 363 Blade corer (Biology)
ROV_B SAM 300 ROV basket (Biology)

In-situ Instruments, intervention/operation by vehicle:
Lift MOOR 361 ROV elevator (SAM)
BC MOOR 362 Benthic Chamber (MES)
SC MOOR Schlieren Kamera (Video)
MIC MOOR 410 MIC profiler (MES)
PO MOOR 369 Planar Optode (MES)
M POS Passive marker (Marker x, Description)
DF MOOR 417 DeepFlow (MES)
RCM_11 MOOR 63 Current meter (MES)
TRACK MOOR Slate rack R1, R2, R3, R4 (Colonization tray, SAM)
Fish Trap MOOR (recovery support only)
In addition, the permanently installed Kongsberg 675 kHz Type 1071 forward looking Scanning Sonar head provided acoustic information of bottom morphology and was also used for detection of gas emissions.

Fig. 17.1: ROV QUEST being recovered aboard Polarstern after a successful dive

Fig. 17.2: ROV QUEST system installation aboard Polarstern (vehicle, LARS, winch, rails)

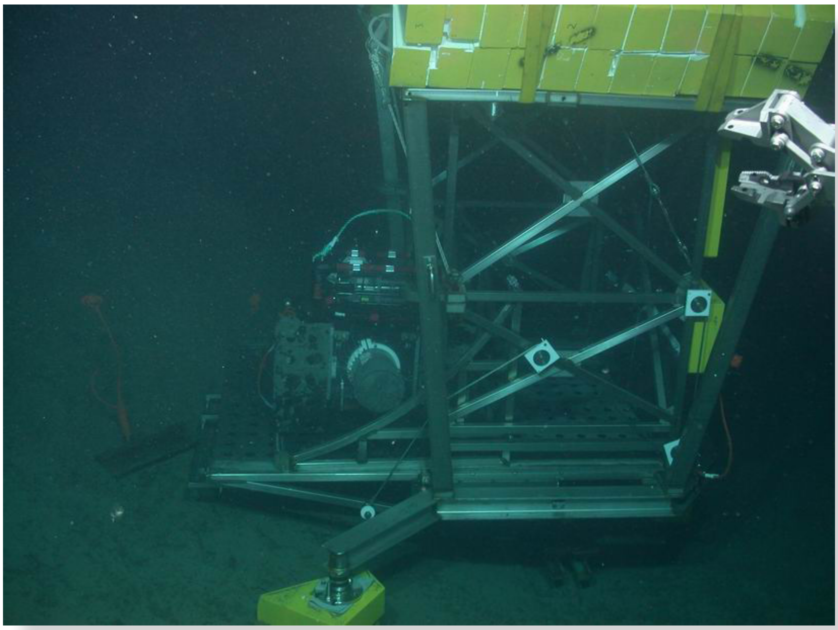

Fig. 17.3: Approaching the MPI's lift system COLOSSOS with QUEST after recovery and loading of in-situ instruments, in order to prepare the lift's release (dive 171)

Foto © 2007 Marum, University of Bremen

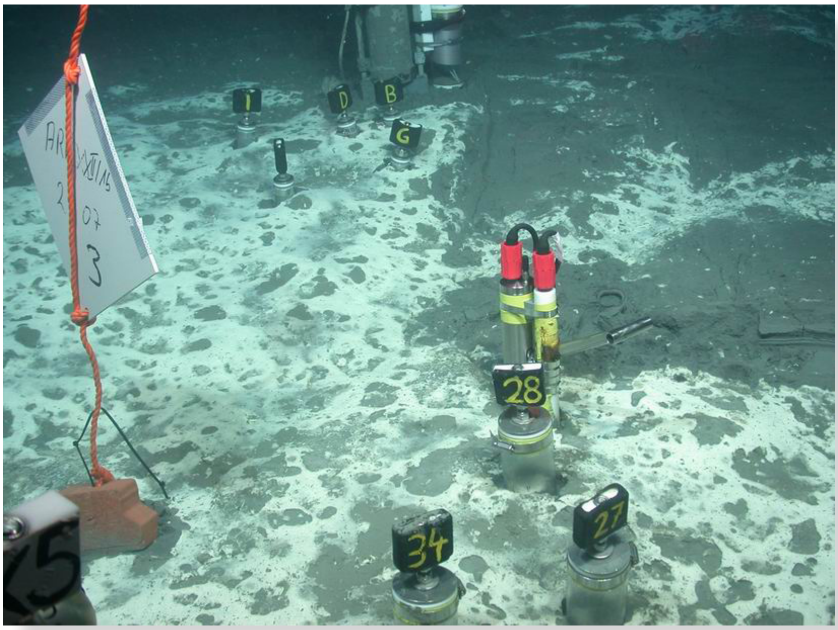

Fig. 17.4: Intensive sampling of a bacterial mat site with pushcores, Insincs and T-Stick, next to a previously deployed current meter and marker (dive 169).

Foto © 2007 MARUM, University of Bremen

18. INVESTIGATIONS OF GAS HYDRATE AND GAS *IN-SITU* INVENTORIES IN HÅKON MOSBY MUD VOLCANO DEPOSITS USING AUTOCLAVE TECHNOLOGY

Thomas Pape, Friedrich Abegg, Hans-Jürgen Hohnberg
(MARUM, Center for Marine Environmental Sciences at the University of Bremen)

Objectives

For submarine mud volcanoes significant enrichments of methane and other low-molecular-weight hydrocarbons (LMWHC) were observed in upward migrating fluids and overlying water masses. Thus, submarine mud volcanoes are considered to emit significant amounts of LMWHCs (Kopf 2002; Dimitrov 2003). Furthermore, in deposits percolated by those fluids, accumulations of gas hydrates are frequently observed. Submarine gas hydrates are of great interest since they are an abundant and dynamic reservoir of LMWHCs predominately of the potent greenhouse gas methane (Kvenvolden 1988).

Recent studies conducted at the submarine Håkon Mosby Mud Volcano (HMMV) area revealed high concentrations of methane in sediments and near-bottom waters (Damm & Budéus 2003; Milkov et al. 2004), the gas bubble emission from the seafloor (Sauter et al., 2006) and occurrences of gas hydrates in shallow sediments (Vogt et al., 1997; Ginsburg et al., 1999; Milkov et al., 2004). A conspicuous zonation of microbial habitats and activities at the HMMV indicate strong geochemical gradients existing in the sediments and on the seafloor (DeBeer et al., 2006; Niemann et al., 2006; Jerosch et al., 2007).

The major objectives of the onboard works during cruise PS 70 ARK-XXII/1b were to quantify *in-situ* abundances of volatile hydrocarbons (C_1 through C_6) present in gas- and hydrate-rich near-surface deposits of the HMMV. In order to improve the current knowledge on the dynamics of LMWHCs and gas hydrates the works moreover aimed at the partitioning of specific LMWHCs in the different sedimentary phases (as free gas, dissolved in interstitial waters, or encapsulated in gas hydrates). Further, inferred LMWHC sources (microbial / thermocatalytic), and the crystalline structure of gas hydrates will be determined on shore. Since sample recovery using conventional tools does not prevent degassing of the sediment and dissociation of the gas hydrates, autoclave technology was applied, which enables to preserve deep sea samples under ambient pressure (Abegg et al., subm.).

Work at sea

Works at sea were directed to the recovery and quantitative degassing of pressurized sediment cores as well as sampling and preparation of gas hydrates and gas subsamples sediment cores as well as sampling and preparation of gas hydrates and gas subsamples for onshore analyses. Sampling locations were known sites of gas hydrate occurrences and areas expected to favour gas hydrate generation.

Sampling was performed using the Dynamic Autoclave Piston Corer I and conventional gravity corers. Prior to DAPC I deployments the presence of near-surface gas hydrates at specific sites was investigated by gravity coring.

Gravity core deployments

To prove the existence of gas and gas hydrates within the reach of the DAPC I and for collecting gas hydrates we used the shipboard gravity corer with a weight of 500 kg and a barrel of 5 m length. Instead of PVC-liner we applied plastic hoses for rapid sample access upon core recovery. Deployment speed varied between 0.5 and 1.5 m s^{-1}, whereas the low deployment speed was used for the center core PS70/069 and high speed in the position at the outer rim of the HMMV (PS70/102).

Deployments of the Dynamic Autoclave Piston Corer I

The Dynamic Autoclave Piston Corer (DAPC I, Fig. 18.1) allows for sampling and preservation of *in-situ* pressures in sediment cores from the deep sea and, thus, prevents dissociation of gas hydrates and degassing during core recovery. DAPC I was successfully used since 2003 and continuously improved during several research cruises. The device can be deployed from a research vessel on the deep sea cable. It is released from variable heights (1 - 5 m) due to the resistance of the seafloor and penetrates the seafloor in a free-fall mode using the release mechanism developed by Kullenberg (1947).

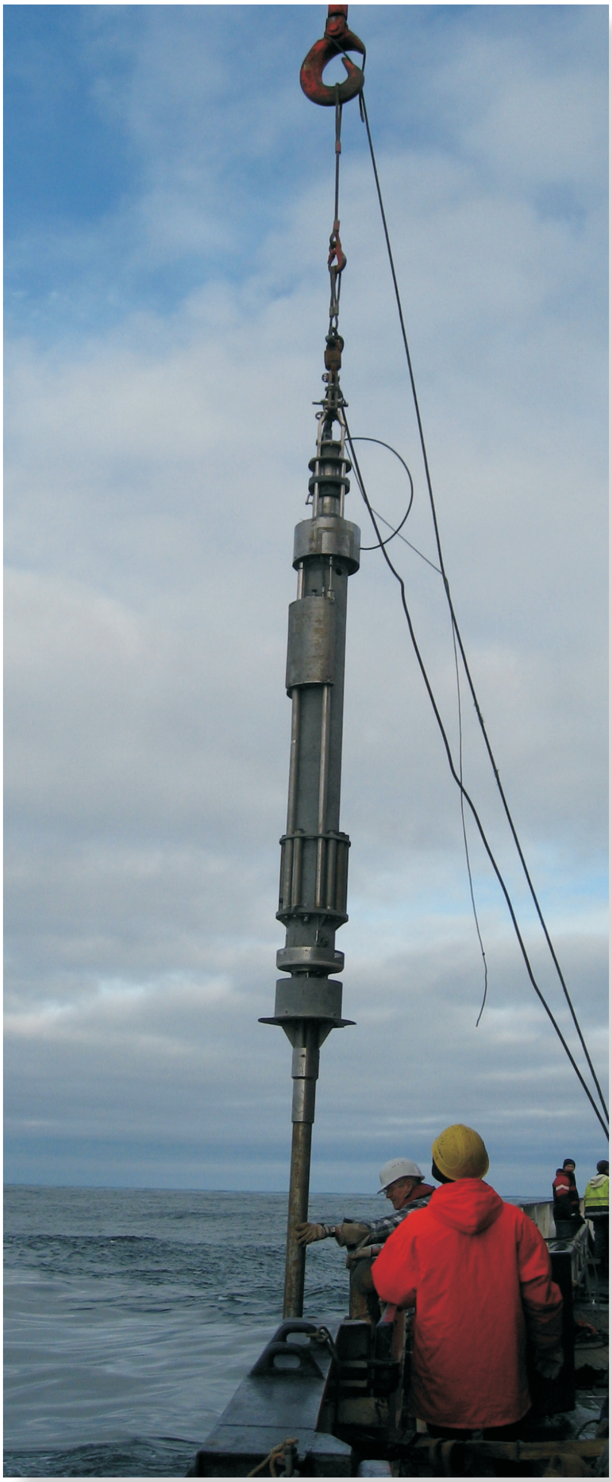

Fig. 18.1: The Dynamic Autoclave Piston Corer during launch from board Polarstern

The total length of the DAPC I is 7.2 m, and its total weight is about 800 kg. It was designed to cut sediment cores from the seafloor surface to a maximum length of 2.6 m and to preserve them at *in-situ* pressure corresponding to water depths of up to 1,400 m. The DAPC I is equipped with a pressure control valve, which allows the deployment down to 5,000 m water depth. An *in-situ* pressure of up to 200 bar (2,000 m water

depth) is preserved, while higher pressures up to 500 bars will be released down to 200 bars.
The core cutting barrel (2.7 m length) hits the seafloor with strong impact. Therefore, it is especially suitable for sampling layered gas hydrate-bearing near-surfaced sediments. During hauling the sediment core is pulled into the pressure chamber and sealed gas-tight. The pressure chamber consists of glass-fiber reinforced plastic, aluminum alloys, seawater resistant steel and aluminum bronze. It is 2.6 m long resulting in an inner core volume of 12 L, and weighs about 230 kg. All parts of the pressure chamber exposed to seawater are suitable for long-term storage of cores under pressure for several weeks. The pressure chamber was checked and approved by the Berlin TÜV (Technischer Überwachungsverein, technical inspection authority of Germany). Deployment of DAPC I from *Polarstern* was similar to that of conventional piston corers but without a core depositing frame.

For an assessment of the in-situ inventories of gas present in gas and hydrate-rich deposits of the HMMV, the overall gas volumes preserved in DAPC I cores were specified by incremental degassing (Heeschen et al., subm.) immediate upon recovery of the tool. In the course of the degassing procedure the pressure preserved inside the DAPC I was monitored using a pressure sensor (Keller Drucktechnik) and gas sub-samples were taken at selected time points for storage and gas chemical measurements onshore. For long-term storage all gas sub-samples were transferred with a gas-tight syringe into glass vials pre-filled with concentrated sodium chloride solution.

For analyses of pore water chlorinity, which is affected by gas hydrate occurrences, pore water was taken at selected depths intervals from the depressurized sediment core.

Preliminary results

During PS 70 ARK-XXII/1b gravity corer and DAPC I stations covering a wide area of expectedly varying gas- and gas hydrate concentrations in deposits of the HMMV were carried out. Most stations were positioned in the hummocky periphery (Unit II; Jerosch et al., 2007) in the northern part of the structure, while three sampling sites were either located in the centre (Unit I) or in the moat area (Unit III; Fig. 18.2).

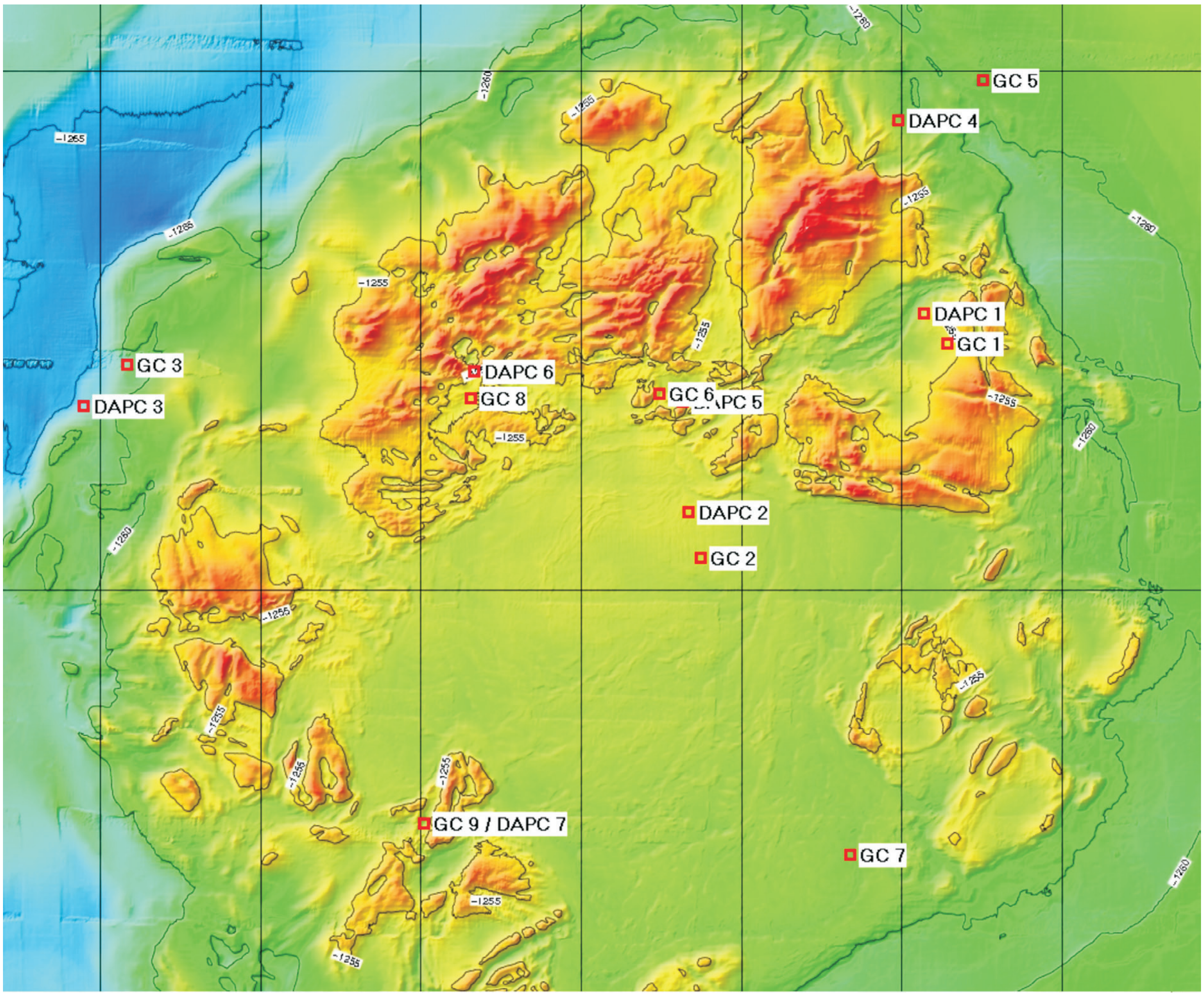

Fig. 18.2: Map showing gravity corer (GC) and Dynamic Autoclave Piston Corer (DAPC I) stations conducted during PS 70 ARK-XXII/1b for sampling of gas- and gas hydrate bearing sediments.

Gravity corer

For inspections of gas hydrate distributions in HMMV deposits 9 gravity corer stations were conducted by our group (Table 18.1). In addition, pieces of gas hydrate were obtained from gravity cores dedicated for sediment temperature measurements and for investigations of sediment compositions (see chapters V and VI, station nos. PS70/92-1 to 94-1) as well as from a box corer conducted for biological investigations (station no. PS70/134-1; chapters V, VI, and XXII). At 9 of these stations near-surface gas hydrates were found.

Tab. 18.1: List of gravity corer stations conducted during PS 70 ARK-XXII/1b for gas hydrate investigations. GC = Gravity corer; GKG = Giant Box Corer *) Gas hydrates found at stations deployed for non-gas hydrate studies. [x]) Positions obtained by USBL underwater navigation system POSIDONIA

Station No. PS 70/	**Device/ running no.**	**Lat. N°**	**Long. E°**	**Gas hydrate pieces stored in liquid N_2**	**Gas released by gas hydrate dissociation**	**Comments** (gh = gas hydrate)
54-1	GC/1	72:0.368	14:44.070	X	X	uppermost part of core lost through weight head due to degassing, gh chips
69-1	GC/2	72:0.265	14:43.686 [x]			recovery 3.8 m, no visible gh but degassing
82-1	GC/3	72:0.358	14:42.791			core lost
92-1*	GC	72:0.31	14:43.61		X	for description refer to chapter V.
93-1*	GC	72:0.31	14:43.47	X	X	for description refer to chapter V.
94-1*	GC	72:0.29	14:43.46	X	X	for description refer to chapter V.
98-1	GC/4	72:0.550	14:44.325 [x]			core partially lost, floating peace of gh visible during recovery
102-1	GC/5	72:0.495	14:44.127 [x]		X	recovery 3.3m, gh chips below 1.8m

Station No. PS 70/	Device/ running no.	Lat. N°	Long. E°	Gas hydrate pieces stored in liquid N_2	Gas released by gas hydrate dissociation	Comments (gh = gas hydrate)
110-1	GC/6	72:0.344	14:43.622 [x]	X	X	recovery 3.6 m, gh chips below 40 cm, gh small fist size below 1.8 m
117-1	GC/7	72:0.122	14:43.920 [x]			core partially lost, dark grey mud with gas
120-1	GC/8	72:0.342	14:43.328 [x]	X	X	pogonophora at the top, 0-5 cm oxic, 5-35 cm black mud no gas, 35-120 black mud with much gh
122-1	GC/9	72:0.135	14:43.236 [x]	X	X	0-5 cm oxic, 5-40 cm black mud no gas, 40-125 black mud with much gh
134-1*	GKG	72:0.26	14:43.29	X	X	Near-surface gh in box corer

Gas hydrate pieces were stored in liquid nitrogen immediately upon recovery until analyses onshore. Gases released by the controlled dissociation of gas hydrates pieces were transferred into glass ampoules.

Autoclave Tools

In sum seven stations were covered by DAPC I. All stations were carried out successfully and sediment cores were recovered under ambient pressure. A total of 109 gas sub-samples were taken during incremental degassing (Table 18.2).

Tab. 18.2: List of DAPC stations performed at the Håkon Mosby Mud Volcano. DAPC I: Dynamic Autoclave Piston Corer I. [x]) Position obtained by USBL underwater navigation system POSIDONIA.

Station No. PS 70/	Device/ running no.	Lat. N°	Long. E°	Type of sample	No. of gas (sub-) samples
53-1	DAPC I/1	72:0.383	14:44,035	Sediment core	20
68-1	DAPC I/2	72:0.287	14:43,667	Sediment core	12
81-1	DAPC I/3	72:0.338	14:42,724 [x]	Sediment core	7
97-1	DAPC I/4	72:0.476	14:43,994 [x]	Sediment core	18
113-1	DAPC I/5	72:0.340	14:43,659 [x]	Sediment core	17

Station No. PS 70/	Device/ running no.	Lat. N°	Long. E°	Type of sample	No. of gas (sub-) samples
126-1	DAPC I/6	72:0.355	14:43,333 ˣ	Sediment core	19
133-1	DAPC I/7	72:0.137	14:43,255 ˣ	Sediment core	16

A wide range of gas volumes preserved in the pressurized sediment cores was found (Table 18.3). Highest total amounts of about 231 L gas preserved in the whole core corresponding to 17.0 L gas per L wet sediment were measured for station PS70/53-1 in the NE section of the HMMV, which according to the classification by Jerosch et al. (2007) is located within the morphological unit II of the HMMV. However, much higher gas – sediment volume ratios were determined for stations PS 70/133-1 (25.2 L gas per L wet sediment) and PS 70/126-1 (70.7 L gas per L wet sediment) also located within unit II. Since for the latter station a relatively small sediment volume was only detected in the liner upon core degassing, it seems plausible to assume the presence of massive near-surface gas hydrates. Thus, the gas – sediment volume calculated for this station has to be taken as a rough estimate. Lowest ratios of 2.6 and 5.1 L gas per L wet sediment were released from cores PS70/81-1 and 68-1, respectively (units I and II).

Tab. 18.3: Accumulated gas volumes and calculated gas-sediment ratios of sediment cores recoverd with the DAPC I at the Håkon Mosby Mud Volcano. ˣ) Core volume estimated based on material contained in core liner and sediment suspensions mobilized and pushed through the tubings of the degassing unit.

Station No. PS 70/	Core volume [mL]	Gas volumes released [mL]	Gas volume / volume wet sediment [mL mL^{-1}]
53-1	13,598	231,200	17.0
68-1	12,823	65,100	5.1
81-1	14,159	37,200	2.6
97-1	14,426	200,500	13.9
113-1	13,892	200,350	14.4
126-1	2,671 ˣ	189,000	70.7 ˣ
133-1	9,083	228,900	25.2

The sample set to be investigated onshore comprises gases and gas hydrates. Gas chemical analyses of samples obtained by the DAPC I and by controlled dissociation of gas hydrates include measurements of LMWH distribution patterns and of stable isotope ratios ($^{12}C/^{13}C$; $^{1}H/D$). Crystalline structures of individual gas hydrate pieces will be examined using X-ray diffraction and kryo-Field Emission SEM. Based on autoclave sampling technology, data on the spatial distributions of gas hydrates and on proportions of methane stored in different phases in sediments of the HMMV area will be obtained. The combination of gas chemical and crystallographic studies is expected to give information on the dynamics of gas hydrate generation and dissociation. The results will allow for an assessment of LMWHC inventories at the HMMV and will contribute new information to the still sparse global data set on gas hydrate occurrences associated to active mud volcanoes.

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19. SEDIMENT TEMPERATURE OBSERVATIONS AT HÅKON MOSBY MUD VOLCANO

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Objectives

The ascent of warm mud and fluids at mud volcanoes creates temperature anomalies close to the seafloor. Analyzing these anomalies provides information on the nature and strength of the mud volcano activity and helps to understand the relationship between fluid seepage, mud expulsion and the distribution of benthic communities. Repeated measurements at selected locations, long-term observation of sediment temperature changes and integration of geochemical observations are essential in order to understand the dynamics of the mud volcano activity.

Numerous sediment temperature measurements obtained during previous cruises helped to identify an area with persistant high seepage rates close to the geometrical center of Håkon Mosby Mud Volcano.

However, recent long term temperature observations and repeated measurements with a short temperature lance operated by an ROV along a transect crossing this active center suggest large fluctuations in the seepage rates.

The objectives for ARK-XXII/1b were to repeat the measurements along the transect using a short temperature lance during ROV dives and to use precisely positioned gravity corers to obtain temperature data from greater sediment depths along the same transect. Further temperature measurements were planned in cooperation with the MPI in order to characterize fluid flow in different habitats. In addition, bottom water temperature data recorded during the ROV dives should help to identify and map seepage areas.

Work at sea

Sediment temperature measurements were obtained using 6 autonomous temperature loggers mounted on outriggers that were welded on the barrel of a 5.75 m gravity corer. Measuring at a resolution of 0.0006 °C and a precision of 0.002°C, the loggers were programmed to record one temperature reading every 5 seconds during the entire deployment. For each measurement, the gravity corer was left in the sediment for a period of 10 minutes in order for the sensors to adjust to ambient temperature. A pressure and tilt meter was used to document the entire deployment. In most cases, the gravity corer over-penetrated, reaching depths of more than 10 mbsf. Consequently, the absolute depth of the measured profiles can only be estimated. The details of 15 deployments of the gravity corer equipped with temperature loggers are listed in Table 19.1.

A short temperature lance with 8 sensors and an autonomous central data logger was used during the ROV dives to obtain measurements from depths of up to 0.6 mbsf. The resolution and precision of this temperature lance are equal to those of the autonomous temperature loggers given above. For each measurement, the lance is left in the sediment for at least 10 minutes. Penetration depth and tilt are estimated from photos taken during the measurements. Table 19.2 shows the details of all 24 sediment temperature measurements during ROV dives.

In addition to the temperature measurements in the sediment, the temperature of the bottom water was recorded at an interval of 5 seconds during each ROV dive using two autonomous temperature loggers (same type as for gravity corer) mounted at different heights on the frame of the ROV.

Preliminary results

The equilibrium temperatures for all measurements in the sediment will be calculated by extrapolation from the recorded data. Preliminary results the gravity corer deployments show maximum temperatures around 25 °C at several meters below the seabed in the active center of Håkon Mosby Mud Volcano, which agrees with previous observations and confirms continuous mud volcano activity.

The bottom water temperatures recorded during the ROV dives range from -0.86 to -0.74 °C and are most likely influenced by diurnal variations due to changing currents. Detailed statistical analyses of the time series with respect to ROV navigation will reveal whether seepage from the mud volcano is sufficiently high to create a temperature anomaly in the bottom water.

Tab. 19.1: Sediment temperature measurements using the gravity corer

Name	Station	Date	Time	Latitude	Longitude
GCT01	PS70/071-1	27/06/2007	12:40	N 72 00.226	E 014 43.778
GCT02	PS70/072-1	27/06/2007	14:21	N 72 00.257	E 014 43.745
GCT03	PS70/074-1	27/06/2007	17:34	N 72 00.295	E 014 43.613
GCT04	PS70/075-1	27/06/2007	19:30	N 72 00.282	E 014 43.628
GCT05	PS70/091-1	30/06/2007	00:18	N 72 00.307	E 014 43.589
GCT06	PS70/092-1	30/06/2007	01:55	N 72 00.321	E 014 43.550
GCT07	PS70/093-1	30/06/2007	03:28	N 72 00.333	E 014 43.493
GCT08	PS70/094-1	30/06/2007	04:54	N 72 00.336	E 014 43.543
GCT09	PS70/114-1	02/07/2007	22:12	N 72 00.186	E 014 43.907
GCT10	PS70/115-1	02/07/2007	23:56	N 72 00.350	E 014 43.633
GCT11	PS70/116-1	03/07/2007	01:33	N 72 00.300	E 014 43.577
GCT12	PS70/129-1	05/07/2007	02:38	N 72 00.271	E 014 43.542
GCT13	PS70/130-1	05/07/2007	04:10	N 72 00.250	E 014 43.498
GCT14	PS70/137-1	06/07/2007	01:41	N 72 00.219	E 014 43.406
GCT15	PS70/138-1	06/07/2007	03:07	N 72 00.205	E 014 43.337

Tab 19.2: Start and end time of sediment temperature measurements during ROV dives

No.	Dive	Date	Time	Latitude	Longitude
1	164	24/06/2007	16:54:56	N 72 00.2929	E 014 43.4719
	164	24/06/2007	17:31:41	N 72 00.2759	E 014 43.5510
2	165	25/06/2007	11:27:12	N 72 00.3023	E 014 43.2573
	165	25/06/2007	12:00:06	N 72 00.3017	E 014 43.4451
3	165	25/06/2007	12:40:55	N 72 00.3020	E 014 43.4192
	165	25/06/2007	12:51:45	N 72 00.3091	E 014 43.4282
4	165	25/06/2007	13:12:37	N 72 00.3053	E 014 43.5786
	165	25/06/2007	13:23:30	N 72 00.3259	E 014 43.6581
5	165	25/06/2007	13:57:44	N 72 00.2939	E 014 43.4859
	166	29/06/2007	08:55:25	N 72 00.3087	E 014 43.3823
6	166	29/06/2007	12:05:05	N 72 00.3259	E 014 43.5109
	166	29/06/2007	12:16:22	N 72 00.3251	E 014 43.5101
7	166	29/06/2007	12:32:06	N 72 00.3149	E 014 43.5790
	166	29/06/2007	12:42:21	N 72 00.3142	E 014 43.5805
8	166	29/06/2007	12:51:07	N 72 00.3109	E 014 43.6262
	166	29/06/2007	13:01:43	N 72 00.3119	E 014 43.6267
9	166	29/06/2007	13:14:48	N 72 00.3006	E 014 43.6165
	166	29/06/2007	13:24:57	N 72 00.3008	E 014 43.6163
10	166	29/06/2007	13:41:25	N 72 00.2892	E 014 43.6715
	166	29/06/2007	13:55:37	N 72 00.2902	E 014 43.6681
11	166	29/06/2007	14:03:45	N 72 00.2703	E 014 43.6682
	166	29/06/2007	14:17:06	N 72 00.2702	E 014 43.6697
12	166	29/06/2007	14:31:00	N 72 00.2481	E 014 43.7079
	166	29/06/2007	14:42:33	N 72 00.2485	E 014 43.7064
13	166	29/06/2007	14:54:26	N 72 00.2283	E 014 43.7109
	166	29/06/2007	15:05:59	N 72 00.2280	E 014 43.7091
14	167	30/06/2007	12:49:09	N 72 00.3217	E 014 43.4954
	167	30/06/2007	13:24:26	N 72 00.3218	E 014 43.4954
15	169	02/07/2007	14:56:50	N 72 00.2030	E 014 43.8955
	169	02/07/2007	15:13:32	N 72 00.2032	E 014 43.8949
16	169	02/07/2007	16:07:47	N 72 00.1571	E 014 43.9480
	169	02/07/2007	16:26:38	N 72 00.1571	E 014 43.9489
17	169	02/07/2007	16:40:46	N 72 00.1376	E 014 44.0145
	169	02/07/2007	17:03:13	N 72 00.1374	E 014 44.0145
18	170	03/07/2007	13:02:36	N 72 00.2960	E 014 43.5720
	170	03/07/2007	13:13:54	N 72 00.2952	E 014 43.5699
19	171	04/07/2007	13:41:21	N 72 00.3012	E 014 43.5750
	171	04/07/2007	13:52:34	N 72 00.3021	E 014 43.5772
20	171	04/07/2007	14:24:04	N 72 00.3098	E 014 43.5558
	171	04/07/2007	14:37:44	N 72 00.3079	E 014 43.5555
21	171	04/07/2007	14:45:49	N 72 00.3183	E 014 43.5504

No.	Dive	Date	Time	Latitude	Longitude
	171	04/07/2007	14:55:54	N 72 00.3171	E 014 43.5447
22	171	04/07/2007	15:31:33	N 72 00.2957	E 014 43.6597
	171	04/07/2007	15:42:22	N 72 00.2960	E 014 43.6633
23	172	05/07/2007	12:35:09	N 72 00.1411	E 014 44.0160
	172	05/07/2007	12:50:08	N 72 00.1419	E 014 44.0171
24	173	06/07/2007	15:05:10	N 72 00.2937	E 014 43.6704
	173	06/07/2007	16:05:28	N 72 00.2935	E 014 43.6694

20. PERIODICITY AND CHANGES IN THE MUD FLOWS DEPOSITION AT HÅKON MOSBY MUD VOLCANO BASED ON LONG GRAVITY CORER ANALYSIS AND SEISMIC CORRELATION

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Objectives

Study both causes and timing of the described changes in the orientation of mud flows at Håkon Mosby Mud Volcano. Study of the periodicity of the mud expulsions.

Work at sea

Two-dimensional sediment echo-sounder profiles collected during both Jan Mayen and VICKING cruises (2005 and 2006 respectively) were analyzed at the University of Tromsø.

The stratigraphical analysis shows the existence of six main seismic units (U6 - U1 from older to younger) separated by five seismic unconformities (D5 - D4 respectively) at Håkon Mosby Mud Volcano. The gravity corer sampling carried out during the ARK-XXII/1b focuses on the youngest unit described in the study area.

The youngest unit U1 presents a hummocky seismic signature and its distribution is restricted to the surroundings of the mud volcano. A correlation between the unit U1 and the mud flow areas described from the SEAMARC side scan sonar mosaic of the Håkon Mosby Mud Volcano confirm that U1 constitutes the mud flows unit. The isopach map of U1 shows that outside the external rim of the Håkon Mosby Mud Volcano, unit U1 presents an average thickness of 5 m.

Due to both the internal reflections observed and the thickness of the mud flows unit, a total number of seven locations for long-gravity corer sampling were proposed. The physical analysis of the samples, its correlation with the seismic data and its relative dating may provide more insights about both the periodicity in the deposition of the mud flows and the changes in its distribution.

Technical specifications

Seven long-gravity corer and a short-gravity corer both equipped with an acoustic positioning system Posidonia were used for the geological sampling on the mud flow area. In addition, sub-bottom profiler Parasound surveying was acquired across the gravity corer locations.

- Long- and short- gravity corer

A total number of seven long-gravity corers and an additional short-gravity corer were collected during the ARK-XXII/1b cruise at Håkon Mosby Mud Volcano. The long-gravity corers are 12 m long and 125 mm of diameter. The total weight was 1.5 Tons and the deployment/recovery speed was 1.5 m/s. In addition, a short gravity corer (6 m long and 125 mm diameter) was collected following the same procedure as with the long-gravity corer (position provided by Tomas Feseker).

The samples were cut in meters and stored in a cooling container at +4° Celsius for further physical analysis at the Alfred Wegener Institute.

- Acoustic position system USBL (Ultra-short Baseline System) Posidonia.

The acoustic position system USBL Posidonia was used in five of a total of eight locations for both long- and short gravity corers sampled due to technical problems. The Posidonia system was calibrated two years ago during the last operation of the ROV "VICTOR 6000". Additionally, the sound speed chart from a CTD profiler at the beginning of the cruise leg was used. Posidonia is supported in Abyss 1.45 Software.

The acoustic positioning system USBL Posidonia was placed at 50 m from the top of the long-gravity corers and at 100 m from the top of the short-gravity corer. The frequency of positioning was set at 10 seconds and 5 seconds respectively. The position of Posidonia refers to the motion sensor of the ship which is related to the main GPS antenna.

- Sub-bottom Profiler System Atlas Parasound P-70

The Atlas Parasound is a permanently installed hull mounted system on *Polarstern*. The Atlas Parasound sub-bottom profiler is a seismic system, which may detect the internal structures of sedimentary cover along the ship track. To penetrate the sedimentary layers at the sea floor, a low frequency signal is required. To combine a reasonably small transducer with a very narrow beam the system takes advantage of the parametric effect, which results from the non-linear hydro-acoustic behaviour of water for high energy signals. The transmission of two high energy signals of slightly different frequencies (i. e. 18 kHz and 21 kHz) creates harmonics at the difference frequency (i. e. 3 kHz) and the frequency sum (i. e. 39 kHz). With variable frequencies from 0.5 kHz to 6 kHz with an opening angle of approx. 4 degrees the system provides high resolution information of the sedimentary layers up to a depth of 200 m below sea floor.

The Parasound system was operated in single pulse mode with a pulse length of 0.25 ms with a primary high frequency of approx. 20 kHz, a secondary low frequency of approx. 4 kHz and a mean sound velocity of 1500 m/s during all surveys of the current cruise. Besides the lot of system crashes (averaged approx. six per day) the sub-bottom profiler produces seismic data of a good quality, stored in ASG (raw data with sediment and water column information), SGY and PS3 data format on magnetic tape, and was helpful for sampling the sea floor.

Preliminary results

Table 20.1 shows the total recovery and positions of the gravity corer sampled at the Håkon Mosby Mud Volcano area.

Tab. 20.1: Long- and short- gravity corer locations sampled

Corer No.	Station No.	Longitude (°E)	Latitude (°N)	Total recovery (cm)	Date	Time (UTC)
GC1	PS70/056-1	14° 41.090	71° 59.960	540	25/06/2007	23:15 h
GC2	PS70/067-1	14° 43.179	71° 59.536	562	27/06/2007	05:45 h
GC3	PS70/077-1	14° 43.487	71° 59.539	615	27/06/2007	22:19 h
GC4	PS70/080-1	14° 42.854	72° 00.630	497		
GC5	PS70/090-1	14° 42.296	72° 00.096	414	29/06/2007	22:44 h
GC6	PS70/109-1	14° 42.720	71° 59.757	506	02/07/2007	02:42 h
GC7	PS70/121-1	14° 42.045	72° 00.273	495	03/07/2007	23:56 h
GCT2	PS70/072-1	14° 43.745	72° 00.275	381	27/06/2007	14:21 h

The gravity corer sampled will be analysed at the Alfred Wegener Institute as follows:

- P-wave velocity analysis for calibration with sediment echosounder profiles. This calibration may provide a velocity model to use for the conversion of time to depth.
- Density analysis which in combination with the P-wave analysis may provide some insight of the different mud lobes in which the mud flow unit is divided.
- Slicing of the gravity corer for further dating analysis in order to provide a relative age for those mud lobes.

21. SURVEY OF METHANE FLARES, AND IN-SITU METHANE MEASUREMENTS AT HÅKON MOSBY MUD VOLCANO

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Objectives

The occurrence of gas flares is often discovered by massive indication by shipborn echo sounders. Even though these signals are significant, it is uncertain how much gas is discharged. Camera systems have been used for the detection of free gas bubbles in the water column to assess these echograms. The concentration of dissolved methane in sea water was measured by using an *in situ* methane profiler.

Work at sea and preliminary results

In-situ methane measurements at Håkon Mosby Mud Volcano

During ROV Quest Dive 165 an autonomous methane sensor was deployed, which recorded the methane concentration every five minutes. Preliminary results have shown methane concentrations up to 50 µmol/L (Fig. 21.1). The results are within the range of former ex-situ measurement. In 2003 Sauter et al. (2006) measured highest methane concentrations of 126 µmol/L.

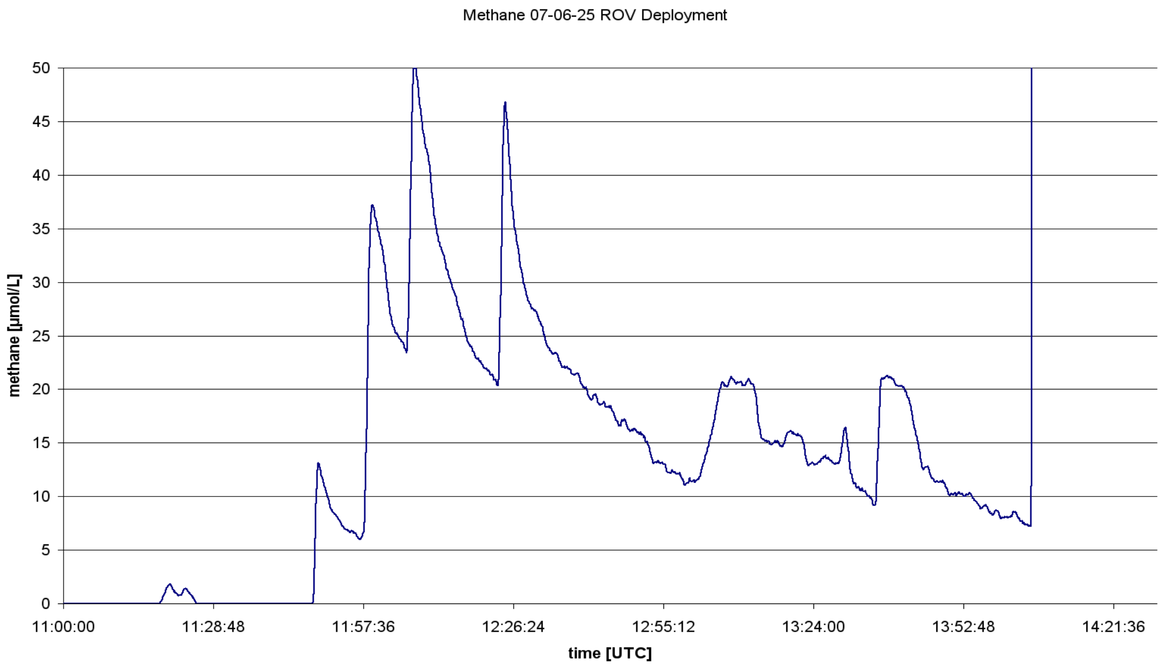


Fig. 21.1 Quest Dive 165. Contros methane recoding

Further deployments of the sensor were not successful due to a system failure of the instrument, which could not be repaired on board. Possible gas flares were often observed on 38 kHz echo sounder. To follow these indications several surveys were performed. As show on the map one major and a few minor areas of gas flares were recognized (Fig. 21.2). The main area was detected in the north-west of central Håkon Mosby Mud Volcano.

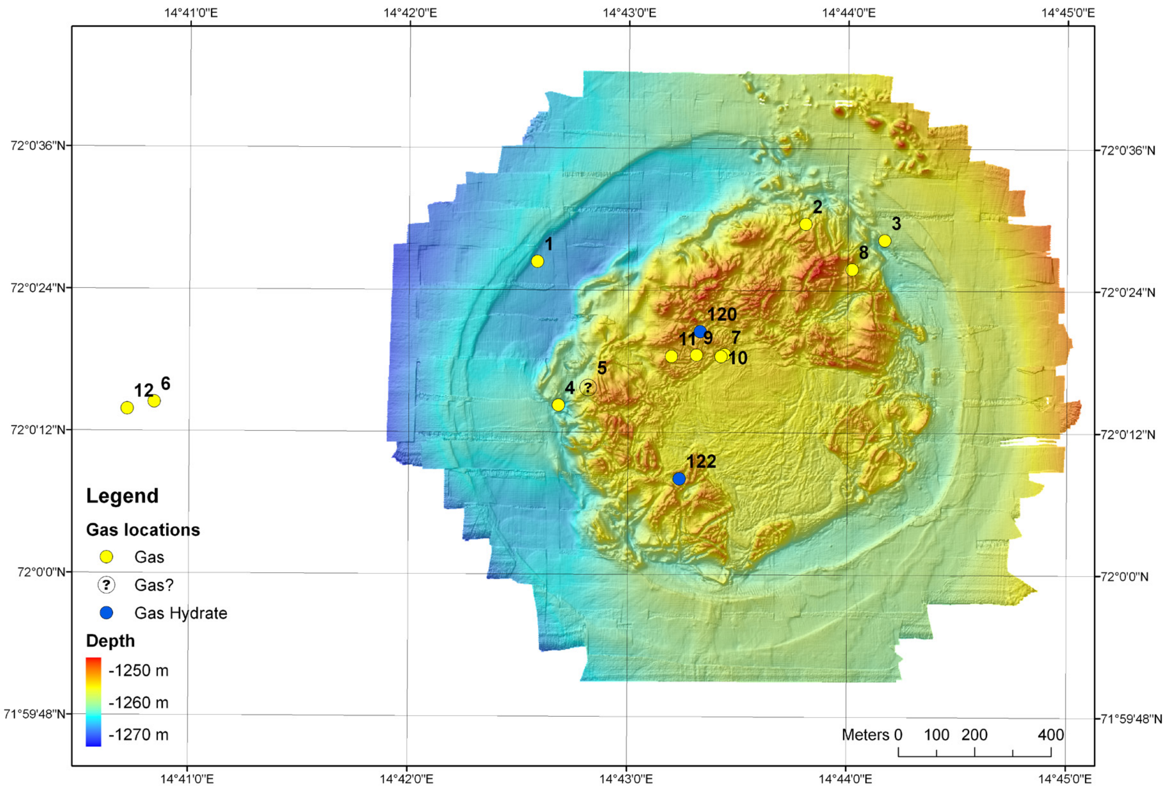


Fig. 21.2: HMMV 38 kHz Echosounder signals. Yellow dots indicate gas flares

Positive bottom reflectors at:

72°00,440'N, 014°43,586'E 72°00,467'N, 014°43,350'E 72°00,494'N, 014°43,808'E
72°00,471'N, 014°44,168'E
72°00,555'N, 014°43,751'E
72°00,238'N, 014°42,648'E
72°00,309'N, 014°43,312'E 72°00,307'N, 014°43,424'E 72°00,307'N, 014°43,198'E
Flair west off Håkon Mosby Mud Volcano 72°00,284'N, 014°41,607'E 72°00,231'N, 014°40,718'E

Camera surveys
Several efforts to record gas bubbles in the water column failed. During the surveys a camera system was deployed and elevated again with a few repetitions. The verification of free gas was negative for all deployments. Even though strong signals from the echo sounder were recorded it turned out that they are not directly linked to massive occurrence of gas bubbles within the water-column.

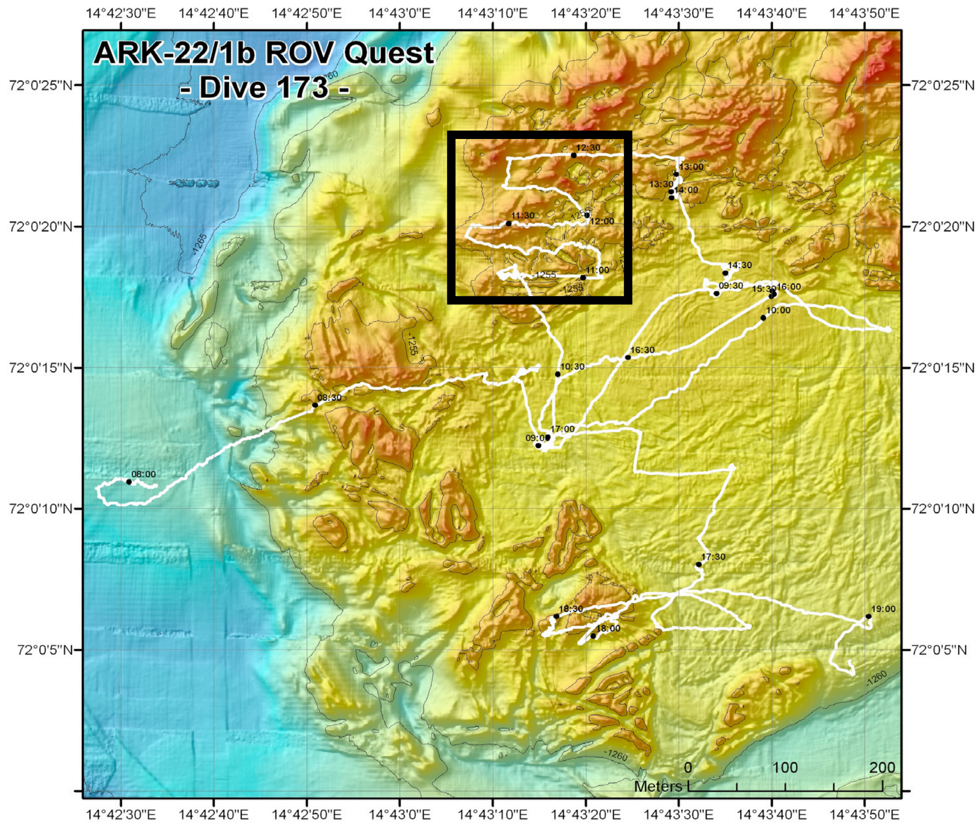


Fig. 21.3 Gas survey, ROV Dive 173, no indication for any gas discharge

During ROV Dive 173 a survey with the ROVs front looking Kongsberg Sonar was performed to detect gas flares at the area were the echograms reflection was strongest (Fig. 21.3). Bubbles were neither with cameras nor with the sonar discovered. Even though this procedure was successful during a few dives in the past one should take into account that signals from echo sounders could easy overestimate the real gas volume in the water column. By personal communication with ROV pilots it turned out that gas seeps with just little escape of bubbles could lead to a strong reflection on echo sound systems.

Acknowledgement
We are very grateful to Chief Scientist Michael Klages for the good atmosphere and working conditions on board. We thank Captain Pahl and the Crew of *Polarstern* for their great support. Working together with Volker Ratmeyer and his ROV team was just great. Thanks also to Lennard Bittermann and Sebastian Albrecht for processing data.

22. GEOMICROBIOLOGICAL INVESTIGATIONS TOGETHER WITH HIGH RESOLUTION POREWATER PROFILING WITH MICROSENSORS AND *IN-SITU* MEASUREMENTS WITH BENTHIC CHAMBERS AND OPTODES

Frank Wenzhöfer, Janine Felden, Stefanie Grünke, Gabriele Schüssler, Tomas Wilkop, Volker Asendorf, Axel Nordhausen
MPI MM

Objectives

Mud volcanoes are very interesting systems, both from the biological and geological perspective. The rising mud and gas represent a window between the deep geosphere and the biosphere. Mud volcanism may be an important natural source of the greenhouse gas methane to the hydrosphere and atmosphere. Recent investigations show that the number of active submarine mud volcanoes might be much higher than anticipated, and that gas emitted from deep-sea seeps might reach the upper mixed ocean. Unfortunately, global methane emission from active submarine mud volcanoes cannot be quantified because their number and gas release are unknown. It is also unclear how efficiently methane-oxidizing microorganisms remove methane. With regard to the global climate change, the study of gas seeps at continental margins is an important contribution to our understanding and quantification of the methane cycle. The geological, chemical and biological investigation of gas seeps in polar regions and other areas of the world's ocean is a focus of research at the MPI, carried out in cooperation with several other national and international institutions within the framework of HERMES.

Only recently it has been discovered that mud volcano ecosystems are similar to those found at other types of cold seeps. Mud volcanoes like the Håkon Mosby Mud Volcano are formed at tectonically inactive areas of continental margins and are generally connected to deep gas reservoirs. Methane and other gases are formed and may accumulate in deep sediment strata to build free or frozen gas reservoirs (gas hydrates). At mud volcanoes, sediment fluids, gas and mud is expelled from deep below forming mounds and crater at the seafloor. Methane oxidizing micro organisms profit from the rising gas and produce sulfide and carbonate – which are utilized by other organisms as energy source and substrate, respectively and are often densely populated by tube worms, clams and other symbiotic organisms. In gassy sediments a microbial symbiosis has been detected, which is able to consume methane by oxidizing it with sulfate. This symbiosis consists of archaea and bacteria, which can use the abundant sulfate in seawater instead of oxygen. Product of this reaction is sulfide which is used as energy source by the chemotrophic organisms (tube worms, clams, giant sulfur bacteria).

Since 2001 we have studied the Håkon Mosby Mud Volcano in the framework of the BMBF/DFG Geotechnologien-funded project MUMM (Mikrobieller Umsatz von Methan in gashydrathaltigen Sedimenten), and since 2005 also within the EU project HERMES. The investigations at Håkon Mosby Mud Volcano are carried out in cooperation with MPI, AWI, and IFREMER, and aim at an analysis of the main factors regulating the activity of the methanotrophic microorganisms and their contribution to biogeochemical fluxes at this mud volcano. Previous measurements at Håkon Mosby Mud Volcano provided the first quantitative estimates of the *in-situ* composition, distribution and activity of methanotrophs in relation to gas emission. The Håkon Mosby Mud Volcano hosts three key communities: aerobic methanotrophic bacteria (Methylococcales), anaerobic methanotrophic archaea (ANME-2) thriving below siboglinid tubeworms, and a previously undescribed clade of archaea (ANME-3) associated with bacterial mats. We found that the upward flow of sulphate- and oxygen-free mud volcano fluids restricts the availability of these electron acceptors for methane oxidation, and hence the habitat range of methanotrophs. This mechanism limits the capacity of the microbial methane filter at active marine mud volcanoes to < 40 % of the total flux.

23. GEOMICROBIOLOGY OF THE HÅKON MOSBY MUD VOLCANO

Stefanie Grünke, Janine Felden, Gabriele Schüssler, Tomas Wilkop, Frank Wenzhöfer
MPI MM

Objectives

Microbially mediated anaerobic oxidation of methane (AOM) is the major biological sink of methane in marine sediments. Hence, this process is crucial in maintaining a sensitive balance of our atmosphere's greenhouse gas content. However, a fundamental understanding of the associated biology is still lacking, consequently preventing a thorough biogeochemical understanding of an integral process in the global carbon cycle. Studies employing stable isotopes, radiotracers, modelling, and microbiological techniques have now established that methane in marine sediments is oxidized biologically under anoxic conditions. Although no anaerobic methanotroph has ever been isolated, biogeochemical studies have shown that the overall process involves a transfer of electrons from methane to sulfate. Accordingly, the isotopic and genetic signatures of the dominant microbial populations in environments enriched with methane proved that this transfer is mediated by a microbial consortium that includes archaea and sulfate-reducing bacteria. The major aim of this study is the investigation of microbial sulfate reduction (SRR) and anaerobic methane oxidation (AOM) in methane enriched surface sediments of the Håkon Mosby Mud Volcano, as well as sampling the sediments for microbiological and molecular analysis.

Work at sea

The focus of the microbiological investigations was on the giant sulfide oxidizing bacteria covering parts of the Håkon Mosby Mud Volcano and their micro diversity. Samples were obtained from the sediment cores which were retrieved by the ROV and by multiple corer hauls and gravity cores. In parallel to the on board rate measurements, sub-samples were taken from cores to determine the total number of bacteria, to quantify different taxonomic groups of bacteria by fluorescence *in-situ* hybridisation (FISH, 16s rDNA clone libraries, DGGE) and to investigate the metabolic activity of methane consuming microorganisms involved in sulfate reduction and methane oxidation under controlled laboratory conditions in microcosms. Furthermore, sediment sub-samples were obtained to investigate the distribution of lipid products derived from members of AOM consortia and their stable carbon isotopic composition which bears diagnostic information on the carbon source and/or metabolic carbon fixation pathway utilized by its producer.

Preliminary results

Samples were taken from grey mats as well as from *Beggiatoa* mats. After retrieval of the push cores all sediment cores were stored at *in situ* temperature for 2 days to allow the mats to recover again. Subsamples were taken for molecular ecology studies, microscopy, and ex situ microsensor measurements. All samples taken will be processed in the home laboratories of MPI. Preliminary microscopy on board revealed a high diversity of bacterial morphotypes including filamentous sulfide-oxidizing bacteria, most likely belonging to the genus *Beggiatoa* (Fig. 23.1).

Tab. 23.1: Push cores taken for microbial diversity studies

Station	Pushcore	molecular samples	FISH samples	DNA samples	AODC samples	MSM	SRR
164 (24.06.07)	PC 27	5	9	8	9	no	1
164 (24.06.07)	PC 26	2	-	-	-	no	2
164 (24.06.07)	PC 32	9	3	-	-	yes	-
164 (24.06.07)	PC 25	17	3	-	-	yes	-
165 (25.06.07)	PC 16	11	8	9	8	no	1
165 (25.06.07)	PC 29	-	-	-	-	no	3
167 (30.06.07)	PC 34	15	3	-	-	yes	-
167 (30.06.07)	PC 18	-	9	8	9	no	1
167 (30.06.07)	PC 23	-	-	-	-	no	3
169 (02.07.07)	PC 4	2	11	12	11	no	-
169 (02.07.07)	PC 11	2	-	-	-	no	3
169 (02.07.07)	PC 1	2	10	11	10	no	-
169 (02.07.07)	PC 27	2	13	13	13	no	-
169 (02.07.07)	PC 34	2	-	-	-	no	3
169 (02.07.07)	PC 7	13	3	-	-	no	-
169 (02.07.07)	PC 29	14	3	-	-	no	-
169 (02.07.07)	PC 28	13	3	-	-	yes	-
169 (02.07.07)	PC 36	13	3	-	-	yes	-
169 (02.07.07)	PC 17	-	12	13	12	no	-
169 (02.07.07)	PC 23	-	-	-	-	no	3
169 (02.07.07)	PC 13	-	-	-	-	no	3
172 (05.07.07)	PC 16	-	13	11	13	no	-

24. HIGH RESOLUTION STUDIES WITH MICRO-SENSORS

Janine Felden, Volker Asendorf, Axel Nordhausen, Frank Wenzhöfer
MPI MM

Objectives

The sediment of Håkon Mosby Mud Volcano host three methane oxidizing communities: anaerobic methanotrophs (*Beggiatoa* mats), free living aerobic methanotrophs (Centre) and symbiotic aerobic methanotrophs. (Pogonophora fields). The methane originates from a deep source and the areas covered by the different microbial communities are relatively large. The centre of the vulcano shows relatively little microbial activity due to extremely high fluid flow rates. Surrounding this centre is a ring of *Beggiatoa* fields, covering anaerobic methane oxidizers, this sediment is soft and fine and contains high amounts of sulfide. The peak in methane oxidation capacity is at 1 - 3 cm under the sediment surface. Then there is an outer ring of pogonophora fields with relatively oxidized sediments. It is planned to investigate the transition between these sediments with high spatial resolution measurements using microsensors.

Work at sea

In-situ measurements were done, using a profiler deployed by ROV QUEST, and *ex-situ*, on retrieved cores on board of the ship. The *in-situ* microprofiler carries 10 microsensors which had a tip diameter of 10 - 50 μm. The following sensors have been used: O_2, H_2S, pH, redox and T. This will improve insight into the carbonate chemistry inside the sediments. The redox sensor responds mainly to O_2, H_2S and Fe_2+, thus – together with porewater analyses - it may also give a hint to interesting iron chemistry in the anaerobic methane oxidizing zone. *Ex-situ* measurements have been done with the same type of sensors on retrieved sediment cores, mainly from *Beggiatoa* mat sites.

Prelimary Results

All deployments of *in-situ* instruments are summarized in Table 24.1.

Tab. 24.1: Deployment lis of *in-situ* devices

DIVE	EQUIPMENT	DATE	Lat	Lon	Area
165	Chamber 1	25/06/2007	N 72 00.2981	E 014 43.2741	bacterial mat
168	Chamber 2	01/07/2007	N 72 00.146	E 014 43.1803	Pogonophora
169	Chamber 3-1	02/07/2007	N 72 00.157	E 014 43.8817	grey mat
169	Chamber 3-2	02/07/2007	N 72 00.157	E 014 43.8842	outside grey mat
170	Chamber 4	03/07/2007	N 72 00.296	E 014 43.5670	*Beggiatoa* mat
171	Chamber 5-1	04/07/2007	N 72 00.300	E 014 43.5787	hot center
171	Chamber 5-2	04/07/2007	N 72 00.297	E 014 43.6686	outer rim of hot center

DIVE	EQUIPMENT	DATE	Lat	Lon	Area
172	Chamber 6	05/07/2007	N 72 00.273	E 014 43.8764	*Beggiatoa* mat
173	Profiler 1-1	06/07/2007	N 72 00.294	E 014 43.5620	hot center
173	Profiler 1-2	06/07/2007	N 72 00.293	E 014 43.6694	outer rim of hot center
167	Deep Flow	30/06/2007	N 72 00.191	E 014 43.2184	*Beggiatoa* mat
172	Planar Optode	05/07/2007	N 72 00.275	E 014 43.8767	*Beggiatoa* mat
165	RCM	25/06/2007	N 72 00.3276	E 14 43.2048	northern part
169	RCM	02/07/2007	N 72 00.158	E 014 43.9485	southern part

Microprofiler

During Dive 173 two deployments of the microprofiler were possible at the hot center and the area surrounding the hot center.

25. CHAMBERS AND OPTODES – *IN-SITU* INVESTIGATIONS OF TOTAL OXYGEN, METHANE AND SULFIDE FLUXES

Frank Wenzhöfer, Janine Felden, Volker Asendorf, Axel Nordhausen
MPI MM

Objectives

Main aim of the chamber and optode work has been to quantify transport dynamics along a gradient of stations from sites colonized by *Beggiatoa* and Pogonophora towards sediments not influenced by methane seepage. From each chamber incubation, a series of water samples is taken at preset intervals that will be analyzed for oxygen, nutrients, and sulfide and methane concentrations. The Optodes serve to measure oxygen in 2D in different areas characterized by different transport mechanisms (e.g. gliding *Beggiatoa*, pumping tube worms, degassing centre). A novel instrument was tested to measure fluid flow in the sediments.

Work at sea

Benthic chambers follow the total exchange of solutes through the sediment water interface over time in an enclosed water volume overlying the sediment. Therefore small support frames, capable of being operated by ROV's, are equipped with a circular (ID 19 cm) chamber to cover a larger area. During the incubation a central stirrer mixes the overlying water simulating the hydrodynamic conditions. The O_2 concentration of the enclosed water is followed continuously by mini-electrodes while other compounds (DIC, methane, H_2S, nutrients) will be analyzed on retrieved water samples taken at pre-programmed time intervals during the incubation. Seep ecosystems often display a great spatial and temporal heterogeneity not resolved by single point measurements with microsensors. The advent of planar optodes for imaging the spatial distribution of O_2 therefore provides a much more detailed insight into the O_2 -dynamics and thus small-scale variations in biogeochemical processes of marine sediments. The technique allows continuous two-dimensional quantification of the O_2-distribution across the sediment–water interface at high spatial (~100 μm) and temporal resolution (seconds). For 2-dimensional O_2-distribution measurements in marine sediments an autonomous the *in-situ* planar optode module subsequently lowers the inverted periscope equipped with the planar O_2-sensor into the sediment ensuring initial alignment of the sediment surface with the centre of the planar optode. The obtained oxygen images cover an area of 7 x 5 with a spatial pixel resolution of ~106 μm, respectively. After placing the sensor foil in the sediment images can be recorded in intervals of seconds to hours for a total period of hours to days.

Advection in marine sediments can be in two directions with opposite effects on biogeochemical processes like AOM: out-flowing pore water will limit AOM to the upper sediment layer where sulfate penetrates, while bio ventilation will enhance influx of sulfate and push the zone of AOM downwards. Pore and fluid water flow can be measured by a novel instrument “DeepFlow” injecting a fluorescent dye into the sediment and subsequently following the movement of the dye cloud through the sediment with optical fibres. The fluorescent dye is excited through the optical fibres, while also the emitted fluorescence is detected through these optical fibres. The device carries an array of 4 optical fibres, following the movement of the dye plume precisely in sediments over space and time. From those measurements pore water or fluid flow rates can be calculated. These rates are necessary to calculated flux rates from pore water solute gradients.

Benthic Chamber

The benthic chamber was deployed 8 times during this cruise (Tab. 24.1). We were able to measure the total oxygen consumption of different habitats at the Håkon Mosby Mud Volcano, e.g. *Beggiatoa* and grey mats, hot center and pogonophora field.
As an example oxygen sensor signals from a benthic chamber incubation at the hot center (Dive 171) and at a *Beggiatoa* mat (Dive 170) are shown. Additional to the sensor measurements we also fixed water samples from the chamber incubation in order to determine methane, sulfide, dissolved inorganic carbon and nutrients. The samples will be analyzed back home in Bremen.

Planar Optode and DeepFlow

One deployment of the Planar Optode and the DeepFlow module were done during dive 172 and dive 167, respectively (Tab. 24.1). However, due to technical problems with the Planar Optode system no images were recorded. Images from the DeepFlow deployment will be analyzed back home to determine the fluid flow according to the dye movement visible on the recorded images.

26. MESOCOSM EXPERIMENTS ON BENTHIC FORAMINIFER'S RESPONSE ON METHANE SEEPAGE

Jutta Wollenburg
Alfred-Wegener-Institut

Objectives

During this cruise the ROV Quest enabled us to collect a couple of push cores from pogonophora (*Sclerolinum contortum*) fields.

Work at sea and preliminary results

Onboard of *Polarstern* the push cores were transferred to aquaria (mesocosms) kept under atmospheric pressure to culture the benthic community for a period of 6 to 12 months. At two sites the ROV team operated two autoclave mesocosms at the sea floor to collect pogonophora faunas, and to keep and culture them under a constant pressure of 125bar, equal to the water depth at which they were collected. At one site pressure was lost on resurfacing. Because there was no spare time for an additional dive with this autoclave, we transferred a large push core in this autoclave and slowly increased the pressure to its original value. In the months to come we will start a series of experiments on both autoclaves and all aquaria to elucidate the influence of methane, bacteria, fluff, and pressure on the geochemism of calcareous benthic foraminiferal tests.

At four sites (three pogonophora sites, one bacterial mat site) samples from push cores and multiple cores have been taken for transmission electron microscope analyzes on the benthic foraminifera protoplasm. We hope that the following ultrastructure analyzes elucidate questions about how some foraminifera can survive times of low oxygen availability, and whether Håkon Mosby Mud Volcano foraminifera have a special diet or endosymbionts

27. EXPLORATION OF MEIOFAUNA AND TROPHO-DYNAMICS IN DIFFERENT MICROHABITATS

Katja Guilini
University of Ghent

Objectives

In order to better understand the function and driving forces of the presence of meiofauna in the different microhabitats on the Håkon Mosby Mud Volcano, the following key questions are addressed:

- What is driving the biological patchiness at seeps? Therefore the meiofauna patchiness and biodiversity will be investigated in relation to the possible food sources and the biogeochemical and microbiological processes.
- What is the trophic position of the meiofauna? Hence the trophic interactions between meiobenthic organisms and their potential food sources will be studied based on stable isotope and fatty acid analyses. Experiments will be performed and samples will be collected from different microhabitats in order to unravel different trophic interactions and potential selectivity for certain food sources with as main emphasis the position of the meiofauna in the benthic food web.
- How do endobenthic organisms thrive in extreme conditions of cold seeps? Here the adaptations among the thriving species to the extreme living conditions will be further dealt with.
- What is the origin of seep-meiofauna species? Therefore the fauna from different seep locations worldwide will be investigated in addition to the fauna from adjacent less extreme sites in order to estimate the importance of local adaptation and the distribution of taxa.

Work at sea and preliminary results

At the Håkon Mosby Mud Volcano *in situ* and *in vitro* experiments were performed in which different ^{13}C labelled potential food sources were added to benthic cores. Both experimental set-ups consider the response of the meiofauna community and the uptake of food. In order to identify the uptake and potential food selectivity stable isotope and fatty acid analyses will be performed after returning to the lab.

For the experiments onboard, samples were collected with the video-guided Multicorer (MUC) and incubated in a cold room at *in-situ* temperature (-0.8°C), after ^{13}C labelled substrates were injected. There are three treatments (acetate, bicarbonate and Thalassiosira diatoms) and one control which are sampled according to a time series (day 1, day 2, day 4 and day 8). The control samples were preserved on 4 % formaldehyde, while the treatment samples for biochemical analysis are stored at -20°C.

Drop 1:

Date: 24.06.07	UTC-time: 20h07 (21h30)	Station nr: PS 70/048
Coordinates:	72°0.165'N 14°43.863'E	Depth: 1293m

Drop 2:

Date: 24.06.07	UTC-time: 21h46 (23h10)	Station nr: PS 70/049
Coordinates:	72°0.294'N 14°43.451'E	Depth: 1290m

Drop 3:

Date: 24.06.07	UTC-time: 23h27 (01h20)	Station nr: PS 70/050
Coordinates:	72°0.296'N 14°43.454'E	Depth: 1291m

This experiment was repeated with samples from a Pogonophora field, collected with the video-guided MUC. The set-up was identical, except for the time series which was sampled on day 2, day 4 and day 8.

Drop 5:

Date: 01.07.07	UTC-time: 22h10 (00h10)	Station nr: PS 70/106
Coordinates:	72°00.189'N 14°43.213'E	Depth: 1291m

Drop 6:

Date: 01.07.07	UTC-time: 23h22 (01h25)	Station nr: PS 70/107
Coordinates:	72°00.183'N 14°43.241'E	Depth: 1291m

The use of a video-guided ROV allowed sampling of a transect across a *Beggiatoa* mat. This was in cooperation with Stefanie Grüncke (MPI). In total 4 push cores were sub-sampled and samples for community analysis were preserved on 4 % formaldehyde, while the samples for biochemical analysis were stored at -20 °C. Nematodes were picked out from the bacteria mats and fixed for TEM.

The ROV deployed 5 colonisation cores successfully in the same *Beggiatoa* mat. There were 2 control cores and 3 treatments in which ^{13}C labelled Thalassiosira diatoms were added on the sediment which was previously collected with the MUC during drop 4. They were recuperated after 3 days. Samples for community analysis were preserved on 4 % formaldehyde, while the samples for biochemical analysis are stored at -20 °C.

Drop 4:

Date: 26.06.07	UTC-time: 01h51 (3h55)	Station nr: PS 70/057
Coordinates:	72°0.291'N 14°43.377'E	Depth: 1290m

28. EXPERIMENTAL COLONIZATION ON ARTIFICIAL SUBSTRATES

Mélina Laurent
CNRS- Université Paris VI

Objectives

The participation of the CNRS - University Paris VI in the ARK-XXII/1b expedition fits in with two research projects:

- the study of the ecosystem Sunken Wood, aiming to describe wood degradation process, diversity of associated organisms, colonization dynamic and influence of environment and geographical area on these aspects
- the study of pogonophorans development, with the investigation of larvae diversity and influence of substrate nature and chemical conditions on their recruitment and settlement

Experiments were set up trying to combine these two research projects. The experimental strategy consists in the deployment of colonizers, called TRACs, in deep seas of various geographical areas, and their recovery after a determined immersion duration, in order to examine both substrate and associated fauna. The TRACs (Fig. 28.1) are cylindrical plastic rings containing three kinds of substrates : wood cubes, carbonates cubes and grass. TRACs series were already deployed in several geographical areas in 2006: the Middle Atlantic Ridge (Momareto expedition), the Nil Delta (Bionil expedition) and the Håkon Mosby Mud Volcano (Vicking expedition). All should be recovered on 2007.

Fig. 28.1: TRAC containing wood cubes

Our objectives during the ARK-XXII/1b expedition were then first to recover the TRACs series deployed during the Vicking expedition on the Håkon Mosby Mud Volcano, secondly to deploy a new series of TRACs in another area on the Håkon Mosby Mud Volcano site, and finally to sample pogonophorans in the sediment.

Colonized substrates of TRACs will be analyzed in order to characterize associated organisms and search for pogonophorans larvae (*in-situ* hybridization experiments). Diversity of free and symbiotic bacteria (in organisms associated with the experimental substrates and in pogonophorans sampled in the sediment) will also be investigated thanks to Fluorescence *In-situ* Hybridization experiments (FISH), phylogenetic analyses, and Scanning and Transmission Electronic Microscope (SEM and TEM) observations. The advancement of wood decomposition process will also be investigated by TEM observations.

Work at sea

The three TRACs I1 to I3, immersed on the 07/06/06 during the Vicking cruise on a *Sclerolinum contortum* patch on the Håkon Mosby Mud Volcano, were recovered on the 29/06/07 during the dive 166-3 of the ROV QUEST 4000 m in the southern part of the Håkon Mosby Mud Volcano (7200.14 N 1443.24 E at 1262 m) at 1,262 meter-depth (Fig. 28.2).

Within the two hours following the recovery of the TRACs the substrates and associated fauna were sorted and fixed, depending on the treatment planned for the laboratory.

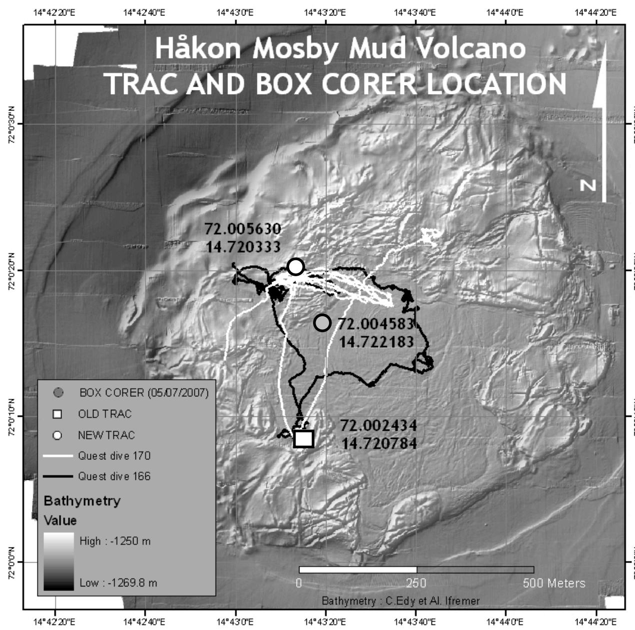


Fig. 28.2: Bathymetry map with the position of TRACs and box corer sampling (IFREMER)

A series of new TRACs, containing the same substrates (wood, grass and carbonates) was deployed in the northern part of the Håkon Mosby Mud Volcano (72°00.33 N 14°43.22 E) on a pogonophorans patch at 1260 meter-depth during the dive 170-7 of the

ROV on the 03/07/07 (Fig.28.2). A biological sampling performed by IFREMER closed to the site of TRACs deployment permitted to determine that it was an *Oligobrachia haakonmosbiensis* patch.

Sampling of pogonophorans was performed on the 05/07/07 using a box corer (Fig. 28.3) at the coordinates 72°00.27 N 14°43.33 E (Fig. 28.2). The sediment obtained was sieved in order to collect pogonophorans. They were isolated and fixed in order to allow their analyses in the laboratory.

Fig. 28.3: Box corer used to sample pogonophorans

Preliminary results

TRACs substrates seemed not really decomposed. Their external appearance was quite equal to the one they had before their deployment. Their analysis with a stereomicroscope succeeded in revealing organisms associated only with the wood substrate. In fact some annelids were collected on the surface of the wood cubes and numerous teredinids were observed inside (Fig. 28.4).

Fig. 28.4: Organisms associated with wood substrate: annelids on the surface of the wood cube (on the left), teredinids in the wood (in the middle), observed with stereomicroscope (on the right).

Concerning the box core, the sediment collected contained numerous *Sclerolinum contortum*, that could reach 20 cm in length. Their curly anterior parts appeared like numerous knots at the surface of the sediment, what made their individualization quite difficult. The rest of their body, straight, was deeply inserted in the sediment. Unfortunately there was no success in removing them from their tube.

29. ADAPTIVE COMPETENCE AND ECOLOGY OF COLD-STENOTHERMAL FISHES IN POLAR REGIONS

Rainer Knust, Melanie Bergmann, Niels Koschnick, Sascha Lehmenhecker, Burkhard Sablotny
Alfred-Wegener-Institut

Objectives

Temperature affects all biological processes and is thus considered to be one of the most important abiotic factors shaping marine ecosystems. To allow a future assessment of climate driven changes it is therefore of paramount importance to determine the *status quo*. Representing the only deep-water connection between the North Atlantic and the Arctic Ocean, the Fram Strait and Barents Sea belong to the climatically sensitive areas of the world ocean. Indeed, long-term heat transport measurements in the Fram Strait at 79°N have shown that a warming signal from the late 1990s is currently spreading in the interior Arctic Ocean. How could this affect the resident fauna?

The thermal tolerance range of aquatic organisms has been studied for decades. A recent comprehensive model of thermal tolerance argues that ectothermic animals (*i.e.* those which must conform to the environmental temperatures at which they live) inhabit an optimal temperature zone. By studying life performance in cold oceans our research focuses on how boundary conditions are defined from a physiological point of view and what metabolic processes and capacities are responsible for temperature adaptation thereby affecting thermal tolerance. The adjustment of aerobic scope, reflected by mitochondrial densities and capacities is identified as a crucial step in thermal adaptation, and mitochondrial enzyme levels are an important determinant of aerobic capacity for ATP production. Recent research has shown that adjustments of aerobic capacities differ between cold-acclimated boreal and cold-adapted polar ectotherms resulting in enhanced mitochondrial matrix enzymes (citrate synthase, $NADP^+$-dependent isocitrate dehydrogenase) over respiratory chain capacities and might support enhanced anabolic processes in cold-adapted compared to cold-acclimated animals. Indeed, temperature-dependent growth performance of Antarctic eelpout in the laboratory revealed highest growth rates at 4°C compared with 12°C for the boreal species. This indicates a mismatch between optimum and ambient habitat temperature likely to be a relict of the deep-sea origin of the genus *Pachycara*. Thus, thermal biology and tolerance are important physiological traits that determine whether a species survives temperature challenges and how it is affected by climate change. Changes in the abundance of key species that shape benthic assemblages may in turn affect population dynamics of prey organisms and thus benthic communities. It is thus also important to understand the ecology and functional ecological role of potential key predators. Although analyses of camera observations indicate that demersal fish belonging to the eelpout family (Zoarcidae) constitute an important fraction of the

Håkon Mosby Mud Volcano megafauna, little is known to date about their physiology and functional ecological role.

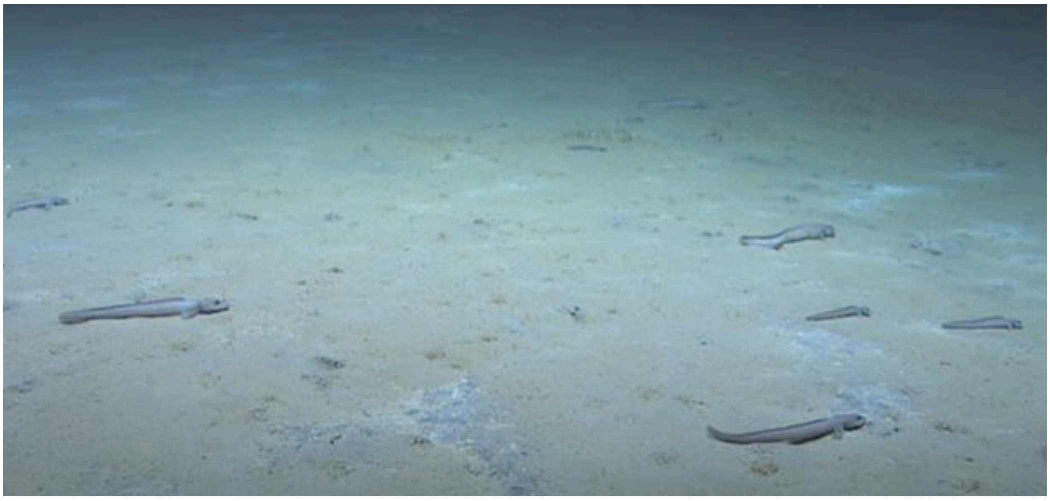


Fig. 29.1: Lycodes squamiventer at the Håkon Mosby Mud Volcano (1,250 m)

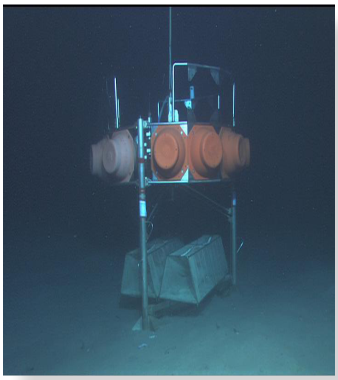
Work at sea

In total baited bottom fish traps and 2 traps fitted to a free-falling lander were deployed at the sea floor at a water depth of ca.1,250 m for 48 - 60 hours five times and twice, respectively. More fish were caught by the slurp gun of Quest during 3 dives with a total dive time of 5 h. Alive fish (*Lycodes squamiventer*) and amphipods (*Eurythenes gryllus*) were maintained in an aquarium container until transport to the home laboratories in Bremerhaven. Dead specimen were used for studies on physiological parameters, populations dynamics, ecology, stable isotope analysis, growth, fecundity and food uptake .

Preliminary results

Video observations with the ROV system indicated a relatively high abundance of *Lycodes squamiventer* in the inner part of the mud volcano area. Highest abundances were found in the northern part and confirm video observations from 2003 (Bergmann, unpublished data). The diversity of fish at the sea floor was low: apart from the dominant eelpout (*L. squamiventer*) only three other species were occasionally observed (Arctic skate *Raja hyperborea*, Greenland halibut *Reinhardtius hippoglossoides* and the rockling *Gaidropsaris argentatus*) in low abundances.

The efficiency of the baited fish traps were very low, even when the traps were modified, so as to lie directly on the sea floor rather then being suspended 40 cm above the bottom. This can be explained by the behaviour of *Lycodes squamiventer* observed by video. The species is a “sit and wait” predator and is therefore unlikely to move into traps. On the other hand, this behaviour explains the high efficiency of the slurp gun. All except one fish caught by trap were dead upon trap recovery or died after a few days. This could be due to the fact that during the recovery of the traps the fish were exposed to temperatures of up to +8 °C at the water surface (bottom temperature = -0.8 °C). By contrast, all fish collected by QUEST were kept in a container with a water temperature of >4 °C and survived. *Eurythenes gryllus* caught by traps survived in our aquaria, too.



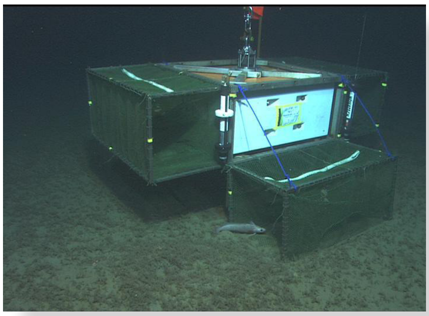


Fig. 29.2: Methods used to catch fish: (from left to right) free-falling lander fitted with traps, trap deployment, slurp gun of QUEST.

30. CRUISE LEG ARK-XXII/1C – HAUSGARTEN – DEEP SEA OBSERVATORY - SUMMARY OF ROV DIVE OPERATIONS DURING CRUISE LEG ARK-XXII/1C

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During ARK-XXII/1c, QUEST performed 5 dives to depths around 2,550 m. All dives with a total of 35 hours bottom time (52 hours total dive time) allowed successful scientific sampling, observations, intervention and recovery operations at different sites at HAUSGARTEN area. QUEST was operated by a team of 8 pilots/technicians with a mean dive time of 10 hours as long as the weather conditions allowed deployment and recovery.

Close cooperation between ROV team and ships crew on deck and bridge allowed a quick gain of experience for the handling procedures during deployment and recovery, which needed to proove even under sea-ice conditions not previously encountered with QUEST. During diving, this cooperation allowed precise positioning and navigation of both ship and ROV, which was essential for accurate sampling and intervention work such as instrument recovery and remote shuttle operation at depth. The ROV team is very grateful for this kind of steady support from the entire ships crew during the whole cruise.

QUEST System description
For a detailed description of the QUEST ROV system, please refer to cruise report ARK-XXII leg 1b.

During ARK-XXII/1c, the following scientific equipment suite was handled with QUEST:

ROV based tools, installed on vehicle:

PC SAM 365 Pushcore (Geochemistry)
SG SAM 127 Slurp gun (8 samples) (Biology)
CC Colonisation cores (Biology)

In-situ Instruments, intervention/operation by vehicle:

Lift MOOR 361 ROV elevator (SAM)
PC 16 Mobile Pushcore Rack (SAM)

Tripod Currentmeter (MES)
Acoustic Currentmeter (MES)
FLUME current channel intervention at 2,550 m
MIC profiler (MES)
M POS Active marker
Sediment Trap MOOR (recovery support only)

31. PHYTOPLANKTON DIVERSITY STUDIES

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Introduction

Species diversity of unicellular plankton in general and phytoplankton in particular in the Arctic have been studied mainly in land-bound laboratories on the basis of the samples and specimens fixed with formalin or Lugol´s solution. These samples are good for the organisms with external or internal skeletons (frustules, loricae, thecae, coccoliths, etc.), however, the major part of delicate species is usually lost or drastically influenced by fixatives so that little is known about species diversity of such groups as athecate or naked dinoflagellates, ciliates, phyto- and zooflagellates. These groups may significantly contribute to the primary production, microbial loop, carbon and nitrogen vertical flux or diet of their predators. The main goal of phytoplankton diversity studies during the ARK-XXII/1c cruise onboard *Polarstern* was sampling and laboratory analysis *in vivo*. Theses studies are the second attempt to fill the gap in our knowledge about athecate dinoflagellates being complementary to those performed during the ARK-XIII/2 cruise to the Greenland Sea in July-August 1997.

Material and Methods

Phytoplankton was sampled periodically during the period of July 10 to 21, 2007, in the northeastern Greenland Sea, in the zone between Molloy Hole and Vestnesa Ridge (78°34'- 79°44'N, 2°59'- 6°05'E), at 22 oceanographic stations (PS70/144, 146, 156, 158, 161, 168, 115 Quest, 173, 178, 181, 187, 188, 193, 195, 199, 205, 208, 213, 215, 219, 220 and 224). Samples were taken with a hand plankton net of 25 cm in diam., mesh size 20 μm (Hydro-Bios, Kiel). Mostly, about 300 l of water was concentrated using the net and a DL40 DEPA air operated diaphragm pump (Alfa Laval Flow GmbH, Düsseldorf) installed permanently onboard the ship and providing sea water from 6-7 m depth in front of it. At CTD stations (158, 161, 173, 178, 195, 199 and 213), phytoplankton was sampled manually from the 25 - 30 m depth to the surface. In addition, the organisms from 1 l of water taken from the same water tube as a net sample or from a CTD 10-liter water-bottle (at 2 m depth) were concentrated using a reverse-filtration device and the nuclepore filters, pore size 1 μm, at each station (small-fractioned samples). Samples were analyzed immediately or within several hours after sampling in a 3-ml plate chamber using a Zeiss Axiovert 40C inverted microscope equipped with phase-contrast A-Plan 10x/0.25, 20x/0.45 and 40x/0.65 objectives. Photographs were taken with an Olympus C7070 digital camera manually adjusted to an eye-piece every time before shooting; two rechargeable batteries were used not to interrupt the analysis of samples. The same cells were photographed in various focal planes preferably in ventral or dorsal view. Live observations were made with a special emphasis on the surface longitudinal striation of many athecate dinoflagellates, the apex, the position of nucleus and other specific organelles, presence or absence of chloroplasts when possible. Length and width of each photographed cell were measured.

Results

In total, more than 2000 images of about 600 algal cells were taken, which will be used for species identification. The relative abundance of phytoplankton species was evaluated visually.

1. Dinoflagellates

Dinoflagellates showed high species diversity at sts. 146, 161, 173, 181, 187, 205, 208 and 213. Sometimes, their relative abundance was also high. Among athecate dinoflagellates, the genera *Gymnodinium, Gyrodinium, Cochlodinium* (several species), *Amphidinium* (*A. sphenoides*), *Katodinium* (*K. glaucum*), *Torodinium* (*T. robustum*), *Pronoctiluca* (*P. pelagica*), *Actiniscus* (*A. pentasterias*, only as star-like silicious elements of its internal skeleton) and Warnowiaceae gen. spp. (most likely, *Nematodinium* or *Nematodiniopsis*) were presented, the former two being the most diverse in species. Thecate dinoflagellate were mainly represented by *Protoperidinium* species, 2 to 4 *Ceratium*, 4 *Dinophysis,* 2 *Peridiniella,* 1 *Prorocentrum,* 1 *Micracanthodinium,* cf. *Oxytoxum* (1) species were also found. In a small-sized fraction, *Prorocentrum minimum* was sometimes abundant and dominant (st. 144, 161 and 188). Two species described by Meunier (1910) from the western Barents and eastern Kara seas as *Echinum minus* (=*Polarella glacialis*?) and *E. majus* (only at st. 187) were encountered, the former being very common and found in aggregations of up to several dozens. A curious phenomenon was observed in most of samples: many aggregations (of several cells to a few dozens) of a small naked dinoflagellate species distinguished by active behavior and covered with a common envelope. It is still questionable whether they represent a stage of life cycle of an unidentified well-known species or they represent coenobia similar to those known, for example, for many freshwater planktonic green algae. The endoparasitic dinoflagellate *Amoebophrya* cf. *ceratii* was found twice inside other dinoflagellate and unidentified algal species (sts. 146 and 181). Some empty thecae of *Gonyaulax* were encountered at sts. 188 and 215.

2. Diatoms

Diatoms were poorly represented in the samples. Among common large-sized background species, *Corethron criophilum, Chaetoceros decipiens, C. borealis, C. concavicornis, C. convolutus, C. debilis* (including cells with resting spores at st. 146), *Thalassiosira* cf. *antarctica*, *Rhizosolenia hebetata* f. *semispina* and *R. styliformis* were found. In several cases, *Chaetoceros atlanticus* (sts. 146, 205 208, 215 and 224), *C. teres* (only at st. 178) and *Proboscia alata* were present. In a small-sized fraction in some samples (especially at st. 173), diatoms prevailed numerically due to an unknown centric diatom (?*Dactyliosolen* sp., 3.5-7.5 μm in diam.), *Cylindrotheca closterium* and *Pseudo-nitzschia* cf. *pseudodelicatissima*. *Eucampia groenlandica* (2.5-17.5 μm in diam.) sometimes was common in nuclepore filtered samples. A number of species were rare: *Chaetoceros* cf. *similis*, *Sceletonema costatum* (only at st. 181), *Fragilariopsis oceanica* (including cells with resting spores at st. 146). A small-sized *Nitzschia* sp. living in the peripherical mucuous layer of *Phaeocystis* colonies was abundant and subdominant in the samples in which *Phaeocystis* cf. *pouchetii* was the dominant species (sts. 187, 195 and 213). Resting spores of *Melosira arctica* and *Chaetoceros furcellatus* were also found (only at sts. 161, 187 and 220); *M. arctica* was also found at sts. 156 and 193. The presence of some typically epiphytic diatoms (sts. 168, 173, 178 and 199) are likely related to the fouling organisms which supposedly inhabit the underwater ship surface.

3. Other flagellates
The main ecological feature related to the presence of other flagellate species was high abundance of *Phaeocystis* cf. *pouchetii* which clogged the net during sampling at sts. 158, 161, 173, 178, 195 and 213. In many samples global bodies comparable in size with ova of planktonic crustaceans were found; supposedly, they are stage of life cycle of *P.* cf. *pouchetii*. Another two colonial species were sometimes relatively abundant, a crysophycean *Dinobryon balticum* (st. 199) and Choanoflagellata gen. sp. (st. 213). Among chrysophyceans, some solitary cells of *Dinobryon faculiferum* and *Meringosphaera mediterranea* were also found. An unidentified cryptophyte of 15-21 μm long was numerically dominant in small-fractioned samples at sts. 161 and 188 and was present at some other stations. Among prymnesiophyceans, four morphotypes of coccolithophorids of 7.5 to 25 μm in diam. were distinguished. *Emiliania huxleyi* was found at low numbers and another unidentified species of 17.5 to 25 μm in diam. was found in many samples and it was numerically dominant at st. 168 and 181. A dictyochophycean *Dictyocha speculum* was encountered in low numbers in almost all the samples. An unidentified phytopflagellate was numerically dominant in a small-sized fraction at st. 199. Unidentified euglenids were found at sts. 144, 220 and 224.

4. Other organisms
Among other major taxonomic groups abundantly presented in samples were ciliates (especially, tintinnids; three different genera were distinguished) and copepods (especially, nauplii). Rare specimens of nematods (sts. 144 and 173), foraminiferas (sts. 146, 178 and 181), radiolarians (sts. 146, 161, 178, 181, 188, 195 and 208) and a filamentous cyanophycean (st. 146), were also found.

5. Indicators of physical oceanographic conditions
According to personal observations and published literature, three species, *Peridiniella catenata* (colonies with up to 4 cells; sts. 146, 156, 187, 193, 195, 205, 208 and 220), *Polarella glacialis* (at many stations, being the most common at st. 193) and *Melosira arctica.* seem to be related with sea ice in their life cycles, and their presence in samples can be interpreted as indicators of the presence of drifting ice in a given area during some period before sampling.

6. Sampling during transit from HAUSGARTEN area to Tromsø

Four additional net and small-sized fraction samples were obtained during sailing from HAUSGARTEN to Tromsø (the code "T" is conventionally given for transit sampling):

T1: 76°57'N, 3°27'E - 76°47'N, 4°00'E (morning, July 23; water temperature 6.03°C);
T2: 75°24'N, 7°58'E - 75°11'N, 8°33'E (evening, July 23; water temperature 7.32°C);
T3: 73°18'N, 13°16'E - 73°08'N, 13°40'E (morning, July 24; water temperature 8.44°C);
T4: 71°53'N, 16°31'E – 71°41'N, 16°56'E (afternoon, July 24; water temperature 9.87°C).

In T1 net haul, *Dictyocha speculum* was dominant, and an unidentified pennate (probably, *Plagiotropis* sp.) was subdominant. *Protoperidinium* spp., especially, *P. pellucidum*, were abundant; the diatom *Thalasiothrix* sp. was observed for the first time. *Ceratium arcticum* was more common than at all previous stations in HAUSGARTEN area. T2-T4 net hauls are characterized by much higher biomass of zooplankton mainly due to the copepod nauplii and copepodite stages and *Ceratium* species; moreover, the latter was relatively diverse in species: *C. arcticum* (at all but T4), *C. longipes, C. fusus, C. furca* (rare cells only in T3 and T4), *C. tripos* and *C. macroceros*. In T4 net haul, *C. macroceros* and *C. tripos* was found more frequently than in previous stations, and *Corethron criophilum* was dominant among large-sized diatoms. Some other taxa such as *Dinophysis acuta* and two unidentified tintinnid and radiolarian species were observed exlusively during the transit. It is suggested that the difference in ratio between different *Ceratium* species in T1-T4 net hauls strongly depends on very pronounced gradients of different water masses, at least, in terms of temperature. The relative abundance of copepods in the studied transit area and period may be interpreted as indicative of high secondary production, which can attract planktivorous sea birds and mammals.

Conclusions and recommendations

Athecate dinoflagellates are morphologically diverse and can significantly contribute to a unicellular plankton population in the study region. This group has been neglected for many years and so far it is understudied. Athecate dinoflagellates prevailed over planktonic diatoms in the number of species during the cruise. More observations *in-vivo* are necessary using an inverted microscope. It is recommended to have a microscope equipped with a digital camera of not less than 7.0 megapixels, a dry 60x or 63x objective of high numerical aperture with an iris diaphragm, a differential interference or relief contrast accessories to be used together with a 40x objective to observe in more detail both external and internal structures of naked dinoflagellates and to take better photographs of them, and epifluorescence facilities to discriminate reliably between photosynthetic and heterotrophic species.

32. EXPLORATION OF MEIOFAUNA AND TROPHO-DYNAMICS IN DEEP-SEA SEDIMENTS

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[2)]NIOO-CEME

Objectives

The dynamics of the meiofauna community during 2000 - 2004 have been studied at different HAUSGARTEN sites by Eveline Hoste (UGent) in collaboration with the Alfred Wegener Institute. As a continuation of this collaboration we focus on the trophodynamics and functional aspects of dominant nematodes. Owing to their ubiquitous presence, nematodes are assumed to play an important role in the benthic food web. However, little is known on their trophic status and functioning in deep-sea sediments. Two experimental setups were designed to decipher their trophic role based on the transfer of stable isotopically labelled food sources in collaboration with the Netherlands Institute of Ecology (NIOO-CEME). The data from both experiments will be evaluated with a model that simulates transfer of ^{13}C amongst the different benthic compartments (e.g. bacteria, nematodes). In order to better understand the trophic status and functioning of deep-sea nematodes, the following key question is addressed:

What is the trophic position of the meiofauna?
Hence the trophic interactions between meiobenthic organisms and their potential food sources (phytodetritus, bacteria) will be studied based on stable isotope and fatty acid analyses. *In-situ* and *in-vitro* experiments will be performed and samples will be collected in order to unravel different trophic interactions and potential selectivity for certain food sources with as main emphasis the position of the meiofauna in the benthic food web. The *in situ* experiment is performed in collaboration with the AWI (Bremerhaven).

Work at sea and preliminary results

At the HAUSGARTEN site *in-situ* and *in-vitro* experiments were performed in which different ^{13}C labelled potential food sources were added to benthic cores. Both experimental set-ups consider the response of the meiofauna community and the uptake of food. In order to identify the uptake and potential food selectivity stable isotope and fatty acid analyses will be performed after returning to the lab.

For the experiments onboard, samples were collected with the Multicorer (MUC) and incubated in a cold room at *in situ* temperature (-0.8 °C), after ^{13}C labelled substrates were injected in the upper 5cm of the sediment. There are four treatments (acetate, bicarbonate, glucose and amino acids) and one control which are sampled according to a time series (day 1, day 2, day 4 and day 7). The control samples are preserved on 8 % formaldehyde, while the treatment samples for biochemical analysis are stored at -20 °C.

MUC drop 1:
Date: 16.07.07 UTC-time: 7:09:45 Station nr: PS 70/188
Coordinates: 79° 7.997' N Depth: 1283 m
06° 5.319' E

MUC drop 2:
Date: 16.07.07 UTC-time: 8:48:15 Station nr: PS 70/190
Coordinates: 79° 7.880' N Depth: 1278 m
06° 5.305' E

MUC drop 3:
Date: 16.07.07 UTC-time: 11:09:50 Station nr: PS 70/192
Coordinates: 79° 7.936' N Depth: 1279 m
06° 5.098' E

The *in-situ* colonisation experiment was performed with the use of the QUEST and a lander, which was together with the colonisation cores designed by the AWI. The QUEST deployed 15 colonisation cores successfully at the 2500 m central HAUSGARTEN site station. The lander, carrying 12 colonisation cores, was deployed several tens of metres away. In both cases there were 3 x 4 treatment cores in which ^{13}C labelled *Thalassiosira* diatoms, *Sceletonema* diatoms, benthic bacteria and bacteria grown on degrading diatoms were added on the azoic sediment which was previously collected from the deepest sediment layers of two giant box corers. The QUEST deployed 3 extra control cores in which only azoic sediment was added. The experiment ended after 10 days of incubation. Control samples are preserved on 8 % formaldehyde, while the treatment samples for biochemical analysis are stored at -20°C.

Giant box corer drop 1:
Date: 10.07.07 UTC-time: 15:47 Station nr: PS 70/146-1
Coordinates: 79° 03.97' N Depth: 2470 m
04° 10.90' E

Giant box corer drop 2:
Date: 10.07.07 UTC-time: 20:41 Station nr: PS 70/148-1
Coordinates: 79° 04.03' N Depth: 2463 m
04° 11.55' E

QUEST deployment:
Date: 11.07.07 UTC-time: 11:33 - 11:57
Coordinates: 79° 04.7117' N Depth: 2475.2 m
04° 05.7435' E

Lander deployment:
Date: 11.07.07 UTC-time: 6:00 Station nr: PS 70/153-1
Coordinates: 79° 04.788' N Depth: 2452 m
04° 05.951' E

33. MULTIDISCIPLINARY INVESTIGATIONS AT THE ARCTIC DEEP-SEA LONG-TERM OBSERVATORY HAUSGARTEN

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Anne-Maria Grave, Christiane Hasemann, Corinna Kanzog, Anja Pappert,
Thomas Soltwedel
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To detect and track the impact of large-scale environmental changes in a the transition zone between the northern North Atlantic and the central Arctic Ocean, and to determine experimentally the factors controlling deep-sea biodiversity, the Alfred Wegener Institute for Polar and Marine Research (AWI) established the deep-sea long-term observatory HAUSGARTEN, which constitutes the first, and until now the only open-ocean long-term station in a polar region.

Objectives

HAUSGARTEN observatory includes 15 permanent sampling sites along a depth transect (1000 - 5500 m) and along a latitudinal transect following the 2500 m isobath crossing the central HAUSGARTEN station (Fig. 33.1). Multidisciplinary research activities at HAUSGARTEN cover almost all compartments of the marine ecosystem from the pelagic zone to the benthic realm, with some focus on benthic processes. Regular sampling as well as the deployment of moorings and different free-falling systems (bottom lander) which act as local observation platforms, have taken place since the observatory was established in summer 1999. The observations with towed photo/video systems allow the assessment of large-scale epifauna distribution patterns as well as their temporal development. To determine the factors controlling deep-sea biodiversity, we carried out a number of biological short- and long-term experiments using the Remotely Operated Vehicle (ROV) "QUEST 4000".

Work at sea

Hydrographic data were assessed using a CTD-system, equipped with water samplers. To characterise and quantify organic matter fluxes to the seafloor, we exchanged moorings carrying sediment traps. To assess the recycling of carbon and to calculate the fluxes of solutes across the sediment water interface, we performed *in-situ* oxygen measurements at the seabed. Virtually undisturbed sediment samples were taken using a video-guided multiple corer. Various biogenic compounds from the sediments were analysed to estimate activities (e.g. bacterial exoenzymatic activity) and total biomass of the smallest sediment-inhabiting organisms. Results will help to describe ecosystem changes in the benthal of the Arctic Ocean. The quantification of benthic organisms from bacteria to megafauna is a major goal in biological investigations.

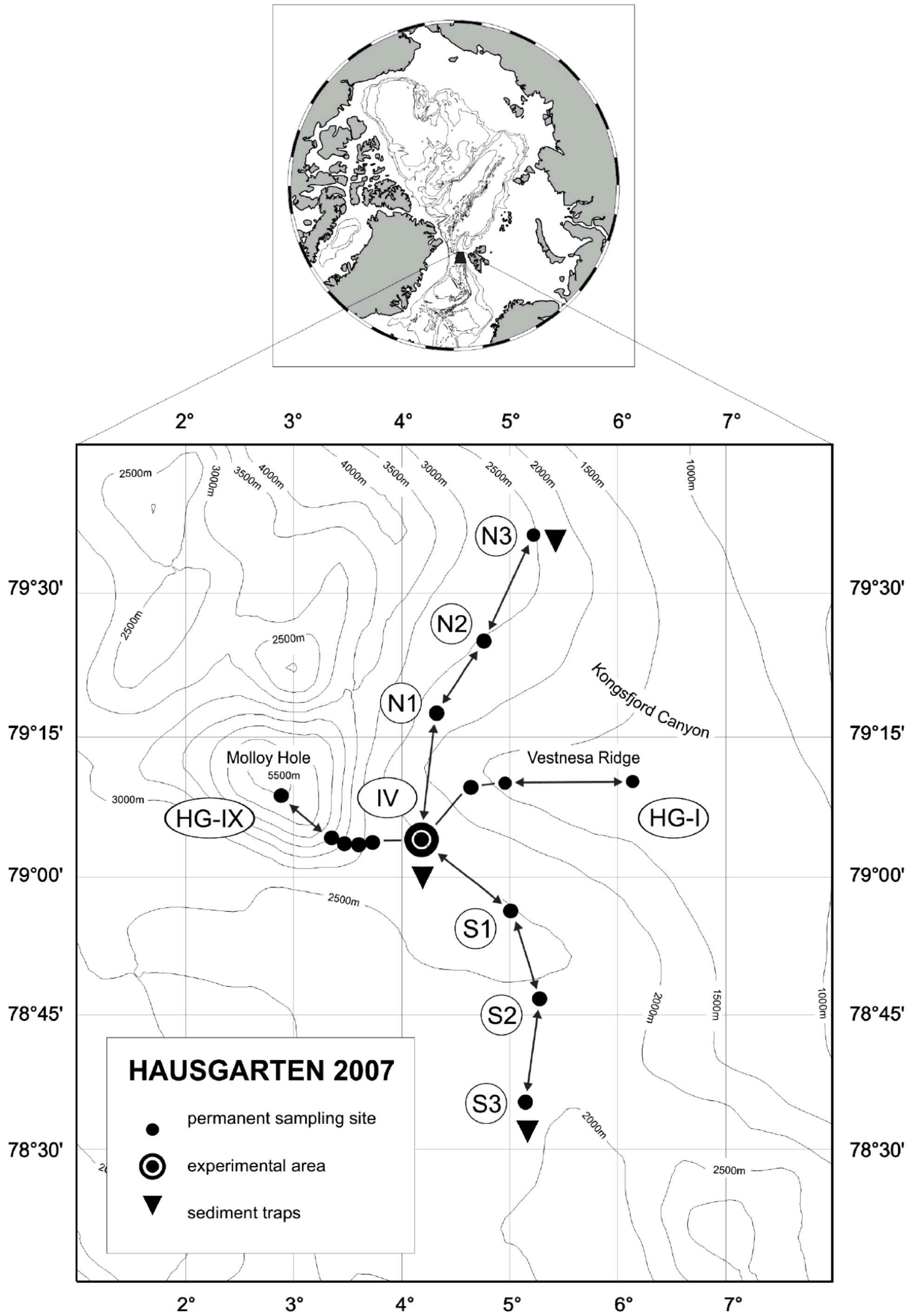

Fig. 33.1: The deep-sea long-term observatory HAUSGARTEN in the eastern Fram Strait

During ARK XXII-1c, we were able to absolve a programme of 20 multicorer-operations in total. With the sampled sediments, we will be able to cover the full set of aspired biochemical analyses and investigations on the benthic organisms itself. Sediment related biochemical analyses comprise estimations for the input of organic matter from phytodetritus sedimentation and analyses of activity and biomass of the small sediment-inhabiting biota as well as assessments of distribution and diversity patterns of benthic organisms (covering all size classes from bacteria to meiofauna) and their temporal development.

Immediately on board we measured the concentrations of sediment bound plant pigments as well as the potential hydrolytical activity of sediment inhabiting bacteria. Both sediment-related parameters showed a nice gradient of decreasing values with increasing water depth with expected very high concentrations on the shallowest shelf stations.

Large-scale distribution patterns of mega/epifauna organisms were assessed using an Ocean Floor Observation System (OFOS), equipped with a video camera and a still camera. Different free-falling devices carrying various biological experiments (colonisation of hardsubstrates, food enrichment to attract the small sediment-inhabiting fauna) were deployed to simulate various factors controlling deep-sea biodiversity. By means of the ROV "QUEST 4000" we terminated and sampled these experiments.

34. BENTHIC FOOD WEB STRUCTURE AND MACROFAUNAL DIVERSITY AT HAUSGARTEN

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Objectives

Wlodarska-Kowalczuk et al. (2004) found that macrofaunal biomass, abundance and species richness decreased with increasing depth along a depth gradient on the continental margin west off Svalbard from 1991 - 2001. In the absence of light, deep-sea fauna rely on nutrients from surface production and lateral advection, thus have to make do with very limited resources. During the passage through the water column, these particles are exposed to biodegradation processes such that the amount of particulate organic matter that reaches the seafloor decreases with depth. This should be reflected in the structure of assemblages found at different depths. However, to date little is known about the interaction with megafaunal organisms and ecosystem function of such assemblages in general. One of the big questions is therefore, how are such ecosystems sustained and who eats whom. In recent years, stable isotope analysis has been increasingly used to characterise food webs. This method relies on the fact that the heavy isotopes of nitrogen and carbon ($\delta^{15}N$, $\delta^{13}C$) are enriched throughout the food web from primary producers via consumers to top predators and scavengers. Results from stable isotope analysis of tissue samples of fish and megafauna indicate differences in the lengths of the food web: the food webs at six different stations along the HAUSGARTEN depth transect (1,200 - 3,200 m) comprising between four and six trophic levels (Bergmann, unpublished data). This large figure may be indicative of a complex food web structure caused by intense recycling of nutrients which is characteristic for food-limited environments such as the deep-sea. For a better understanding of the trophic relationships between organisms in benthic food webs even the smallest biota should be taken into account. One of the ecologically most important groups inhabiting deep-sea sediments is meiofauna. As grazers of bacteria, meiofauna affect nutrient cycling. Organic matter and nutrients consumed by meiofauna are easily assimilated by other consumers, for example by macrofaunal organisms. So, meiofauna is an integral link in the benthic food web.

Work at Sea

One giant box corer was taken at HAUSGARTEN stations I, II, III, IV and V. Two additional cores were obtained from HAUSGARTEN IV. Each core was divided into two halves and the upper 15 - 20 centimetres washed through a 1 mm sieve using the benthos washing machine. The sample was cooled with sea ice whilst sorting under a binocular. From one half of the core, tissue samples were taken from macrofaunal organisms and nematodes for stable isotope analysis and stored at -80°C before freeze-drying. Reference specimens were preserved in formalin for species identification at the home laboratories. The other half of the core was also pre-sorted and preserved for species identification in Poland. Further tissue samples were obtained from fauna caught in fish traps deployed at HAUSGARTEN III and S3.

Meiofaunal sub-samples were taken from the second half of each box core (dedicated to taxonomy). The upper five centimetres of the sediment were taken, using a Plexiglas tube (ø = 3.6 cm). Samples were fixed with 4% formalin. The meiofauna will be extracted from the sediments in the laboratory using the LUDOX density gradient centrifugation technique and organisms will be counted and classified to higher taxon using a stereo-microscope.

Bottom and surface water (50 m) samples were taken by the CTD rosette and the bottom water sampler. The water was filtered so as to obtain phytoplankton and particulate organic matter for stable isotope analysis. Surface sediment samples were taken from multiple cores (HAUSGARTEN I-V, N4) for stable isotope analysis as an estimate for the trophic level of bacteria. These samples were also freeze-dried.

Preliminary results

The total abundance of macrofaunal organisms decreased with increasing water depth. The abundance and diversity of bivalves was highest at HAUSGARTEN station I (1200 m) and decreased with increasing depth. Polychaetes (e.g. *Myriochele* spp.) were the most abundant group at all stations, but the composition varied with depth. Sponges were only found at 2400 and 3100 m depth. Sipunculids were very abundant at 2000 m.

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35. TURN OVER OF ORGANIC MATERIAL IN ARCTIC SEDIMENTS IN THE HAUSGARTEN AREA

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Objectives

The Arctic is not only essential to the global ocean circulation through formation of deepwater it makes up an important marine ecosystem which has only been sporadically studied. Our research group has developed and used state of the art *in-situ* investigation techniques (autonomous bottom landers) for more than 10 years to study biological, chemical, and physical processes at the sea floor and in sediments. During ARK-XXII/1c we used one of our bottom landers equipped with a suite of instruments to study the degradation rates of organic matter *in-situ* on a depth gradient reaching from the shallower HG1 station (1,200 m) over the central HG4 station (2,500 m) to the deep (5,600 m) HG9 station. To obtain additional information from these sites we also collected sediment samples with a multiple corer. The samples were sliced in depth intervals and the porewater was extracted for later analyzing of Dissolved Organic Carbon (DOC) and nutrients.

Work at sea

The lander was equipped with three incubation chambers which each closes off 400 cm^2 of the seafloor to asses the chemical exchange (fluxes) between the sediment and the overlying water. Oxygen consumption is measured directly in the chambers with oxygen optodes. Two optodes were also mounted outside the chambers at different levels above the sediment to log oxygen oscillations and gradients in the bottom water. Here we collaborate and compare our results with data collected from the “bottom water sampler” of Eberhard Sauter (AWI).

The total carbonate (TCO_2), nutrient and DOC production is obtain by analyzing water samples collected in the chambers (9 in each) with syringes. Samples for TCO_2 are analyzed on board while the other parameters are analyzed upon return to the home laboratory. Samples are also taken to determine the dissolution of calcium carbonate, through alkalinity analysis.

At the end of the bottom deployment the incubated sediment was collected. In each chamber the sediment was sampled for bacteria (Ingo Schewe, AWI), for meiofauna (Ingo Schewe, AWI), for macrofauna (Katarzyna Grzelak, IOPAS and Melanie Bergmann, AWI), for grain size (Katarzyna Grzelak, IOPAS) and stable isotopes (Melanie Bergmann, AWI). We also took samples for Organic Carbon and Nitrogen analysis in the home lab.

On the lander we also operated a so called planar optode which was used to take "photos" the oxygen concentration in two dimensions in the sediment and at the sediment-water interface.

In addition a multifunctional current meter measuring currents, salinity, temperature, depth and particle concentrations were mounted on the top of the lander and video camera at the bottom, to film the sediment surface.

Preliminary results

The lander was successfully deployed three times, one at each station (HG1, HG4 and HG9). During these deployments the three incubation chambers and auxiliary instruments worked according to expectations. With the Planar Optode we only obtained high quality oxygen images at the deep station. At the other two it did not penetrate the sediment deep enough. At HG9 40 oxygen images (equal a 2400 oxygen profiles) were collected which will be compared with microelectrode measurements on collected cores (done by Christophe Rabouille and Bruno Bombled, LSCE) from the same station.

Preliminary results of oxygen uptake and efflux of TCO_2 give, as expected, lower degradation rates at the HG4 station than at the deeper (HG9) and shallower (HG1) stations.

Oxygen in the bottom water is surprisingly variable and oscillates with up to 10 μM in time scales of hours. Similar trends have been seen in long-term (one year deployments) measurements of oxygen bottom water concentrations at the same station. Before and during this expedition we have collaborated closely with Thomas Soltwedel and Burkhard Sablotny (AWI) on the quality control and evaluation of these long-term measurements which are unique and clearly demonstrates that oxygen, even in the deep ocean, is more dynamic than previously thought.

36. GRADIENTS IN THE NEAR BOTTOM WATER COLUMN

Eberhard Sauter[1], Melanie Bergmann[1], Bruno Bombled [2], Anders Tengberg[3]

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Objectives

The exchange of solutes produced, consumed, or modified by benthic organisms as well as early diagenetic processes follows and governs biogeochemical gradients at the sediment-water interface. Whereas biogeochemical processes within the sediment have been interpreted on the basis of sediment and pore water depth profiles, bottom water gradients had been hardly taken into account in the past. Although the assumption of an equal distribution of solutes within the bottom water column can be a good approximation under certain conditions, it has been recognized during the last decade that dissolved matter fluxes through the sediment-water interface strongly depend on near-bottom flow regime (Huettel and Gust, 1992; Huettel et al., 1996; Asmus et al., 1998; Boudreau et al., 2001). In fact, many especially microbially mediated processes take place within the benthic boundary itself or close to the interface whereby residence times of particles depend on the flow regime close to the seabed. Most of the studies on these processes have been performed in shallow waters whereas there are so far much less data from deep-sea environments.

As the bottom flow regime determines transport, mixing and interfacial exchange rates, one of the HAUSGARTEN projects deals wit the effects of different bottom currents set up experimentally by the installation of a flume at Station HG S-3 in 2003 and the deployment of current meters during this expedition (see following section).

During this expedition, sampling of different individual layers of the near-bottom zone was projected. Bottom water was to be analyzed for oxygen concentration and nutrients. Water was also to be filtered in order to determine the $\delta^{15}N$ and $\delta^{13}C$ signals at particulate matter in the near-bottom zone. This isotope signature serves as a base line for further food web studies. As particulate organic matter is the ultimate primary food source to fuel benthic life, the investigation of isotope signatures are hoped to allow tracing of the carbon and nutrient metabolism in the food chain of this deep-sea environments.

Work at sea

This was carried out by means of a specific bottom water sampler (BoWaSnapper, Fig. 36.1) developed at the AWI. The system described in more detail by Sauter et al. (2005), basically consists of 6 horizontal sampling bottles arrayed in 20, 37, 66, 96, 150, and 208 cm altitude on a turnable centre pillar of ~2 m height. The sampler is released at the seafloor by a bottom contact switch. However, bottles are closed only ~10 min after the touch down, when the resuspension cloud has disappeared. Prior to closure, bottles are turned into the bottom current by a current vane in order to guarantee for water exchange while standing at the sea floor.

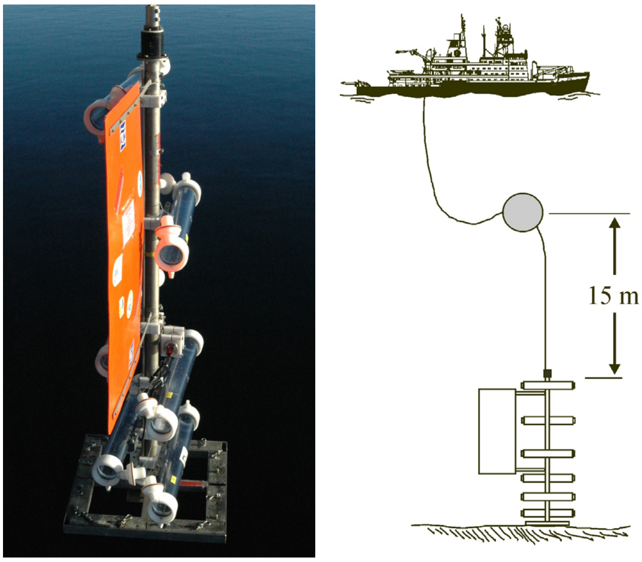

Fig. 36.1: Bottom water sampler (BoWaSnapper) with open sampling bottles before deployment (a), schematic view of decoupling from the ship's motion (b).

The bottom water sampler was deployed at the following HAUSGARTEN stations (Tab. 36.1):

Tab. 36.1: Bottom water sampler stations

Station	Latitude	Longitude	Max. cable length [m]	HG Location
PS70/160-1	79° 8,08' N	5° 59,31' E	1307	HG1
PS70/169-1	79° 4,42' N	4° 14,35' E	2414	HG IV Central
PS70/172-1	78° 36,59' N	5° 3,96' E	2350	HG S-3
PS70/196-1	79° 36,45' N	5° 9,04' E	2802	HG N-3
PS70/221-1	79° 8,07' N	2° 50,57' E	5585	HG 9 Molley Deep

Upon recovery, water samples were taken immediately for oxygen, nutrients and particulate organic matter. While nutrients were stored in the cool room, oxygen samples were analyzed by Winckler titration. For subsequent $\delta^{15}N$ and $\delta^{13}C$ analysis at particulate organic matter, water sub-samples were filtered on board. Filter samples were stored cool for subsequent isotope analysis.

Preliminary results

While nutrient analyses will be carried out back home (University Gothenburg), oxygen profiles were analyzed immediately by Winckler titration. Most of the profiles do not exhibit a monotonous decrease in oxygen towards the sea bed, indicative of rather large (turbulent) bottom flow velocities, and of possibly highly variable concentrations

(Nilsen and Tengberg this cruise report). However, at Station HG Central, we found a slight decrease in oxygen towards the sea bed, although the concentrations only varied in a narrow range (305 - 307 μM, Fig. 36.2). In general, near-bottom oxygen values increase on the depth transect from the shallow Station HG I (1,200 m depth; 303 - 305 μM) down to HG IX (Molloy Hole, 5500 m; 304 -309 μM). Highest concentrations were found at the northernmost station HG N-3 (307-316 μM, Fig. 36.2). All values measured during this campaign were lower than those obtained in 2001. Under consideration of other data such as time series optode measurements, it has to be examined, whether the difference of these results is indicative of a long term trend or spatial and temporal dynamics in the benthic boundary system.

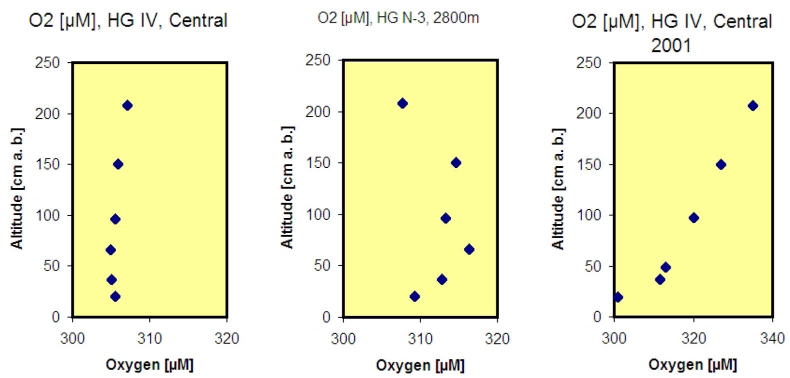

Fig. 36.2: Selected oxygen profiles of the near-bottom zone at stations HG IV, Central (left) and N-3, the northern most station (middle). For compa@rison at the right a profile is shown which was obtained at HG Central station in 2001 (mind different scale).

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37. OXYGEN MICROPROFILE VARIABILITY ON HAUSGARTEN TRANSECTS BASED ON SHIP-BOARD MEASUREMENTS

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Objectives

The objective of performing on board oxygen microprofiles was the study of oxygen distribution and organic matter remineralisation in the sediment along a Nort-South transect on the sea-floor at a constant depth of ca 2500 m and on a bathymetric transect from 1,300 to 5,500 meters in the HAUSGARTEN area. In addition, we explored the effect of small scale features (burrows, crinoids, hydrozoans and foraminifera colonies) on oxygen dynamics in the sediment.

Work at sea

We performed on board oxygen profiles on 13 different stations from the HAUSGARTEN area (central Arctic). Cores were mainly collected using the AWI Multicorer (MUC), except for the S3 station where cores were collected using ROV pushcores. Profiles were acquired in a cold room maintained at 2°C within a few hours after core recovery without air bubbling or stirring. The profiles were performed in duplicate or triplicate using a 100 μm tip oxygen microelectrode (Clark with a guard cathode) and monitored by a PA2000 picoampermeter (Unisense). The electrode was moved using a micromanipulator with a maximum resolution of 500 μm. Several small-scale biological features were studied in these cores:

- Crinoid in core HG4b
- agglutinated hydrozoans or foraminifera in core HG6
- Large burrow in core N1

One short profile was also performed to assess the oxygen level in cores recovered from the enrichment experiment at site HG4 conducted by Gent University and NIOO.

Tab. 37.1: Oxygen profiles taken on 13 different stations from the HAUSGARTEN area

Label	Station	Date	Long	Lat	Depth (m)	Gear
PS70-147	HG 4	10.07.07	79° 3,94' N	4° 10,73' E	2475	MUC
PS70-210	HG 4b	19.07.07	79° 5,69' N	4° 7,46' E	2451	MUC
PS70/190	HG 1b	16.07.07	79° 7,88' N	6° 5,31' E	1287	MUC
PS70/184	HG6	15.07.07	79° 3,60' N	3° 34,81' E	3548	MUC
PS70/211	HG7	19.07.07	79° 3,59' N	3° 28,50' E	4065	MUC
PS70/212	HG8	19.07.07	79° 3,79' N	3° 18,80' E	5140	MUC
PS70/222	HG9	22.07.07	79° 8,21' N	2° 50,77' E	5590	MUC
PS70/175	S2	14.07.07	78° 46,85' N	5° 19,98' E	2477	MUC
PS70/177	S3	14.07.07	78° 36,23' N	5° 4,58' E	2348	ROV cores
PS70/193	N1	16.07.07	79° 16,97' N	4° 19,70' E	2406	MUC
PS70/194	N2	16.07.07	79° 24,57' N	4° 41,80' E	2552	MUC
PS70/197	N3	17.07.07	79° 36,32' N	5° 9,23' E	2804	MUC
PS70/200	N4	17.07.07	79° 44,19' N	4° 25,66' E	2644	MUC

Preliminary results

The replicate profiles performed on sediment cores were very reproducible. They all showed a large decrease in the uppermost layers but at most stations the penetration depth of oxygen exceeded the measuring depth of 10 cm. There is little variation appearing on the North-South transect along 2,500 m, but a large decreasing trend in oxygen gradient and asymptotic concentration from 1,300 m to 4,000 m. In this depth range, the only core with an anoxic zone is the core at 1300 m with an oxygen penetration of 27 - 33 mm. The situation below 4,000 m reverses to an oxygen-limited system. At 5,000 m, on the lower slope of the Molloy Deep, the sediment contains an iron oxide crust at 2 cm, and the oxygen penetration is 35 mm. At 5,500 m, in the Molloy Deep, the oxygen penetration is 60 mm which corresponds to a colour transition observed in the core from brown-green to grey sediments. The depth pattern of oxygen uptake observed along the bathymetric transect reflects the decreasing input of organic matter from 1,300 m to 4,000 m and the concentration of organic matter due to the Molloy Deep below this depth.

38. CONTROLLED PERTURBATIONS: OXYGEN AND FLOW MEASUREMENTS AT A DEEP-SEA FLUME AND AT A WHALE CARCASS SITE

Eberhard Sauter[1], Ulrich Hoge[1], Christophe Rabouille[2], Bruno Bombled[2]

1) Alfred-Wegener-Institut
2) LSCE

Objectives

One objective of this cruise was to quantify the effect of controlled perturbation of the system such as increased current in a flume or disposal of a whale carcass as an external food source on the overall functioning of the ecosystem.

Work at sea

ROV-based microprofile measurements inside and outside the flume

In total, three ROV dives were performed with the AWI microprofiler (MIC). The microprofiler was carried down to the seafloor on the ROV Porch which allowed a rapid start of the experiment after the exact target area had been reached. For the flume experiment, we decided to perform oxygen measurements at a reference station 5 meters south of the *in-situ* flume and to perform the controlled perturbation measurements in the central part of the flume. The first set of profiles was obtained during ROV dive #175 and lasted 5 hours. The microprofiler stayed overnight on the sea floor and the second set of profiles (inside flume) was achieved during the subsequent dive #176. The whale carcass was investigated during a single ROV dive (#178) using a shorter microprofiler programme which lasted 3 hours. The first set of measurement was achieved on the site of whale disposal, whereas the second set of profiles was measured 20 meters away from the former whale carcass. After all dives the MIC was recovered using the COLOSSOS lift. The MIC was equipped with 5 oxygen microelectrodes with tip diameter of 50 μm (provided by Unisense) and a resistivity electrode of 1 cm width. The oxygen sensors were calibrated using a two point approach: oxygen concentrations in bottom water were determined by Winkler titration and the zero was determined from the anoxic zone measured on dive #178 during the whale carcass set of profiles. Dithionite zeroes were tried at near *in-situ* temperature (2 °C), but showed poor adequation to bottom water zeroes.

Tab. 38.1: Profiles of ROV drives

ROV dive	Label	Date	Station	Depth (m)	Position
#175	PS70-171	13 July 2007	S3	2353m	78° 36,22' N 5° 05,13' E
#176	PS70-177	14 July 2007	S3	2353m	idem
#178	PS70-215	20 July 2007	HG Central	2487m	79° 4,58' N 4° 08,54' E

Installation of long-term bottom current meters
An acoustic travel time current meter of the type MAVS3 (Nobska Instruments) was installed by the ROV Quest in the central part of the flume during dive #176 in order to record the current speed directly in the flume (Fig. 38.1 left). The deployment was programmed over a Period of one year with several 2 Hz measurements every 12 hours.

A similar current meter was installed at the same height above bottom (30 cm) outside the flume on a tripodal umbrella frame (Fig. 38.1 right). These two current meters are supposed to document the current speed and direction in and outside the flume.

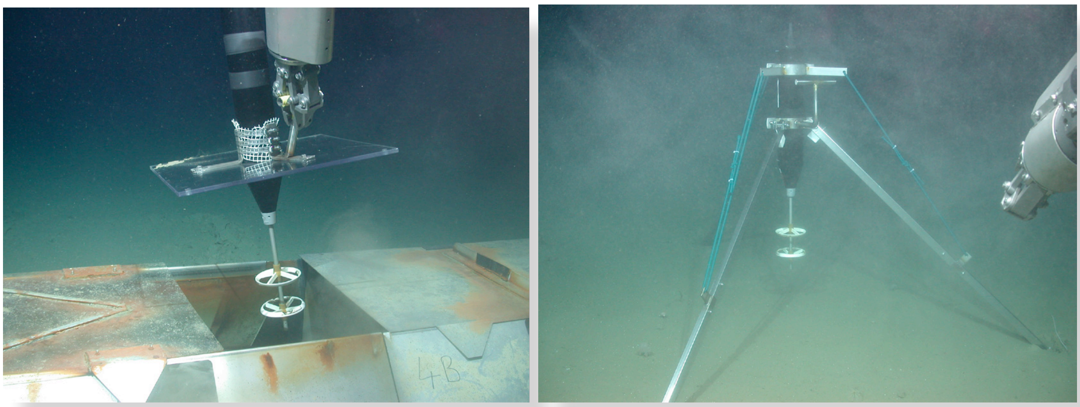

Fig. 38.1: Placement of acoustic time current meters in side (left) and outside the deep-sea flume (right). Photographs © marum

Comparative microprofile measurements using push cores and onboard measurements
Two push cores were collected inside and outside the flume in order to measure oxygen profiles on board ship. The cores outside the flume were collected on the southern side of the flume whereas the core in the flume was sampled 1.5 meter away from the MIC measurement.

Preliminary results

O_2 Microprofiles
During the 3 ROV dives, 16 oxygen microprofiles and 4 resistivity microprofiles were acquired by the MIC. Concerning the flume experiment, 4 workable profiles were acquired in and outside the flume (one electrode broke during the first set of profiles). The results of the *in-situ* experiment show a similar pattern in the flume and in the reference zone in the uppermost 2 centimetres and a difference in concentration in

lower layers of the sediment, with an average concentration of 25 µmol/l lower in the flume than outside the flume. The diffusive oxygen uptakes (DOU) are similar in and outside the flume, whereas oxygen penetration depth is different. A drift in the sensor signal due to the sensor itself or the cooling of the electronics can be ruled out as several sensors showed little drift and the signal difference in the lower profile was much larger than the signal drift. These results are surprising, as the flume has been closed by a top lid for 4 years (since its deployment in 2003) with accelerated bottom current which should have lead to a reduction of vertical organic matter input and increased sediment resuspension in the flume. The oxygen fluxes show that diffusive uptake has remained at a high level in the flume, with potentially larger consumption in lower layers (below 2 cm).

With pushcores from the flume area, the comparison of *in-situ* and on board profiles showed a contrasted pattern. Indeed, the profiles in the flume had a similar pattern when measured on board and *in-situ* except the initial slope which was larger when measured on cores. This might be due to core compaction during sampling. On the contrary, the measurements outside the flume showed little discrepancy between both techniques in the upper part of the profile but lower concentration when measured on board compared to *in-situ*. This difference may be related to natural variability in sediment, as this same difference between techniques was observed on separate cores from a single cast.

Concerning the whale carcass, the visible remains of the whale were totally absent, except a rim of darker sediments around the former carcass. The profiles performed within this rim showed a large reduction of oxygen penetration compared to the reference site. This indicates that the sediment is still active below the former whale carcass two years after disposal.

39. 3 - DIMENSIONAL OXYGEN MICROGRADIENTS

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Objectives

Since 2001 the biological work at the HAUSGARTEN carried out by the AWI Deep-Sea Group was complimented by geochemical investigations in close cooperation with the AWI Geochemistry Group. During the 6 years of observation, significant trends in several benthic parameters such as bottom water oxygen concentration, benthic chlorophyll content, etc. were recognized. By means of the French remotely operated vehicle (ROV) "Victor 6000" and autonomous benthic lander systems, *in-situ* experiments and detailed studies were performed in order to obtain an improved understanding of causes and effects of small scale gradients at the sediment-water interface. In this context, the ROV-operated *in-situ* microprofiler unit MIC (see previous section) was built which was deployed for targeted measurements at the HAUSGARTEN site, e.g. in the aftermath of lander-based food fall experiments (Sauter et al., 2006, Soltwedel et al., 2005; Rabouille et al., this cruise report), around sponges (Hoffmann et al., submitted), experimental sediment set-ups (Gallucci et al., submitted; Rabouille et al., this cruise report) and at other specific deep-sea environments (De Beer et al., 2006; Niemann et al., 2006).

In order to further resolve 3D gradients around biogenic structures, the development of a special 3D deep-sea microprofiler was initiated at the AWI. This system was designed to allow new insights into spatial small scale variabilities generated by benthic organisms. The new device is not restricted to lower sensors vertically into the sediment but is able to displace its sensor array (up to 12 microsensors, Fig. 39.1) horizontally in order to measure cascades of microprofiles over a target area of ~30 x 35 cm (Fig. 39.2). Together with a sequence of photographs taken prior, during and after the measurements, this allows the 3D reconstruction of the pore water oxygen distribution for descriptive geochemical habitat characterization e.g. around biogenic structures, as well as for 3D pore water modelling. The system was to be deployed for the first time during the ARK-XXII/1c cruise in the HAUSGARTEN area.

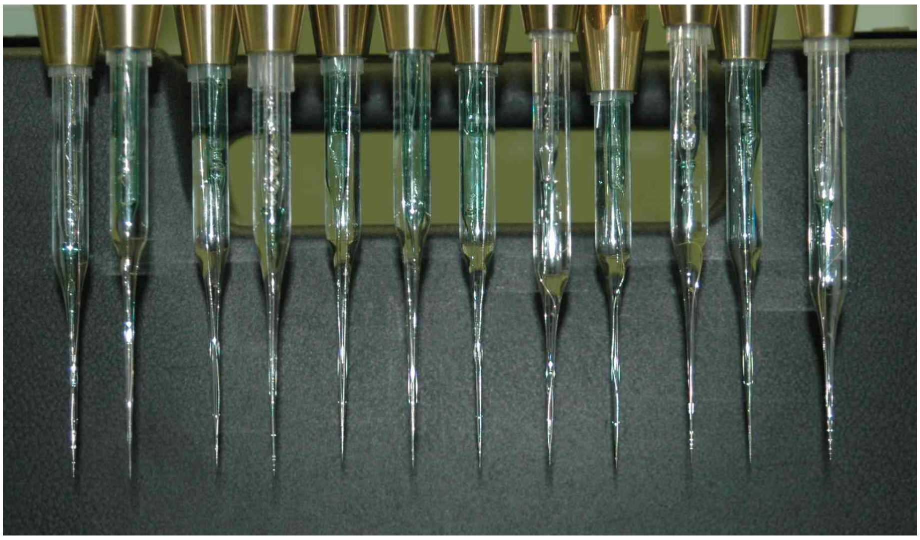

Fig. 39.1: Microsensor array of the 3D microprofiler

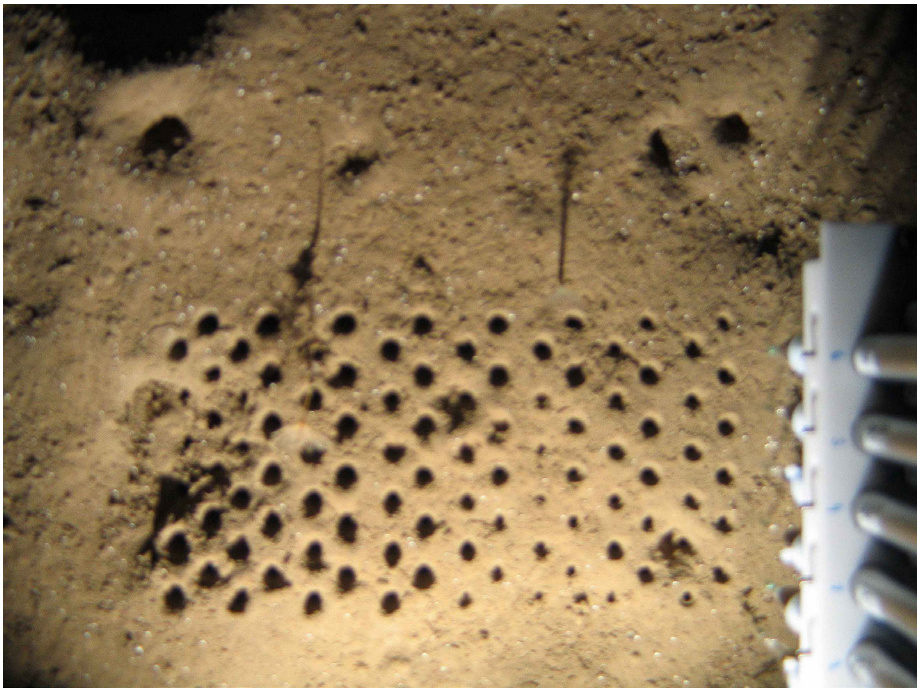

Fig. 39.2: Sediment image from above taken after the measurement. According to the small scale bottom topography, the penetration depth of the sensors is different, which can be seen by the different diameter of the individual holes.

Work at sea and first results

For its first deep-ocean deployments, the 3D microprofiler was mounted into the frame of a free falling lander. In contrast to the ROV-operated MIC module with one central electronics housing, the 12 microsensors of the 3D profiler are directly attached to individual mini amplifier housings (developed by Unisense AS). Due to this design, only a light mobile amplifier unit has to be moved in x, y, and z direction instead of the large main electronics unit. However the first field deployments under deep-sea conditions revealed several technical details to be further improved. The 3D profiler was deployed one time at HAUSGARTEN South (HG S-3,) and three times close to the HAUSGARTEN Central Station (HG IV):

Station	Latitude	Longitude	Water depth (m)
PS70/168-1	78° 36,29' N	5° 3,48' E	2353
PS70/185-1	79° 1,01' N	4° 20,69' E	2591
PS70/205-1	79° 5,62' N	4° 7,77' E	2449
PS70/216-1	79° 4,59' N	4° 10,79' E	2449

Based on the results of the first unsuccessful deployments, the power supply system was exchanged and technical and software modifications were carried out. Subsequently, the programmed measuring procedure was performed and images were taken by the down-looking camera. The still poor signal resolution of the oxygen measurements has to be investigated in detail. However, as shown in Fig. 39.3, the profile cascades can be used to derive locations of burrows, small-scale topography and the distribution of oxygen penetration depth.

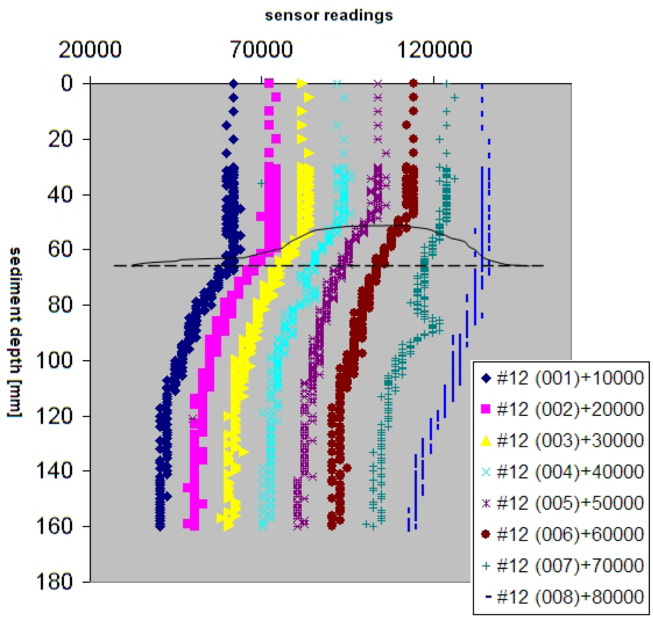

Fig. 39.3: Raw profiles (not transferred into oxygen concentration yet) of sensor 12 throughout 8 measurements with a horizontal displacement of 30 mm per step. The black line represents the bottom topography as it connects the sediment/water interface at each measuring location. Profiles 004 and 007 are characterized by local oxygen maxima, most likely caused by burrows flushed with oxygen-rich water

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40. IMPACT OF SMALL-SCALE ENVIRONMENTAL CHANGES ON MEIOBENTHIC COMMUNITY STRUCTURE

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Objective

To investigate the impact of small-scale environmental changes on meiobenthic community structure a short-term *in-situ* experiment was carried out to examine and monitor factors controlling deep-sea diversity. In order to understand the complex interactions between the biota (their functioning and diversity) and environmental perturbations/relaxations a free-falling device (bottom lander) equipped with a sediment disturber (SD) was used (Fig. 40.1).

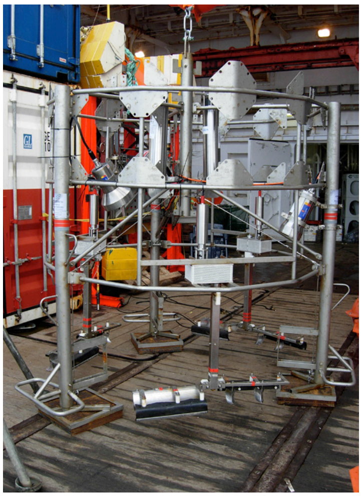

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Fig. 40.1 Bottom lander equipped with sediment disturber (SD) and camera system.

This *in-situ* technology will provide scientific insight to effects on the sediment geochemistry and associated benthic fauna, due to repeated disturbances (e.g. as caused by bioturbating megafauna). This will allow the investigation of shifts in biodiversity of the small sediment-inhabiting biota in response to perturbations and changing chemical condition of the deep-sea sediment.

Work at sea

The SD was deployed at the central HAUSGARTEN station (79° 4.48`N 4° 8.58`E, 2,493 m water depth) for nine days. The SD carries three rotating fork-like disturber units able to perturbate the upper sediment layers at chosen time intervals (Fig. 40.2).

Three disturbed areas were created by the SD with different disturbance frequencies of four (disturber unit I), two (disturber unit II) and one disturbance (disturber unit III) within nine days. A camera system continuously monitors all SD actions.

Sediment sampling at the end point of the deployment has been carried out using push-coring devices handled by the ROV "Quest 4000". With the manipulator arm of the ROV three sediment cores were taken from each disturbed area. In front of each disturbed area two background samples were taken outside the SD footprint.

The sediment cores were sub-sampled to study the effect of controlled sediment perturbations on biochemical sediment parameters as well as on benthic bacteria and meiofauna communities (with special focus on nematode communities).

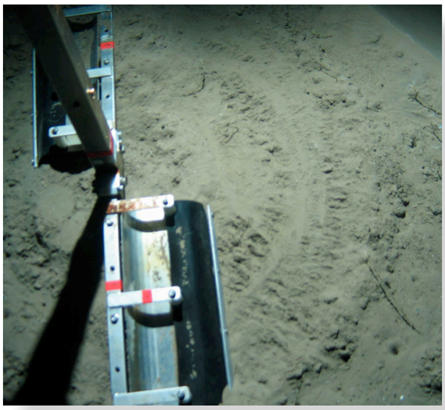

Fig. 40.2 Sediment perturbation by disturber unit I at the deep-sea floor

APPENDIX

A.1 PARTICIPATING INSTITUTIONS

A.2 CRUISE PARTICIPANTS

A.3 SHIP'S CREW

A.4 STATION LIST

A.5 LIST OF GIANT BOX CORER AND VAN VEEN GRAB SAMPLES TAKEN DURING ARK XXII/1A

A.1 TEILNEHMENDE INSTITUTE / PARTICIPATING INSTITUTIONS

Abkürzung/Acronym	Adresse/Address
ATLAS	ATLAS Hydrographic GmbH Kurfürstenallee 130 28211 Bremen Germany
AWI	Alfred-Wegener-Institut für Polar und Meeresforschung Am Handelshafen 12 27570 Bremerhaven Germany
BU	Bielefeld University Applied Neuroinformatics Group Faculty of Technology PO Box 100130 D-33501 Bielefeld Germany
DWD	Deutscher Wetterdienst Bernhard-Nocht Straße 20359 Hamburg Germany
FIELAX	FIELAX Gesellschaft für wissenschaftliche Datenverarbeitung mbH Schifferstr. 10 - 14 27568 Bremerhaven Germany
IFM-GEOMAR	IFM-GEOMAR Leibniz-Institut für Meereswissenschaften Wischhofstr. 1-3 24148 Kiel Germany

Abkürzung/Acronym	Adresse/Address
IFREMER	Institut français de recherche pour l'exploitation de la mer BP70 29280 Plouzane France
IOPAS	Institute of Oceanology of the Polish Academy of Sciences P.B. 68 81-712 Sopot Poland
JUB	Jacobs University Bremen Campusring 1 28759 Bremen Germany
Laeisz	Reederei F. Laeisz (Bremerhaven) GmbH Brückenstrasse 25 27568 Bremerhaven Germany
LSCE	Laboratoire des Sciences du Climat et de l'Environnement CEA-CNRS-UVSQ Domaine du CNRS Bat 12 - Avenue de la Terrasse F-91198 Gif-sur-Yvette France
LMU	Ludwig-Maximilians-University Munich Richard-Wagner-Strasse 10 80333 München Germany
MPI	Max Planck Institute for Marine Microbiology Celsiusstr. 1 28359 Bremen Germany

Abkürzung/Acronym	Adresse/Address
NIOO - CEME	Netherlands Institute of Ecolgy Centre for Estuarine and Marine Ecology Korringaweg 7, Yerseke 4400 AC Yerseke The Netherlands
OecklTV	Oecklfilmtv Produktion Mainzer Strasse 28 50678 Köln Germany
Oktopus	Oktopus GmbH Kieler Straße 51 24594 Hohenwestedt Germany
OPTIMARE	OPTIMARE Am Luneort 15a 27572 Bremerhaven Germany
RCOM	Research Center Ocean Margins University of Bremen P.O. Box 330440 D-28334 Bremen Germany
UB	Institute for Biology University of Bergen HIB - Thormøhlensgt. 55 N-5020 Bergen Norway
UG	Goteborg University Department of Chemistry 412 96 Goteborg Sweden
UGent	Ghent University Marine Biology Section Krijgslaan 281/S8 B-9000 Gent Belgium

Abkürzung/Acronym	Adresse/Address
UParis	Université Pierre et Marie Curie Adaptation et Evolution en milieux extrêmes Systematique Adaptation Evolution Directrice adjointe de l'UMR 7138 CNRS IRD MNHN UPMC Bat A 4 etage, case 5 7 Quai Saint Bernard 75005 Paris France
UPly	University of Plymouth Department of Marine Sciences Plymouth Devon, PL4 8AA United Kingdom
USev	Biodiversidad y Ecología de Invertebrados Marinos Departamento de Fisiología y Zoología Facultad de Biología Universidad de Sevilla Reina Mercedes 6 41012 – Sevilla Spain
UiTø	University of Tromsø Drammsveien 201 9037 Tromsø Norway
VUB	Laboratory for Ecotoxicology and Polar Ecology Free University of Brussels Pleinlaan 2 1050 Brussels Belgium

A.2 FAHRTTEILNEHMER / CRUISE PARTICIPANTS

Name	Vorname/ First Name	Institut/ Institute	Beruf / Profession
Abegg	Friedrich	RCOM	Geologist
Albrecht	Sebastian	FIELAX	Computer scientist
Alfke	Rolf	ATLAS	Engineer
Asendorf	Volker	MPI	Technician, electronics
Bauer	Michael	Germany	Teacher
Bauerfeind	Eduard	AWI	Biologist
Bergenthal	Markus	MARUM	Physicist
Bergmann	Melanie	AWI	Biologist
Bittermann	Lennart	AWI	Student, physics
Blume	Marlen	AWI	Biologist
Boche	Martin	Laeisz	Inspector
Bombled	Bruno	LSCE	Technician, biology
Brauer	Jens	HeliTransair	Technician, helicopter
Buldt	Klaus	DWD	Technician, meteorology
Cardenas	Paco	UiB	Biologist
Cathalot	Cecile	LSCE	Biologist
Decker	Carole	IFREMER	Biologist
Dorso	Gael	IFREMER	Biologist
Duessmann	Ralf	MARUM	Technician, ROV
Eggermont	Mieke	Belgium	Teacher
Eisenschmidt	Julia	FIELAX	Student, geology
El-Naggar	Saad	AWI	Physicist
Erlandsen	Rune	JUB	Student biology
Ewert	Jörn	ATLAS	Engineer
Fangueiro Ramos	Manuela	USev	Biologist
Federowitz	Marcus	HeliTransair	Pilot
Felden	Janine	MPI	Biologist
Feseker	Tomas	MPI	Geologist
Flögel	Sascha	IFM-GEOMAR	Geologist

Name	Vorname/ First Name	Institut/ Institute	Beruf / Profession
Fonsecca	Gustavo	AWI	Biologist
Franke	Phillip	MARUM	Geologist
Funk	Gesche	JUB	Student, biology
Gauger	Steffen	FIELAX	Engineer, Geomatik
Gerchow	Peter	FIELAX	Computer scientist
Graf von Spee	Caspar	Laeisz	Inspector
Grave	Anne	AWI	Student, biology
Grünke	Stefanie	MPI	Biologist
Grzelak	KatarzynaAnna	IOPAS	Biologist
Guilini	Katja	UGent	Biologist
Hall-Spencer	Jason	UPly	Biologist
Hanelt	Nora	JUB	Biologist
Hasemann	Christiane	AWI	Biologist
Hissmann	Karen	IFM-GEOMAR	Biologist
Hofbauer	Michael	JUB	Computer scientist
Hoffmann	Friederike	MPI	Biologist
Hoge	Ulrich	AWI	Engineer, electronics
Hohnberg	Hans-Jürgen	RCOM	Engineer, mechanics
Joiris	Claude	VUB	Biologist
Jolly	Cecile	UiB	Technician, biology
Kanzog	Corinna	AWI	Biologist
Karpen	Volker	JUB	Oceanographer
Kerby	Tina	IFM-GEOMAR	Student, biology
Klages	Michael	AWI	Biologist
Knab	Nina	MPI	Biologist
Knust	Rainer	AWI	Biologist
Koschnick	Nils	AWI	Technician, biology
Kuhn	Gerhard	AWI	Geologist
Laurent	Melina	UParis	Biologist
Lehmenhecker	Sascha	AWI	Computer scientist
Lensch	Norbert	AWI	Technician, geology
Lessmann	Birgit	UBiel	Computer scientist

Name	Vorname/ First Name	Institut/ Institute	Beruf / Profession
Liebe	Thomas	Laeisz	Inspector
Lochthofen	Normen	AWI	Engineer, mechanics
Lütticke	Ulrich	ATLAS	Engineer, electronics
Meyer	Jörn Patrick	MARUM	Technician, ROV
Michalski	Ulrich	HeliTransair	Pilot
Moje	Annika	JUB	Technician, biology
Monsees	Matthias	OPTIMARE	Technician, physics
Müller	Eugen	DWD	Meteorologist
Munyaruguru	Aline	JUB	Student, biology
Niessen	Frank	AWI	Geologist
Nilsson	Madeleine	UGoteborg	Chemist
Nordhausen	Axel	MPI	Technician, biology
Oeckl	Dieter	OecklTV	Journalist
Oevelen	Dick van	NIOO-CEME	Biologist
Okolodkov	Juri	AWI	Biologist
Pape	Thomas	RCOM	Geologist
Pappert	Anja	AWI	Technician, biology
Perez-Garcia	Carolina	UiTø	Geologist
Pirlet	Hans	UGent	Biologist
Purser	Autun	JUB	Biologist
Rabouille	Christophe	LSCE	Chemist
Ratmeyer	Volker	MARUM	Geologist
Rehage	Ralf	MARUM	Technician, electrics
Reuter	Michael	MARUM	Technician, ROV
Ritt	Benedicte	IFREMER	Biologist
Rüggeberg	Andres	IFM-GEOMAR	Geologist
Sablotny	Burkhard	AWI	Engineer, electronics
Sachs	Oliver	AWI	Geologist
Saukel	Cornelia	AWI	Geologist
Sauter	Eberhard	AWI	Chemist
Schauer	Jürgen	IFM-GEOMAR	JAGO pilot
Schewe	Ingo	AWI	Biologist
Schmidt	Werner	MARUM	Geologist

Name	Vorname/ First Name	Institut/ Institute	Beruf / Profession
Schoberth	Thomas	OeckITV	Media stylist
Schott	Thorsten	OKTOPUS	Technician, electronics
Schöttner	Sandra	MPI	Biologist
Schüssler	Gabriele	MPI	Technician, biology
Seiter	Christian	MARUM	Technician, ROV
Smaadahl	Thale	Norway	Teacher
Söffker	Marta Karolina	UPly	Biologist
Soltwedel	Thomas	AWI	Biologist
Sterk	Wilfried	VUB	Biologist
Sünkler	Sigrid	OeckITV	Journalist
Tengberg	Anders	UGoteborg	Chemist
Thiede	Jörn	AWI	Geologist
Thomsen	Laurenz	JUB	Biologist
Todt	Christiane	UiB	Biologist
Tornes	Magnus	UB	Biologist
Unnithan	Vikraim	JUB	Teacher
Viergutz	Thomas	JUB	Engineer, mechanics
Wehrmann	Laura	MPI	Biologist
Wenzhöfer	Frank	MPI	Biologist
Wild	Christian	LMU	Biologist
Wilkop	Tomas	MPI	Technician, biology
Wittek	Steffen	JUB	Student, biology
Wollenburg	Jutta	AWI	Geologist
Zarrouk	Marcel	MARUM	Engineer, ROV

A.3 SHIP'S CREW

No.	Name	Rank
1.	Pahl, Uwe	Master
2.	Grundmann, Uwe	1.Offc.
3.	Ziemann,Olaf	Ch.Eng.
4.	Bratz, Herbert	2.Offc.
5.	Röder, Thomas	2.Offc.
6.	Hering, Igor	2.Offc.
7.	Schneider, Marcel	Doctor
8.	Koch, Georg	R.Offc.
9.	Kotnik, Herbert	2.Eng.
10.	Schnürch, Helmut	2.Eng.
11.	Westphal, Henning	3.Eng.
12.	Holtz, Hartmut	Elec.Tech.
13.	Rehe, Lars	Electron.
14.	Dimmler, Werner	Electron.
15.	Fröb, Martin	Electron.
16.	Feiertag, Thomas	Electron.
17.	Clasen, Burkhard	Boatsw.
18.	Neisner, Winfried	Carpenter
19.	Kreis, Reinhard	A.B.
20.	Schultz, Ottomar	A.B.
21.	Burzan, G.-Ekkehard	A.B.
22.	Schröder, Norbert	A.B.
23.	Moser, Siegfried	A.B.
24.	Pousada, Martinez S.	A.B.
25.	Hartwig-L., Andreas	A.B.
26.	Vehlow, Ringo	A.B.
27.	Beth, Detlef	Storekeep.
28.	Kliem, Peter	Mot-man
29.	Fritz, Günter	Mot-man
30.	Krösche, Eckard	Mot-man
31.	Dinse, Horst	Mot-man
32.	Watzel, Bernhard	Mot-man

No.	Name	Rank
33.	Fischer, Matthias	Cook
34.	Tupy, Mario	Cooksmate
35.	Völske,Thomas	Cooksmate
36.	Dinse, Petra	1.Stwdess
37.	Stelzmann, Sandra	Stwdss/KS
38.	Streit, Christina	2.Steward
39.	Schmidt, Maria	2.Stwdess
40.	Deuß, Stefanie	2.Stwdess
41.	Hu Guo, Yong	2.Steward
42.	Sun, YongSheng	2.Steward
43.	Yu, ChungLeung	Laundrym.

A.4 STATIONSLISTE / STATION LIST

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/001-1	01.06.07	09:39	64° 1.12'	7° 53.00’	245.9	HS_PS	start track
PS70/001-1	01.06.07	14:16	64° 8.76'	8° 13.90’	349.7	HS_PS	profile end
PS70/001-2	01.06.07	14:46	64° 8.21'	8° 11.52’	323.4	CTD/RO	surface
PS70/001-2	01.06.07	15:08	64° 8.19'	8° 11.43’	321.5	CTD/RO	at depth
PS70/001-2	01.06.07	15:22	64° 8.18'	8° 11.32’	321.9	CTD/RO	on deck
PS70/002-1	02.06.07	12:55	67° 30.39'	9° 25.62’	310.1	CTD/RO	surface
PS70/002-1	02.06.07	13:15	67° 30.36'	9° 25.62’	301.9	CTD/RO	at depth
PS70/002-1	02.06.07	13:29	67° 30.41'	9° 25.61’	310.6	CTD/RO	on deck
PS70/002-2	02.06.07	13:33	67° 30.41'	9° 25.60’	312.9	GKG	surface
PS70/002-2	02.06.07	13:42	67° 30.39'	9° 25.55’	304.2	GKG	at sea bottom
PS70/002-3	02.06.07	13:49	67° 30.36'	9° 25.55’	303.9	GKG	surface
PS70/002-2	02.06.07	13:49	67° 30.36'	9° 25.55’	303.9	GKG	on deck
PS70/002-3	02.06.07	13:55	67° 30.34'	9° 25.57’	296.1	GKG	at sea bottom
PS70/002-3	02.06.07	14:05	67° 30.39'	9° 25.68’	303.6	GKG	on deck
PS70/003-1	02.06.07	15:25	67° 31.75'	9° 30.19’	334.4	CTD/RO	surface
PS70/003-1	02.06.07	15:42	67° 31.85'	9° 30.26’	351.4	CTD/RO	at depth
PS70/003-1	02.06.07	15:53	67° 31.92'	9° 30.28’	358.7	CTD/RO	on deck
PS70/003-2	02.06.07	16:05	67° 31.70'	9° 30.07’	320.1	GKG	surface
PS70/003-2	02.06.07	16:12	67° 31.69'	9° 30.03’	317.5	GKG	at sea bottom
PS70/003-2	02.06.07	16:23	67° 31.78'	9° 30.10’	341.8	GKG	on deck
PS70/003-3	02.06.07	16:29	67° 31.85'	9° 30.17’	354.1	GKG	surface
PS70/003-3	02.06.07	16:35	67° 31.85'	9° 30.14’	350.8	GKG	at sea bottom
PS70/003-3	02.06.07	16:46	67° 31.81'	9° 30.12’	346.1	GKG	on deck
PS70/004-1	02.06.07	17:08	67° 32.07'	9° 28.55’	435.5	HS_PS	start track
PS70/004-1	02.06.07	17:38	67° 30.39'	9° 23.44’	400.6	HS_PS	alter course
PS70/004-1	02.06.07	18:38	67° 33.05'	9° 32.79’	317.9	HS_PS	alter course
PS70/004-1	02.06.07	19:38	67° 29.99'	9° 24.52’	294.3	HS_PS	alter course
PS70/004-1	02.06.07	20:40	67° 33.19'	9° 34.20’	274.8	HS_PS	alter course
PS70/004-1	02.06.07	21:43	67° 29.65'	9° 25.43’	285.4	HS_PS	profile end
PS70/004-2	02.06.07	22:21	67° 31.23'	9° 26.25’	415.5	CTD/RO	surface
PS70/004-2	02.06.07	22:45	67° 31.23'	9° 26.01’	426.0	CTD/RO	at depth
PS70/004-2	02.06.07	22:57	67° 31.21'	9° 25.88’	429.2	CTD/RO	on deck
PS70/004-3	02.06.07	23:02	67° 31.21'	9° 25.87’	430.6	GKG	surface
PS70/004-3	02.06.07	23:12	67° 31.21'	9° 25.88’	429.4	GKG	at sea bottom
PS70/004-3	02.06.07	23:26	67° 31.18'	9° 25.92’	426.1	GKG	on deck
PS70/005-1	02.06.07	23:52	67° 30.56'	9° 23.05’	435.3	HS_PS	start track
PS70/005-1	03.06.07	02:22	67° 22.15'	8° 58.91’	601.0	HS_PS	alter course
PS70/005-1	03.06.07	05:05	67° 30.11'	9° 24.07’	330.1	HS_PS	alter course
PS70/005-1	03.06.07	07:36	67° 21.25'	8° 59.63’	512.7	HS_PS	alter course
PS70/005-1	03.06.07	10:06	67° 30.02'	9° 24.79’	292.4	HS_PS	profile end
PS70/006-1	03.06.07	11:33	67° 31.77'	9° 29.77’	329.0	JAGO	to Water
PS70/006-1	03.06.07	12:02	67° 32.14'	9° 29.88’	389.3	JAGO	on Deck
PS70/006-1	03.06.07	12:59	67° 31.61'	9° 29.51’	325.2	JAGO	to Water
PS70/006-1	03.06.07	13:04	67° 31.66'	9° 29.55’	317.4	JAGO	Hydrophon to Water
PS70/006-1	03.06.07	13:26	67° 31.73'	9° 29.80’	327.8	JAGO	Hydrophon on Deck
PS70/006-1	03.06.07	13:46	67° 32.17'	9° 29.73’	407.1	JAGO	on Deck

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/006-1	03.06.07	14:31	67° 32.15'	9° 30.59’	364.7	JAGO	Hydrophon to Water
PS70/006-1	03.06.07	14:37	67° 32.29'	9° 30.57’	372.8	JAGO	Hydrphon on Deck
PS70/006-1	03.06.07	14:40	67° 32.36'	9° 30.54’	378.8	JAGO	Hydrophon to Water
PS70/006-1	03.06.07	14:55	67° 32.59'	9° 30.46’	407.6	JAGO	Hydrophon on Deck
PS70/006-1	03.06.07	16:01	67° 31.74'	9° 30.08’	336.2	JAGO	to Water
PS70/006-1	03.06.07	20:21	67° 31.82'	9° 30.77’	307.1	JAGO	on Deck
PS70/007-1	03.06.07	20:58	67° 32.67'	9° 27.98’	530.6	GC	surface
PS70/007-1	03.06.07	21:11	67° 32.64'	9° 28.05’	527.4	GC	at sea bottom
PS70/007-1	03.06.07	21:26	67° 32.59'	9° 28.27’	507.0	GC	on deck
PS70/007-2	03.06.07	21:42	67° 32.55'	9° 28.14’	521.0	GC	surface
PS70/007-2	03.06.07	21:54	67° 32.50'	9° 28.13’	517.7	GC	at sea bottom
PS70/007-2	03.06.07	22:08	67° 32.61'	9° 28.28’	505.3	GC	on deck
PS70/007-3	03.06.07	22:34	67° 32.80'	9° 27.58’	556.7	GC	surface
PS70/007-3	03.06.07	22:44	67° 32.83'	9° 27.51’	570.4	GC	at sea bottom
PS70/007-3	03.06.07	23:00	67° 32.86'	9° 27.54’	559.7	GC	on deck
PS70/008-1	03.06.07	23:32	67° 29.81'	9° 24.90’	286.6	HS_PS	start track
PS70/008-1	04.06.07	02:27	67° 20.81'	9° 2.13’	358.2	HS_PS	alter course
PS70/008-1	04.06.07	04:46	67° 30.03'	9° 25.51’	283.2	HS_PS	alter course
PS70/008-1	04.06.07	05:03	67° 31.27'	9° 24.22’	499.2	HS_PS	alter course
PS70/008-1	04.06.07	05:48	67° 29.36'	9° 17.40’	526.6	HS_PS	alter course
PS70/008-1	04.06.07	06:15	67° 31.00'	9° 22.16’	507.9	HS_PS	profile end
PS70/009-1	04.06.07	06:32	67° 30.52'	9° 25.25’	344.9	CTD	surface
PS70/009-1	04.06.07	06:52	67° 30.48'	9° 25.24’	337.0	CTD	at depth
PS70/009-1	04.06.07	07:03	67° 30.48'	9° 25.31’	326.3	CTD	on deck
PS70/009-2	04.06.07	07:12	67° 30.54'	9° 25.00’	354.7	JAGO	information
PS70/009-2	04.06.07	07:31	67° 30.50'	9° 25.13’	350.9	JAGO	to Water
PS70/009-2	04.06.07	08:03	67° 30.72'	9° 25.35’	362.8	JAGO	information
PS70/009-2	04.06.07	10:35	67° 30.47'	9° 25.67’	304.5	JAGO	information
PS70/009-2	04.06.07	11:07	67° 30.71'	9° 25.24’	370.5	JAGO	on Deck
PS70/009-3	04.06.07	11:30	67° 30.17'	9° 21.10’	479.7	HS_PS	start track
PS70/009-3	04.06.07	12:40	67° 26.40'	9° 8.70’	583.9	HS_PS	alter course
PS70/009-3	04.06.07	13:30	67° 29.22'	9° 17.18’	533.4	HS_PS	profile end
PS70/009-4	04.06.07	14:13	67° 30.23'	9° 25.36’	291.1	JAGO	to Water
PS70/009-4	04.06.07	14:40	67° 30.32'	9° 25.50’	291.1	JAGO	information
PS70/009-4	04.06.07	16:48	67° 30.63'	9° 25.85’	320.7	JAGO	information
PS70/009-4	04.06.07	16:55	67° 30.68'	9° 25.93’	330.0	JAGO	on Deck
PS70/009-5	04.06.07	17:12	67° 30.69'	9° 26.11’	327.6	CTD/RO	surface
PS70/009-5	04.06.07	17:28	67° 30.74'	9° 26.19’	325.2	CTD/RO	at depth
PS70/009-5	04.06.07	17:38	67° 30.78'	9° 26.27’	342.1	CTD/RO	on deck
PS70/010-1	05.06.07	07:26	69° 9.31'	12° 43.77’	2852.0	HS_PS	start track
PS70/010-1	05.06.07	08:33	69° 13.21'	13° 9.45’	2773.0	HS_PS	alter course
PS70/010-1	05.06.07	09:19	69° 17.11'	13° 26.25’	2716.0	HS_PS	alter course
PS70/010-1	05.06.07	09:31	69° 17.13'	13° 26.06’	2718.0	HS_PS	continue the profile
PS70/010-1	05.06.07	10:15	69° 13.27'	13° 9.81’	2767.0	HS_PS	alter course
PS70/010-1	05.06.07	10:27	69° 13.26'	13° 9.77’	2768.0	HS_PS	continue the profile
PS70/010-1	05.06.07	11:13	69° 16.96'	13° 25.61’	2722.0	HS_PS	profile break

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/010-1	05.06.07	11:51	69° 17.27'	13° 27.13'	2714.0	HS_PS	continue the profile
PS70/010-1	05.06.07	13:15	69° 13.27'	13° 9.78'	2771.0	HS_PS	alter course
PS70/010-1	05.06.07	13:29	69° 13.25'	13° 9.69'	2776.0	HS_PS	continue the profile
PS70/010-1	05.06.07	14:38	69° 15.96'	13° 20.84'	2743.0	HS_PS	Information
PS70/010-1	05.06.07	15:24	69° 16.10'	13° 21.90'	2744.0	HS_PS	continue the profile
PS70/010-1	05.06.07	15:28	69° 16.39'	13° 23.13'	2732.0	HS_PS	alter course
PS70/010-1	05.06.07	15:31	69° 16.23'	13° 23.91'	2729.0	HS_PS	continue the profile
PS70/010-1	05.06.07	17:00	69° 7.25'	13° 33.49'	1372.0	HS_PS	alter course
PS70/010-1	05.06.07	17:00	69° 7.25'	13° 33.49'	1372.0	HS_PS	continue the profile
PS70/010-1	05.06.07	17:31	69° 6.15'	13° 28.68'	1713.0	HS_PS	Information
PS70/010-1	05.06.07	18:05	69° 6.52'	13° 30.97'	1564.0	HS_PS	continue the profile
PS70/010-1	05.06.07	18:24	69° 7.59'	13° 34.60'	1358.0	HS_PS	alter course
PS70/010-1	05.06.07	19:40	69° 16.33'	13° 23.77'	2731.0	HS_PS	alter course
PS70/010-1	05.06.07	20:37	69° 22.81'	13° 11.83'	2825.0	HS_PS	profile end
PS70/011-1	06.06.07	17:25	69° 44.21'	16° 33.23'	935.9	GKG	surface
PS70/011-1	06.06.07	17:39	69° 44.21'	16° 33.28'	927.2	GKG	at sea bottom
PS70/011-1	06.06.07	18:00	69° 44.21'	16° 33.37'	914.1	GKG	on deck
PS70/011-2	06.06.07	18:13	69° 44.20'	16° 33.19'	941.1	GC	surface
PS70/011-2	06.06.07	18:29	69° 44.20'	16° 32.90'	991.2	GC	at sea bottom
PS70/011-2	06.06.07	18:50	69° 44.23'	16° 33.05'	973.1	GC	on deck
PS70/011-3	06.06.07	18:56	69° 44.24'	16° 33.07'	970.7	GC	surface
PS70/011-3	06.06.07	19:19	69° 44.21'	16° 33.27'	926.9	GC	at sea bottom
PS70/011-3	06.06.07	19:38	69° 44.21'	16° 33.23'	935.5	GC	on deck
PS70/012-1	07.06.07	04:00	69° 9.94'	13° 59.97'	1732.0	CTD/RO	surface
PS70/012-1	07.06.07	04:38	69° 9.61'	13° 59.64'	1657.0	CTD/RO	at depth
PS70/012-1	07.06.07	04:57	69° 9.47'	13° 59.45'	1580.0	CTD/RO	on deck
PS70/012-2	07.06.07	05:49	69° 7.25'	14° 1.40'	1271.0	HS_PS	start track
PS70/012-2	07.06.07	07:44	68° 57.82'	13° 58.49'	144.0	HS_PS	Information
PS70/012-2	07.06.07	07:59	68° 57.60'	13° 57.75'	130.4	HS_PS	continue the profile
PS70/012-2	07.06.07	08:40	68° 59.73'	14° 5.73'	213.8	HS_PS	alter course
PS70/012-2	07.06.07	09:18	68° 59.94'	14° 5.86'	212.1	HS_PS	alter course
PS70/012-2	07.06.07	10:02	68° 57.74'	13° 57.68'	132.3	HS_PS	profile end
PS70/012-3	07.06.07	10:27	68° 58.37'	14° 0.92'	190.3	VGRAB	to Water
PS70/012-3	07.06.07	10:39	68° 58.33'	14° 0.89'	188.1	VGRAB	at bottom
PS70/012-3	07.06.07	10:56	68° 58.26'	14° 0.58'	179.4	VGRAB	on Deck
PS70/012-4	07.06.07	11:05	68° 58.30'	14° 0.72'	184.5	VGRAB	to Water
PS70/012-4	07.06.07	11:13	68° 58.31'	14° 0.72'	183.3	VGRAB	at bottom
PS70/012-4	07.06.07	11:20	68° 58.32'	14° 0.78'	185.6	VGRAB	on Deck
PS70/012-5	07.06.07	11:35	68° 58.15'	14° 0.32'	171.9	VGRAB	to Water
PS70/012-5	07.06.07	11:44	68° 58.18'	14° 0.23'	170.7	VGRAB	at bottom
PS70/012-5	07.06.07	11:50	68° 58.17'	14° 0.23'	171.2	VGRAB	on Deck
PS70/012-6	07.06.07	12:05	68° 58.21'	13° 59.83'	166.3	VGRAB	to Water
PS70/012-6	07.06.07	12:12	68° 58.21'	13° 59.85'	167.0	VGRAB	at bottom
PS70/012-6	07.06.07	12:17	68° 58.20'	13° 59.79'	166.1	VGRAB	on Deck
PS70/012-7	07.06.07	12:57	69° 2.09'	13° 59.27'	197.3	VGRAB	to Water

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/012-7	07.06.07	13:07	69° 2.09'	13° 59.23'	197.8	VGRAB	at bottom
PS70/012-7	07.06.07	13:14	69° 2.09'	13° 59.14'	197.6	VGRAB	on Deck
PS70/012-8	07.06.07	13:31	69° 2.57'	13° 59.81'	214.3	VGRAB	to Water
PS70/012-8	07.06.07	13:40	69° 2.57'	13° 59.75'	213.8	VGRAB	at bottom
PS70/012-8	07.06.07	13:46	69° 2.58'	13° 59.73'	213.7	VGRAB	on Deck
PS70/012-9	07.06.07	14:07	69° 2.57'	13° 59.71'	214.9	JAGO	information
PS70/012-9	07.06.07	14:25	69° 2.51'	13° 59.84'	209.6	JAGO	to Water
PS70/012-9	07.06.07	14:30	69° 2.52'	13° 59.94'	212.6	JAGO	information
PS70/012-9	07.06.07	14:37	69° 2.51'	14° 0.16'	211.6	JAGO	information
PS70/012-9	07.06.07	14:51	69° 2.45'	14° 0.60'	207.4	JAGO	information
PS70/012-9	07.06.07	16:48	69° 2.28'	13° 59.87'	202.4	JAGO	information
PS70/012-9	07.06.07	17:04	69° 2.22'	13° 59.88'	202.8	JAGO	on Deck
PS70/012-9	07.06.07	17:08	69° 2.18'	13° 59.86'	201.8	JAGO	information
PS70/012-10	07.06.07	17:32	69° 3.63'	14° 0.32'	405.3	HS_PS	start track
PS70/012-10	07.06.07	18:43	69° 6.94'	14° 14.27'	735.3	HS_PS	alter course
PS70/012-10	07.06.07	18:56	69° 7.16'	14° 12.49'	946.2	HS_PS	continue the profile
PS70/012-10	07.06.07	20:41	69° 2.37'	13° 50.96'	93.3	HS_PS	alter course
PS70/012-10	07.06.07	20:49	69° 2.62'	13° 50.26'	109.9	HS_PS	continue the profile
PS70/012-10	07.06.07	22:38	69° 7.81'	14° 11.99'	1020.0	HS_PS	alter course
PS70/012-10	07.06.07	22:54	69° 8.56'	14° 11.02'	1098.0	HS_PS	continue the profile
PS70/012-10	08.06.07	00:55	69° 2.66'	13° 49.59'	130.3	HS_PS	alter course
PS70/012-10	08.06.07	01:04	69° 2.92'	13° 48.85'	179.5	HS_PS	continue the profile
PS70/012-10	08.06.07	03:03	69° 9.41'	14° 9.80'	914.7	HS_PS	profile break
PS70/012-10	08.06.07	03:31	69° 6.56'	14° 14.58'	703.1	HS_PS	continue the profile
PS70/012-10	08.06.07	04:31	69° 3.90'	14° 2.70'	424.5	HS_PS	alter course
PS70/012-10	08.06.07	04:45	69° 3.82'	13° 59.46'	458.4	HS_PS	continue the profile
PS70/012-10	08.06.07	05:12	69° 2.67'	13° 54.53'	178.8	HS_PS	alter course
PS70/012-10	08.06.07	05:20	69° 2.74'	13° 55.92'	229.7	HS_PS	continue the profile
PS70/012-10	08.06.07	05:40	69° 3.58'	13° 59.95'	398.2	HS_PS	alter course
PS70/012-10	08.06.07	05:51	69° 3.58'	14° 2.37'	376.1	HS_PS	alter course
PS70/012-10	08.06.07	06:08	69° 2.02'	13° 58.77'	194.8	HS_PS	profile end
PS70/013-1	08.06.07	21:03	67° 30.13'	9° 25.02'	291.6	JAGO	information
PS70/013-1	08.06.07	21:20	67° 30.07'	9° 24.50'	314.7	JAGO	to Water
PS70/013-1	08.06.07	21:49	67° 30.06'	9° 24.60'	296.0	JAGO	information
PS70/013-1	08.06.07	21:58	67° 30.04'	9° 24.58'	294.0	JAGO	information
PS70/013-1	08.06.07	22:16	67° 30.03'	9° 24.53'	293.2	JAGO	information
PS70/013-1	09.06.07	00:13	67° 30.24'	9° 24.47'	327.0	JAGO	information
PS70/013-1	09.06.07	00:29	67° 30.26'	9° 24.47'	330.9	JAGO	information
PS70/013-1	09.06.07	00:40	67° 30.23'	9° 24.58'	328.7	JAGO	on Deck
PS70/013-1	09.06.07	00:44	67° 30.26'	9° 24.51'	327.7	JAGO	information
PS70/013-2	09.06.07	01:05	67° 30.60'	9° 25.38'	349.7	VGRAB	to Water
PS70/013-2	09.06.07	01:19	67° 30.60'	9° 25.40'	351.3	VGRAB	at bottom
PS70/013-2	09.06.07	01:28	67° 30.61'	9° 25.43'	349.4	VGRAB	on Deck
PS70/013-3	09.06.07	01:36	67° 30.54'	9° 25.33'	345.9	VGRAB	to Water
PS70/013-3	09.06.07	01:48	67° 30.54'	9° 25.34'	345.4	VGRAB	at bottom

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/013-3	09.06.07	01:57	67° 30.54'	9° 25.34'	345.2	VGRAB	on Deck
PS70/013-4	09.06.07	02:04	67° 30.50'	9° 25.26'	340.9	VGRAB	to Water
PS70/013-4	09.06.07	02:16	67° 30.49'	9° 25.23'	340.8	VGRAB	at bottom
PS70/013-4	09.06.07	02:24	67° 30.50'	9° 25.36'	334.9	VGRAB	on Deck
PS70/013-5	09.06.07	02:30	67° 30.49'	9° 25.42'	330.6	VGRAB	to Water
PS70/013-5	09.06.07	02:41	67° 30.49'	9° 25.42'	330.0	VGRAB	at bottom
PS70/013-5	09.06.07	02:48	67° 30.48'	9° 25.41'	333.5	VGRAB	on Deck
PS70/013-6	09.06.07	02:52	67° 30.48'	9° 25.39'	332.6	VGRAB	to Water
PS70/013-6	09.06.07	03:05	67° 30.48'	9° 25.38'	332.2	VGRAB	at bottom
PS70/013-6	09.06.07	03:12	67° 30.46'	9° 25.37'	330.3	VGRAB	on Deck
PS70/013-7	09.06.07	03:21	67° 30.46'	9° 25.34'	330.9	VGRAB	to Water
PS70/013-7	09.06.07	03:31	67° 30.47'	9° 25.32'	327.6	VGRAB	at bottom
PS70/013-7	09.06.07	03:39	67° 30.47'	9° 25.32'	328.9	VGRAB	on Deck
PS70/013-8	09.06.07	03:43	67° 30.47'	9° 25.41'	334.2	VGRAB	to Water
PS70/013-8	09.06.07	03:54	67° 30.46'	9° 25.42'	331.7	VGRAB	at bottom
PS70/013-8	09.06.07	04:01	67° 30.44'	9° 25.37'	333.2	VGRAB	on Deck
PS70/013-9	09.06.07	04:06	67° 30.46'	9° 25.42'	333.0	VGRAB	to Water
PS70/013-9	09.06.07	04:17	67° 30.47'	9° 25.43'	333.3	VGRAB	at bottom
PS70/013-9	09.06.07	04:25	67° 30.46'	9° 25.40'	335.5	VGRAB	on Deck
PS70/013-10	09.06.07	04:37	67° 30.45'	9° 25.38'	334.3	VGRAB	to Water
PS70/013-10	09.06.07	04:47	67° 30.45'	9° 25.38'	334.3	VGRAB	at bottom
PS70/013-10	09.06.07	04:54	67° 30.45'	9° 25.37'	334.9	VGRAB	on Deck
PS70/013-11	09.06.07	05:02	67° 30.43'	9° 25.35'	333.2	VGRAB	to Water
PS70/013-11	09.06.07	05:14	67° 30.43'	9° 25.35'	333.7	VGRAB	at bottom
PS70/013-11	09.06.07	05:21	67° 30.44'	9° 25.33'	329.3	VGRAB	on Deck
PS70/014-1	09.06.07	05:49	67° 31.12'	9° 23.21'	484.3	CTD/RO	surface
PS70/014-1	09.06.07	06:13	67° 31.18'	9° 23.22'	490.1	CTD/RO	at depth
PS70/014-1	09.06.07	06:27	67° 31.23'	9° 23.14'	497.9	CTD/RO	on deck
PS70/014-2	09.06.07	06:45	67° 30.38'	9° 23.67'	386.4	CTD	surface
PS70/014-2	09.06.07	07:06	67° 30.45'	9° 23.69'	390.6	CTD	at depth
PS70/014-2	09.06.07	07:15	67° 30.46'	9° 23.70'	389.7	CTD	on deck
PS70/014-3	09.06.07	07:34	67° 29.68'	9° 24.14'	287.8	CTD	surface
PS70/014-3	09.06.07	07:50	67° 29.75'	9° 24.20'	288.7	CTD	at depth
PS70/014-3	09.06.07	07:59	67° 29.80'	9° 24.21'	290.8	CTD	on deck
PS70/014-4	09.06.07	08:37	67° 29.88'	9° 24.30'	290.7	JAGO	information
PS70/014-4	09.06.07	08:43	67° 29.91'	9° 24.33'	293.1	JAGO	to Water
PS70/014-4	09.06.07	09:06	67° 29.91'	9° 24.31'	293.4	JAGO	information
PS70/014-4	09.06.07	11:32	67° 30.05'	9° 24.17'	315.6	JAGO	information
PS70/014-4	09.06.07	11:53	67° 30.00'	9° 24.29'	296.2	JAGO	information
PS70/014-4	09.06.07	12:00	67° 29.99'	9° 24.16'	306.2	JAGO	on Deck
PS70/014-4	09.06.07	12:04	67° 29.98'	9° 24.01'	316.7	JAGO	on Deck
PS70/014-5	09.06.07	12:23	67° 30.53'	9° 25.35'	343.6	GKG	surface
PS70/014-5	09.06.07	12:32	67° 30.53'	9° 25.36'	344.0	GKG	at sea bottom
PS70/014-5	09.06.07	12:43	67° 30.51'	9° 25.35'	340.5	GKG	on deck
PS70/014-6	09.06.07	13:03	67° 30.47'	9° 25.39'	329.3	GKG	surface
PS70/014-6	09.06.07	13:10	67° 30.48'	9° 25.39'	329.9	GKG	at sea bottom
PS70/014-6	09.06.07	13:20	67° 30.49'	9° 25.37'	331.3	GKG	on deck
PS70/014-7	09.06.07	14:07	67° 30.52'	9° 25.35'	343.5	GC	surface
PS70/014-7	09.06.07	14:08	67° 30.52'	9° 25.36'	342.2	GC	at sea bottom
PS70/014-7	09.06.07	14:28	67° 30.52'	9° 25.33'	343.9	GC	on deck
PS70/014-8	09.06.07	14:39	67° 30.52'	9° 25.40'	341.9	GC	surface

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/014-8	09.06.07	14:46	67° 30.52'	9° 25.34'	342.2	GC	at sea bottom
PS70/014-8	09.06.07	14:58	67° 30.51'	9° 25.34'	341.7	GC	on deck
PS70/014-9	09.06.07	15:21	67° 30.47'	9° 25.42'	330.5	GC	surface
PS70/014-9	09.06.07	15:28	67° 30.48'	9° 25.39'	332.1	GC	at sea bottom
PS70/014-9	09.06.07	15:39	67° 30.46'	9° 25.41'	333.8	GC	on deck
PS70/014-10	09.06.07	15:47	67° 30.47'	9° 25.41'	330.8	GC	surface
PS70/014-10	09.06.07	15:54	67° 30.48'	9° 25.40'	330.1	GC	at sea bottom
PS70/014-10	09.06.07	16:02	67° 30.47'	9° 25.45'	330.8	GC	on deck
PS70/015-1	09.06.07	16:27	67° 30.01'	9° 25.35'	286.0	JAGO	to Water
PS70/015-1	09.06.07	16:54	67° 30.03'	9° 25.04'	286.8	JAGO	information
PS70/015-1	09.06.07	19:00	67° 30.08'	9° 24.35'	310.4	JAGO	information
PS70/015-1	09.06.07	19:09	67° 30.05'	9° 24.39'	319.6	JAGO	information
PS70/015-1	09.06.07	19:55	67° 30.35'	9° 25.27'	309.8	JAGO	information
PS70/015-1	09.06.07	20:16	67° 30.40'	9° 25.46'	303.3	JAGO	information
PS70/015-1	09.06.07	20:29	67° 30.39'	9° 25.37'	303.6	JAGO	on Deck
PS70/015-1	09.06.07	20:31	67° 30.39'	9° 25.35'	306.2	JAGO	information
PS70/015-2	09.06.07	20:48	67° 30.41'	9° 25.39'	310.6	GC	surface
PS70/015-2	09.06.07	20:57	67° 30.44'	9° 25.40'	330.4	GC	at sea bottom
PS70/015-2	09.06.07	21:09	67° 30.44'	9° 25.38'	332.7	GC	on deck
PS70/015-3	09.06.07	21:17	67° 30.45'	9° 25.39'	331.4	GC	surface
PS70/015-3	09.06.07	21:28	67° 30.46'	9° 25.39'	332.0	GC	at sea bottom
PS70/015-3	09.06.07	21:40	67° 30.45'	9° 25.34'	330.7	GC	on deck
PS70/015-4	09.06.07	21:58	67° 30.44'	9° 25.44'	329.5	GC	surface
PS70/015-4	09.06.07	22:07	67° 30.45'	9° 25.42'	331.2	GC	at sea bottom
PS70/015-4	09.06.07	22:19	67° 30.45'	9° 25.35'	331.8	GC	on deck
PS70/015-5	09.06.07	23:20	67° 31.12'	9° 24.74'	463.3	FLS	Start Track
PS70/015-5	09.06.07	23:35	67° 30.20'	9° 27.11'	276.2	FLS	Course Change
PS70/015-5	09.06.07	23:45	67° 30.10'	9° 27.01'	278.6	FLS	
PS70/015-5	09.06.07	23:59	67° 31.01'	9° 24.59'	441.0	FLS	Course Change
PS70/015-5	10.06.07	00:14	67° 31.02'	9° 24.16'	465.9	FLS	
PS70/015-5	10.06.07	00:30	67° 30.07'	9° 26.53'	284.2	FLS	End of Track
PS70/015-6	10.06.07	01:10	67° 32.35'	9° 27.82'	523.7	HS_PS	start track
PS70/015-6	10.06.07	01:39	67° 30.72'	9° 23.11'	452.8	HS_PS	alter course
PS70/015-6	10.06.07	01:51	67° 30.99'	9° 22.27'	505.2	HS_PS	continue the profile
PS70/015-6	10.06.07	03:00	67° 34.88'	9° 33.53'	394.2	HS_PS	alter course
PS70/015-6	10.06.07	03:09	67° 34.67'	9° 34.06'	362.3	HS_PS	continue the profile
PS70/015-6	10.06.07	03:56	67° 31.92'	9° 26.95'	503.9	HS_PS	alter course
PS70/015-6	10.06.07	04:03	67° 31.90'	9° 28.02'	437.8	HS_PS	continue the profile
PS70/015-6	10.06.07	04:44	67° 34.40'	9° 34.53'	329.3	HS_PS	alter course
PS70/015-6	10.06.07	04:57	67° 34.21'	9° 35.04'	301.6	HS_PS	continue the profile
PS70/015-6	10.06.07	05:24	67° 32.49'	9° 31.01'	346.7	HS_PS	alter course
PS70/015-6	10.06.07	05:33	67° 32.18'	9° 32.15'	270.9	HS_PS	continue the profile
PS70/015-6	10.06.07	05:48	67° 33.07'	9° 34.63'	266.0	HS_PS	profile end
PS70/016-1	10.06.07	06:34	67° 30.42'	9° 26.32'	282.5	JAGO	information
PS70/016-1	10.06.07	06:49	67° 30.75'	9° 26.46'	322.1	JAGO	to Water
PS70/016-1	10.06.07	07:17	67° 30.82'	9° 26.70'	336.4	JAGO	information

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/016-1	10.06.07	10:22	67° 30.84'	9° 26.48’	352.4	JAGO	information
PS70/016-1	10.06.07	10:27	67° 30.84'	9° 26.50’	349.0	JAGO	on Deck
PS70/016-1	10.06.07	10:32	67° 30.84'	9° 26.56’	350.8	JAGO	on Deck
PS70/016-2	10.06.07	11:06	67° 31.88'	9° 26.01’	498.4	HS_PS	start track
PS70/016-2	10.06.07	11:20	67° 30.87'	9° 27.67’	285.0	HS_PS	profile end
PS70/016-3	10.06.07	11:46	67° 31.88'	9° 26.00’	496.6	CTD/RO	surface
PS70/016-3	10.06.07	12:07	67° 31.88'	9° 26.04’	495.9	CTD/RO	at depth
PS70/016-3	10.06.07	12:20	67° 31.90'	9° 26.10’	503.5	CTD/RO	on deck
PS70/016-4	10.06.07	12:37	67° 31.61'	9° 26.46’	455.5	CTD/RO	surface
PS70/016-4	10.06.07	12:56	67° 31.61'	9° 26.54’	453.0	CTD/RO	at depth
PS70/016-4	10.06.07	13:06	67° 31.62'	9° 26.54’	451.6	CTD/RO	on deck
PS70/016-5	10.06.07	13:35	67° 30.80'	9° 27.87’	279.3	CTD/RO	surface
PS70/016-5	10.06.07	13:48	67° 30.80'	9° 27.81’	280.4	CTD/RO	at depth
PS70/016-5	10.06.07	13:56	67° 30.80'	9° 27.79’	280.4	CTD/RO	on deck
PS70/017-1	10.06.07	14:09	67° 31.25'	9° 28.45’	351.8	JAGO	information
PS70/017-1	10.06.07	14:18	67° 31.25'	9° 28.45’	352.1	JAGO	information
PS70/017-1	10.06.07	14:26	67° 31.19'	9° 28.41’	344.0	JAGO	to Water
PS70/017-1	10.06.07	14:51	67° 31.22'	9° 28.43’	341.0	JAGO	information
PS70/017-1	10.06.07	14:53	67° 31.22'	9° 28.44’	341.8	JAGO	information
PS70/017-1	10.06.07	18:12	67° 31.17'	9° 28.72’	324.4	JAGO	information
PS70/017-1	10.06.07	18:32	67° 31.07'	9° 28.48’	327.8	JAGO	information
PS70/017-1	10.06.07	18:47	67° 31.06'	9° 28.45’	321.8	JAGO	on Deck
PS70/017-1	10.06.07	18:51	67° 31.08'	9° 28.54’	321.9	JAGO	information
PS70/017-2	10.06.07	19:19	67° 31.88'	9° 25.97’	499.0	VIDEO	in water
PS70/017-2	10.06.07	20:09	67° 31.91'	9° 25.97’	502.2	VIDEO	in water
PS70/017-2	10.06.07	20:23	67° 31.88'	9° 26.05’	497.3	VIDEO	start profile
PS70/017-2	10.06.07	20:39	67° 31.80'	9° 26.06’	490.7	VIDEO	on deck
PS70/017-3	10.06.07	21:05	67° 31.88'	9° 25.97’	498.0	VGRAB	to Water
PS70/017-3	10.06.07	21:24	67° 31.89'	9° 26.02’	499.3	VGRAB	at bottom
PS70/017-3	10.06.07	21:38	67° 31.89'	9° 26.13’	504.4	VGRAB	on Deck
PS70/017-4	10.06.07	21:42	67° 31.90'	9° 26.12’	504.6	VGRAB	to Water
PS70/017-4	10.06.07	21:58	67° 31.91'	9° 25.94’	502.6	VGRAB	at bottom
PS70/017-4	10.06.07	22:14	67° 31.90'	9° 25.99’	500.2	VGRAB	on Deck
PS70/017-5	10.06.07	22:40	67° 31.47'	9° 22.17’	524.9	HS_PS	start track
PS70/017-5	10.06.07	23:30	67° 34.77'	9° 14.88’	910.5	HS_PS	alter course
PS70/017-5	10.06.07	23:55	67° 34.51'	9° 17.91’	890.7	HS_PS	continue the profile
PS70/017-5	11.06.07	00:58	67° 30.61'	9° 18.26’	565.0	HS_PS	alter course
PS70/017-5	11.06.07	01:05	67° 30.44'	9° 18.92’	538.6	HS_PS	continue the profile
PS70/017-5	11.06.07	02:16	67° 34.44'	9° 30.89’	480.8	HS_PS	alter course
PS70/017-5	11.06.07	02:27	67° 34.64'	9° 30.13’	536.3	HS_PS	continue the profile
PS70/017-5	11.06.07	03:41	67° 30.78'	9° 17.45’	600.0	HS_PS	alter course
PS70/017-5	11.06.07	03:56	67° 31.36'	9° 17.37’	626.0	HS_PS	continue the profile
PS70/017-5	11.06.07	05:05	67° 35.01'	9° 29.46’	579.3	HS_PS	alter course
PS70/017-5	11.06.07	05:08	67° 35.07'	9° 30.00’	564.9	HS_PS	continue the profile
PS70/017-5	11.06.07	05:21	67° 34.58'	9° 32.46’	460.5	HS_PS	profile end
PS70/018-1	11.06.07	06:06	67° 31.75'	9° 31.08’	272.5	MOORST	surface
PS70/018-1	11.06.07	06:10	67° 31.75'	9° 31.06’	273.8	MOORST	at depth

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/018-1	11.06.07	06:16	67° 31.74'	9° 31.07'	272.3	MOORST	action
PS70/019-1	11.06.07	07:06	67° 30.79'	9° 27.81'	280.9	VGRAB	to Water
PS70/019-1	11.06.07	07:14	67° 30.78'	9° 27.80'	280.9	VGRAB	at bottom
PS70/019-1	11.06.07	07:21	67° 30.79'	9° 27.77'	281.0	VGRAB	on Deck
PS70/019-2	11.06.07	07:49	67° 31.07'	9° 27.40'	339.6	VGRAB	to Water
PS70/019-2	11.06.07	08:01	67° 31.03'	9° 27.47'	323.0	VGRAB	at bottom
PS70/019-2	11.06.07	08:13	67° 30.99'	9° 27.51'	316.8	VGRAB	on Deck
PS70/019-3	11.06.07	08:21	67° 30.85'	9° 27.70'	284.1	VIDEO	in water
PS70/019-3	11.06.07	08:35	67° 30.89'	9° 27.67'	291.3	VIDEO	start profile
PS70/019-3	11.06.07	09:30	67° 31.20'	9° 27.19'	356.1	VIDEO	end profile
PS70/019-3	11.06.07	09:45	67° 31.25'	9° 27.07'	368.8	VIDEO	on deck
PS70/019-4	11.06.07	09:55	67° 31.07'	9° 27.66'	329.0	VGRAB	to Water
PS70/019-4	11.06.07	10:08	67° 31.04'	9° 27.56'	325.0	VGRAB	at bottom
PS70/019-4	11.06.07	10:17	67° 31.03'	9° 27.48'	323.4	VGRAB	on Deck
PS70/019-4	11.06.07	10:27	67° 31.03'	9° 27.57'	324.0	VGRAB	at bottom
PS70/019-4	11.06.07	10:33	67° 31.02'	9° 27.53'	322.7	VGRAB	on Deck
PS70/019-5	11.06.07	10:53	67° 31.20'	9° 27.18'	356.5	VIDEO	in water
PS70/019-5	11.06.07	11:09	67° 31.21'	9° 27.19'	357.1	VIDEO	start profile
PS70/019-5	11.06.07	12:25	67° 31.58'	9° 26.52'	451.4	VIDEO	end profile
PS70/019-5	11.06.07	12:40	67° 31.57'	9° 26.53'	448.7	VIDEO	on deck
PS70/019-6	11.06.07	12:53	67° 31.50'	9° 26.68'	431.3	VGRAB	to Water
PS70/019-6	11.06.07	13:17	67° 31.51'	9° 26.67'	432.5	VGRAB	at bottom
PS70/019-6	11.06.07	13:35	67° 31.50'	9° 26.74'	430.3	VGRAB	on Deck
PS70/019-7	11.06.07	13:38	67° 31.51'	9° 26.75'	429.8	VGRAB	to Water
PS70/019-7	11.06.07	13:53	67° 31.52'	9° 26.67'	434.1	VGRAB	at bottom
PS70/019-7	11.06.07	14:04	67° 31.52'	9° 26.66'	433.6	VGRAB	on Deck
PS70/019-8	11.06.07	14:23	67° 31.40'	9° 26.78'	403.4	VGRAB	to Water
PS70/019-8	11.06.07	14:39	67° 31.40'	9° 26.80'	402.7	VGRAB	at bottom
PS70/019-8	11.06.07	14:48	67° 31.41'	9° 26.80'	403.8	VGRAB	on Deck
PS70/019-9	11.06.07	15:22	67° 31.05'	9° 27.51'	328.9	VGRAB	to Water
PS70/019-9	11.06.07	15:35	67° 31.05'	9° 27.51'	326.1	VGRAB	at bottom
PS70/019-9	11.06.07	15:43	67° 31.05'	9° 27.52'	326.9	VGRAB	on Deck
PS70/019-10	11.06.07	16:07	67° 31.57'	9° 26.46'	450.7	VIDEO	in water
PS70/019-10	11.06.07	16:25	67° 31.56'	9° 26.49'	448.5	VIDEO	start profile
PS70/019-10	11.06.07	16:47	67° 31.67'	9° 26.37'	465.1	VIDEO	end profile
PS70/019-10	11.06.07	16:58	67° 31.69'	9° 26.33'	469.7	VIDEO	on deck
PS70/018-1	11.06.07	17:48	67° 31.73'	9° 31.04'	273.7	MOORST	on deck
PS70/019-11	11.06.07	18:17	67° 31.64'	9° 25.97'	493.8	VGRAB	to Water
PS70/019-11	11.06.07	18:35	67° 31.69'	9° 26.01'	495.9	VGRAB	at bottom
PS70/019-11	11.06.07	18:57	67° 31.53'	9° 27.52'	419.2	VGRAB	on Deck
PS70/020-1	11.06.07	19:13	67° 31.83'	9° 30.64'	332.2	VIDEO	in water
PS70/020-1	11.06.07	19:30	67° 31.89'	9° 30.60'	350.5	VIDEO	start profile
PS70/020-1	11.06.07	20:43	67° 31.61'	9° 29.72'	319.8	VIDEO	end profile
PS70/020-1	11.06.07	20:52	67° 31.64'	9° 29.73'	330.3	VIDEO	on deck
PS70/021-1	11.06.07	21:18	67° 33.40'	9° 34.13'	310.8	HS_PS	start track
PS70/021-1	11.06.07	22:31	67° 37.62'	9° 46.36'	240.4	HS_PS	alter course
PS70/021-1	11.06.07	22:38	67° 37.84'	9° 46.15'	246.4	HS_PS	continue the profile
PS70/021-1	12.06.07	00:01	67° 33.77'	9° 34.30'	303.7	HS_PS	alter course
PS70/021-1	12.06.07	00:11	67° 33.93'	9° 33.95'	352.0	HS_PS	continue the profile

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/021-1	12.06.07	01:21	67° 37.92'	9° 45.70'	255.8	HS_PS	alter course
PS70/021-1	12.06.07	01:39	67° 38.10'	9° 45.43'	272.7	HS_PS	continue the profile
PS70/021-1	12.06.07	02:44	67° 34.56'	9° 34.81'	331.6	HS_PS	alter course
PS70/021-1	12.06.07	02:55	67° 34.72'	9° 34.40'	357.1	HS_PS	continue the profile
PS70/021-1	12.06.07	03:57	67° 38.19'	9° 44.95'	295.9	HS_PS	alter course
PS70/021-1	12.06.07	04:06	67° 38.35'	9° 44.51'	315.7	HS_PS	continue the profile
PS70/021-1	12.06.07	05:07	67° 34.95'	9° 33.80'	387.1	HS_PS	alter course
PS70/021-1	12.06.07	05:17	67° 35.12'	9° 33.19'	424.2	HS_PS	continue the profile
PS70/021-1	12.06.07	06:21	67° 38.62'	9° 44.33'	336.8	HS_PS	profile end
PS70/022-1	12.06.07	07:45	67° 31.89'	9° 30.60'	350.8	VIDEO	in water
PS70/022-1	12.06.07	07:57	67° 31.95'	9° 30.50'	357.7	VIDEO	on deck
PS70/022-1	12.06.07	08:00	67° 31.95'	9° 30.49'	354.9	VIDEO	in water
PS70/022-1	12.06.07	08:14	67° 31.89'	9° 30.44'	354.0	VIDEO	start profile
PS70/022-1	12.06.07	09:11	67° 31.60'	9° 29.82'	316.7	VIDEO	end profile
PS70/022-1	12.06.07	09:22	67° 31.62'	9° 29.82'	317.3	VIDEO	on deck
PS70/022-2	12.06.07	09:29	67° 31.61'	9° 29.83'	311.0	VGRAB	to Water
PS70/022-2	12.06.07	09:41	67° 31.63'	9° 29.83'	313.1	VGRAB	at bottom
PS70/022-2	12.06.07	09:48	67° 31.66'	9° 29.84'	321.4	VGRAB	on Deck
PS70/022-2	12.06.07	09:50	67° 31.66'	9° 29.84'	327.1	VGRAB	to Water
PS70/022-2	12.06.07	10:02	67° 31.63'	9° 29.82'	313.8	VGRAB	at bottom
PS70/022-2	12.06.07	10:09	67° 31.61'	9° 29.87'	317.7	VGRAB	on Deck
PS70/022-3	12.06.07	10:26	67° 31.74'	9° 30.26'	328.7	VGRAB	to Water
PS70/022-3	12.06.07	10:39	67° 31.77'	9° 30.21'	338.0	VGRAB	at bottom
PS70/022-3	12.06.07	10:47	67° 31.75'	9° 30.18'	335.8	VGRAB	on Deck
PS70/022-3	12.06.07	10:47	67° 31.75'	9° 30.18'	335.8	VGRAB	to Water
PS70/022-3	12.06.07	10:58	67° 31.77'	9° 30.19'	340.7	VGRAB	at bottom
PS70/022-3	12.06.07	11:07	67° 31.75'	9° 30.23'	334.3	VGRAB	on Deck
PS70/022-4	12.06.07	11:26	67° 31.20'	9° 28.39'	347.3	CTD/RO	surface
PS70/022-4	12.06.07	11:46	67° 31.22'	9° 28.46'	342.6	CTD/RO	at depth
PS70/022-4	12.06.07	12:02	67° 31.25'	9° 28.44'	353.8	CTD/RO	on deck
PS70/023-1	12.06.07	17:47	66° 58.14'	11° 7.91'	327.2	VIDEO	in water
PS70/023-1	12.06.07	18:04	66° 58.18'	11° 7.85'	326.6	VIDEO	start profile
PS70/023-1	12.06.07	19:14	66° 58.24'	11° 7.36'	321.5	VIDEO	end profile
PS70/023-1	12.06.07	19:21	66° 58.25'	11° 7.29'	320.0	VIDEO	on deck
PS70/023-2	12.06.07	19:43	66° 58.20'	11° 7.81'	327.0	CTD/RO	surface
PS70/023-2	12.06.07	20:01	66° 58.15'	11° 7.69'	325.5	CTD/RO	at depth
PS70/023-2	12.06.07	20:13	66° 58.10'	11° 7.56'	324.2	CTD/RO	on deck
PS70/023-3	12.06.07	20:24	66° 58.12'	11° 7.79'	327.3	VGRAB	to Water
PS70/023-3	12.06.07	20:37	66° 58.11'	11° 7.79'	328.0	VGRAB	at bottom
PS70/023-3	12.06.07	20:45	66° 58.14'	11° 7.79'	326.8	VGRAB	on Deck
PS70/023-4	12.06.07	20:49	66° 58.15'	11° 7.77'	327.3	VGRAB	to Water
PS70/023-4	12.06.07	21:02	66° 58.14'	11° 7.80'	326.6	VGRAB	at bottom
PS70/023-4	12.06.07	21:13	66° 58.19'	11° 7.73'	326.5	VGRAB	on Deck
PS70/023-5	12.06.07	21:19	66° 58.06'	11° 7.47'	322.9	VGRAB	to Water
PS70/023-5	12.06.07	21:32	66° 58.08'	11° 7.46'	324.2	VGRAB	at bottom
PS70/023-5	12.06.07	21:40	66° 58.06'	11° 7.39'	322.4	VGRAB	on Deck
PS70/023-6	12.06.07	21:58	66° 58.00'	11° 7.94'	327.9	VIDEO	in water

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/023-6	12.06.07	22:14	66° 58.03'	11° 7.98'	328.3	VIDEO	start profile
PS70/023-6	12.06.07	23:28	66° 58.32'	11° 7.77'	323.1	VIDEO	end profile
PS70/023-6	12.06.07	23:40	66° 58.30'	11° 7.80'	324.9	VIDEO	on deck
PS70/023-7	12.06.07	23:46	66° 58.29'	11° 7.53'	322.0	VGRAB	to Water
PS70/023-7	12.06.07	23:57	66° 58.29'	11° 7.52'	323.5	VGRAB	at bottom
PS70/023-7	13.06.07	00:06	66° 58.28'	11° 7.59'	322.9	VGRAB	on Deck
PS70/023-8	13.06.07	00:16	66° 58.23'	11° 7.25'	320.7	VGRAB	to Water
PS70/023-8	13.06.07	00:27	66° 58.23'	11° 7.22'	319.5	VGRAB	at bottom
PS70/023-8	13.06.07	00:35	66° 58.23'	11° 7.23'	319.1	VGRAB	on Deck
PS70/023-9	13.06.07	00:46	66° 58.18'	11° 7.33'	318.5	VGRAB	to Water
PS70/023-9	13.06.07	01:01	66° 58.18'	11° 7.33'	320.6	VGRAB	at bottom
PS70/023-9	13.06.07	01:09	66° 58.18'	11° 7.33'	319.2	VGRAB	on Deck
PS70/023-10	13.06.07	01:52	66° 58.00'	11° 5.91'	308.9	HS_PS	start track
PS70/023-10	13.06.07	02:02	66° 58.00'	11° 8.19'	329.2	HS_PS	alter course
PS70/023-10	13.06.07	02:09	66° 58.25'	11° 8.09'	328.9	HS_PS	continue the profile
PS70/023-10	13.06.07	02:28	66° 58.24'	11° 3.89'	294.1	HS_PS	alter course
PS70/023-10	13.06.07	02:35	66° 58.47'	11° 3.97'	290.4	HS_PS	continue the profile
PS70/023-10	13.06.07	03:04	66° 58.47'	11° 9.94'	325.3	HS_PS	alter course
PS70/023-10	13.06.07	03:11	66° 58.71'	11° 9.97'	304.0	HS_PS	continue the profile
PS70/023-10	13.06.07	03:40	66° 58.71'	11° 3.92'	290.0	HS_PS	profile end
PS70/023-11	13.06.07	04:12	66° 58.26'	11° 6.77'	309.9	VIDEO	in water
PS70/023-11	13.06.07	04:26	66° 58.28'	11° 6.79'	309.0	VIDEO	start profile
PS70/023-11	13.06.07	05:27	66° 58.70'	11° 6.28'	285.3	VIDEO	end profile
PS70/023-11	13.06.07	05:34	66° 58.72'	11° 6.26'	285.0	VIDEO	on deck
PS70/023-12	13.06.07	06:25	66° 58.11'	11° 7.83'	326.4	GC	surface
PS70/023-12	13.06.07	06:33	66° 58.12'	11° 7.82'	324.7	GC	at sea bottom
PS70/023-12	13.06.07	06:44	66° 58.08'	11° 7.75'	326.1	GC	on deck
PS70/023-13	13.06.07	06:50	66° 58.17'	11° 7.82'	327.3	GC	surface
PS70/023-13	13.06.07	07:00	66° 58.14'	11° 7.80'	326.6	GC	at sea bottom
PS70/023-13	13.06.07	07:12	66° 58.16'	11° 7.75'	326.5	GC	on deck
PS70/023-14	13.06.07	07:22	66° 58.17'	11° 7.87'	327.3	GC	surface
PS70/023-14	13.06.07	07:32	66° 58.13'	11° 7.82'	324.0	GC	at sea bottom
PS70/023-14	13.06.07	07:39	66° 58.11'	11° 7.77'	326.0	GC	on deck
PS70/023-15	13.06.07	07:51	66° 58.24'	11° 7.82'	327.2	GC	surface
PS70/023-15	13.06.07	07:58	66° 58.22'	11° 7.82'	326.4	GC	at sea bottom
PS70/023-15	13.06.07	08:06	66° 58.21'	11° 7.77'	326.1	GC	on deck
PS70/023-16	13.06.07	08:26	66° 58.20'	11° 7.84'	327.1	GC	surface
PS70/023-16	13.06.07	08:36	66° 58.20'	11° 7.82'	327.0	GC	at sea bottom
PS70/023-16	13.06.07	08:46	66° 58.24'	11° 7.80'	326.3	GC	on deck
PS70/023-17	13.06.07	08:55	66° 58.19'	11° 7.81'	326.4	GC	surface
PS70/023-17	13.06.07	09:08	66° 58.21'	11° 7.82'	327.1	GC	at sea bottom
PS70/023-17	13.06.07	09:16	66° 58.22'	11° 7.80'	327.0	GC	on deck
PS70/023-18	13.06.07	09:31	66° 58.13'	11° 7.81'	324.2	GC	surface
PS70/023-18	13.06.07	09:42	66° 58.16'	11° 7.80'	327.4	GC	at sea bottom
PS70/023-18	13.06.07	09:52	66° 58.16'	11° 7.75'	327.2	GC	on deck
PS70/023-19	13.06.07	10:16	66° 58.17'	11° 7.75'	326.8	GC	surface
PS70/023-19	13.06.07	10:26	66° 58.16'	11° 7.81'	327.2	GC	at sea bottom
PS70/023-19	13.06.07	10:36	66° 58.19'	11° 7.79'	326.0	GC	on deck

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/023-20	13.06.07	11:00	66° 58.13'	11° 7.76'	324.9	GC	surface
PS70/023-20	13.06.07	11:07	66° 58.13'	11° 7.81'	324.1	GC	at sea bottom
PS70/023-20	13.06.07	11:18	66° 58.14'	11° 7.81'	325.6	GC	on deck
PS70/024-1	13.06.07	11:34	66° 58.10'	11° 8.03'	327.9	MOR	surface
PS70/024-1	13.06.07	11:42	66° 58.10'	11° 8.06'	329.6	MOR	on the ground
PS70/024-1	13.06.07	11:46	66° 58.09'	11° 8.00'	328.5	MOR	surface
PS70/023-21	13.06.07	12:14	66° 58.22'	11° 7.26'	321.7	GKG	surface
PS70/023-21	13.06.07	12:22	66° 58.22'	11° 7.28'	321.7	GKG	at sea bottom
PS70/023-21	13.06.07	12:32	66° 58.22'	11° 7.29'	321.0	GKG	on deck
PS70/023-22	13.06.07	12:51	66° 58.36'	11° 6.53'	303.5	GKG	surface
PS70/023-22	13.06.07	12:59	66° 58.35'	11° 6.57'	305.3	GKG	at sea bottom
PS70/023-22	13.06.07	13:10	66° 58.35'	11° 6.60'	303.5	GKG	on deck
PS70/023-23	13.06.07	13:26	66° 58.25'	11° 7.63'	322.7	GC	surface
PS70/023-23	13.06.07	13:35	66° 58.23'	11° 7.66'	323.5	GC	at sea bottom
PS70/023-23	13.06.07	13:46	66° 58.24'	11° 7.57'	322.0	GC	on deck
PS70/024-2	13.06.07	14:03	66° 58.08'	11° 8.03'	327.7	JAGO	information
PS70/024-2	13.06.07	14:15	66° 58.09'	11° 8.10'	328.2	JAGO	to Water
PS70/024-2	13.06.07	14:44	66° 58.19'	11° 8.16'	329.4	JAGO	information
PS70/024-2	13.06.07	18:16	66° 58.17'	11° 7.10'	318.4	JAGO	information
PS70/024-2	13.06.07	18:36	66° 58.14'	11° 6.94'	318.6	JAGO	information
PS70/024-2	13.06.07	18:48	66° 58.08'	11° 6.61'	313.7	JAGO	on Deck
PS70/024-2	13.06.07	18:48	66° 58.08'	11° 6.61'	313.7	JAGO	on Deck
PS70/024-3	13.06.07	19:17	66° 58.08'	11° 7.36'	321.7	CTD/RO	surface
PS70/024-3	13.06.07	19:33	66° 58.08'	11° 7.33'	321.6	CTD/RO	at depth
PS70/024-3	13.06.07	19:43	66° 58.07'	11° 7.23'	320.8	CTD/RO	on deck
PS70/024-4	13.06.07	19:50	66° 58.06'	11° 7.23'	320.5	CTD/RO	surface
PS70/024-4	13.06.07	20:07	66° 58.04'	11° 7.22'	320.5	CTD/RO	at depth
PS70/024-4	13.06.07	20:13	66° 58.03'	11° 7.21'	320.5	CTD/RO	on deck
PS70/024-5	13.06.07	20:19	66° 58.08'	11° 7.08'	319.2	CTD/RO	surface
PS70/024-5	13.06.07	20:40	66° 58.08'	11° 7.05'	319.1	CTD/RO	at depth
PS70/024-5	13.06.07	20:46	66° 58.07'	11° 7.04'	318.7	CTD/RO	on deck
PS70/024-6	13.06.07	20:53	66° 58.03'	11° 7.08'	319.5	CTD/RO	surface
PS70/024-6	13.06.07	21:10	66° 58.05'	11° 7.04'	318.9	CTD/RO	at depth
PS70/024-6	13.06.07	21:11	66° 58.05'	11° 7.03'	319.6	CTD/RO	on deck
PS70/024-7	13.06.07	21:22	66° 58.10'	11° 7.22'	322.0	CTD/RO	surface
PS70/024-7	13.06.07	21:36	66° 58.14'	11° 7.23'	322.1	CTD/RO	at depth
PS70/024-7	13.06.07	21:42	66° 58.14'	11° 7.27'	323.3	CTD/RO	on deck
PS70/024-8	13.06.07	21:48	66° 58.12'	11° 7.35'	322.6	CTD/RO	surface
PS70/024-8	13.06.07	22:01	66° 58.12'	11° 7.44'	324.6	CTD/RO	at depth
PS70/024-8	13.06.07	22:07	66° 58.10'	11° 7.46'	323.6	CTD/RO	on deck
PS70/024-9	13.06.07	22:14	66° 58.18'	11° 7.42'	323.7	CTD/RO	surface
PS70/024-9	13.06.07	22:28	66° 58.18'	11° 7.46'	324.0	CTD/RO	at depth
PS70/024-9	13.06.07	22:35	66° 58.17'	11° 7.43'	323.4	CTD/RO	on deck
PS70/024-10	13.06.07	22:53	66° 58.68'	11° 10.40'	307.8	HS_PS	start track
PS70/024-10	13.06.07	23:28	66° 58.65'	11° 18.10'	293.1	HS_PS	alter course
PS70/024-10	13.06.07	23:36	66° 58.43'	11° 18.07'	295.0	HS_PS	continue the profile
PS70/024-10	14.06.07	02:40	66° 58.04'	11° 2.93'	292.5	HS_PS	alter course
PS70/024-10	14.06.07	02:51	66° 57.77'	11° 3.48'	299.9	HS_PS	continue the profile
PS70/024-10	14.06.07	03:23	66° 57.70'	11° 10.17'	353.2	HS_PS	alter course

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/024-10	14.06.07	03:33	66° 58.23'	11° 10.17'	340.7	HS_PS	continue the profile
PS70/024-10	14.06.07	03:44	66° 58.21'	11° 7.85'	326.8	HS_PS	profile end
PS70/025-1	14.06.07	05:00	66° 55.46'	10° 54.00'	313.1	GC	surface
PS70/025-1	14.06.07	05:08	66° 55.47'	10° 54.05'	313.6	GC	at sea bottom
PS70/025-1	14.06.07	05:19	66° 55.47'	10° 54.05'	313.5	GC	on deck
PS70/025-2	14.06.07	05:33	66° 55.47'	10° 54.04'	312.8	GC	surface
PS70/025-2	14.06.07	05:41	66° 55.48'	10° 54.03'	313.5	GC	at sea bottom
PS70/025-2	14.06.07	05:51	66° 55.48'	10° 54.02'	312.5	GC	on deck
PS70/026-1	14.06.07	07:17	66° 58.21'	11° 7.56'	325.9	JAGO	to Water
PS70/026-1	14.06.07	10:57	66° 58.42'	11° 6.44'	298.5	JAGO	on Deck
PS70/026-1	14.06.07	11:02	66° 58.44'	11° 6.19'	295.1	JAGO	on Deck
PS70/026-2	14.06.07	11:21	66° 58.02'	11° 6.42'	312.6	CTD/RO	surface
PS70/026-2	14.06.07	11:36	66° 58.03'	11° 6.44'	312.8	CTD/RO	at depth
PS70/026-2	14.06.07	11:44	66° 58.02'	11° 6.47'	313.0	CTD/RO	on deck
PS70/026-3	14.06.07	12:05	66° 58.07'	11° 7.60'	324.4	CTD/RO	surface
PS70/026-3	14.06.07	12:19	66° 58.08'	11° 7.63'	325.1	CTD/RO	at depth
PS70/026-3	14.06.07	12:27	66° 58.08'	11° 7.63'	325.4	CTD/RO	on deck
PS70/024-1	14.06.07	12:52	66° 58.14'	11° 7.40'	323.5	MOR	mooring on deck
PS70/026-4	14.06.07	13:05	66° 58.35'	11° 6.58'	305.8	CTD/RO	surface
PS70/026-4	14.06.07	13:20	66° 58.35'	11° 6.55'	304.0	CTD/RO	at depth
PS70/026-4	14.06.07	13:36	66° 58.33'	11° 6.59'	306.7	CTD/RO	on deck
PS70/026-5	14.06.07	13:54	66° 58.54'	11° 6.54'	290.6	CTD/RO	surface
PS70/026-5	14.06.07	14:08	66° 58.55'	11° 6.56'	289.5	CTD/RO	at depth
PS70/026-5	14.06.07	14:16	66° 58.55'	11° 6.51'	290.2	CTD/RO	on deck
PS70/026-6	14.06.07	14:30	66° 57.34'	11° 5.76'	335.0	HS_PS	start track
PS70/026-6	14.06.07	15:00	66° 56.25'	10° 59.96'	313.2	HS_PS	profile end
PS70/027-1	14.06.07	15:39	66° 58.37'	11° 7.12'	309.8	JAGO	information
PS70/027-1	14.06.07	15:48	66° 58.37'	11° 7.15'	311.0	JAGO	to Water
PS70/027-1	14.06.07	16:13	66° 58.34'	11° 6.86'	310.2	JAGO	information
PS70/027-1	14.06.07	19:01	66° 58.32'	11° 6.26'	299.3	JAGO	information
PS70/027-1	14.06.07	19:20	66° 58.32'	11° 6.08'	299.1	JAGO	information
PS70/027-1	14.06.07	19:33	66° 58.31'	11° 5.76'	295.3	JAGO	on Deck
PS70/027-1	14.06.07	19:37	66° 58.33'	11° 5.78'	295.2	JAGO	on Deck
PS70/028-1	15.06.07	01:53	67° 38.07'	9° 26.98'	763.9	CTD/RO	surface
PS70/028-1	15.06.07	02:19	67° 38.08'	9° 26.96'	766.4	CTD/RO	at depth
PS70/028-1	15.06.07	02:31	67° 38.07'	9° 26.97'	764.3	CTD/RO	on deck
PS70/028-2	15.06.07	04:04	67° 38.06'	9° 26.97'	760.7	GKG	surface
PS70/028-2	15.06.07	04:19	67° 38.05'	9° 26.98'	761.2	GKG	at sea bottom
PS70/028-2	15.06.07	04:37	67° 38.07'	9° 26.98'	763.8	GKG	on deck
PS70/029-1	15.06.07	06:56	67° 33.10'	9° 32.08'	378.9	JAGO	information
PS70/029-1	15.06.07	07:05	67° 33.09'	9° 32.25'	352.5	JAGO	to Water
PS70/029-1	15.06.07	07:32	67° 32.97'	9° 32.76'	309.9	JAGO	information
PS70/029-1	15.06.07	09:13	67° 33.01'	9° 32.72'	310.2	JAGO	information
PS70/029-1	15.06.07	09:29	67° 33.05'	9° 32.79'	307.0	JAGO	information
PS70/029-1	15.06.07	09:38	67° 33.05'	9° 32.82'	305.1	JAGO	on Deck
PS70/029-1	15.06.07	09:41	67° 33.03'	9° 32.81'	313.7	JAGO	on Deck
PS70/029-2	15.06.07	10:33	67° 35.25'	9° 28.98'	602.6	CTD/RO	surface
PS70/029-2	15.06.07	10:55	67° 35.24'	9° 28.94'	602.9	CTD/RO	at depth
PS70/029-2	15.06.07	11:07	67° 35.24'	9° 28.96'	602.5	CTD/RO	on deck
PS70/029-3	15.06.07	11:12	67° 35.24'	9° 28.93'	604.4	GKG	surface

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/029-3	15.06.07	11:24	67° 35.23'	9° 28.92'	604.1	GKG	at sea bottom
PS70/029-3	15.06.07	11:43	67° 35.26'	9° 28.79'	608.0	GKG	on deck
PS70/030-1	15.06.07	12:17	67° 32.82'	9° 30.55'	417.5	CTD/RO	surface
PS70/030-1	15.06.07	12:33	67° 32.78'	9° 30.53'	409.6	CTD/RO	at depth
PS70/030-1	15.06.07	12:42	67° 32.80'	9° 30.53'	412.9	CTD/RO	on deck
PS70/030-2	15.06.07	12:44	67° 32.81'	9° 30.54'	414.5	GKG	surface
PS70/030-2	15.06.07	12:53	67° 32.75'	9° 30.51'	407.0	GKG	at sea bottom
PS70/030-2	15.06.07	13:04	67° 32.76'	9° 30.44'	409.9	GKG	on deck
PS70/030-3	15.06.07	13:35	67° 32.39'	9° 31.26'	297.6	CTD/RO	surface
PS70/030-3	15.06.07	13:47	67° 32.40'	9° 31.26'	299.6	CTD/RO	at depth
PS70/030-3	15.06.07	13:56	67° 32.41'	9° 31.27'	298.1	CTD/RO	on deck
PS70/031-1	15.06.07	14:32	67° 31.27'	9° 27.94'	375.4	JAGO	information
PS70/031-1	15.06.07	14:41	67° 31.25'	9° 27.92'	370.8	JAGO	to Water
PS70/031-1	15.06.07	15:11	67° 31.24'	9° 27.89'	365.6	JAGO	information
PS70/031-1	15.06.07	17:27	67° 31.35'	9° 28.30'	361.7	JAGO	information
PS70/031-1	15.06.07	17:35	67° 31.30'	9° 28.43'	343.4	JAGO	on Deck
PS70/031-1	15.06.07	17:40	67° 31.29'	9° 28.49'	342.9	JAGO	information
PS70/032-1	15.06.07	21:03	67° 52.33'	8° 30.86'	2097.0	CTD/RO	surface
PS70/032-1	15.06.07	22:01	67° 52.31'	8° 30.68'	2100.0	CTD/RO	at depth
PS70/032-1	15.06.07	22:34	67° 52.25'	8° 30.91'	2090.0	CTD/RO	on deck
PS70/032-2	15.06.07	22:38	67° 52.23'	8° 30.99'	2090.0	GKG	surface
PS70/032-2	15.06.07	23:11	67° 52.22'	8° 30.72'	2098.0	GKG	at sea bottom
PS70/032-2	15.06.07	23:46	67° 52.39'	8° 30.84'	2095.0	GKG	on deck
PS70/033-1	16.06.07	01:47	67° 43.08'	8° 55.10'	1834.0	CTD/RO	surface
PS70/033-1	16.06.07	02:39	67° 42.98'	8° 55.17'	1824.0	CTD/RO	at depth
PS70/033-1	16.06.07	03:08	67° 43.01'	8° 55.06'	1825.0	CTD/RO	on deck
PS70/033-2	16.06.07	03:13	67° 43.02'	8° 55.08'	1827.0	GKG	surface
PS70/033-2	16.06.07	03:40	67° 43.01'	8° 55.00'	1824.0	GKG	at sea bottom
PS70/033-2	16.06.07	04:10	67° 43.00'	8° 54.93'	1824.0	GKG	on deck
PS70/034-1	16.06.07	06:20	67° 31.94'	9° 30.30'	361.6	JAGO	information
PS70/034-1	16.06.07	06:38	67° 31.96'	9° 30.17'	361.4	JAGO	to Water
PS70/034-1	16.06.07	09:15	67° 31.97'	9° 30.49'	348.6	JAGO	information
PS70/034-1	16.06.07	09:43	67° 32.03'	9° 30.95'	319.2	JAGO	information
PS70/034-1	16.06.07	09:58	67° 31.99'	9° 31.10'	294.0	JAGO	on Deck
PS70/034-1	16.06.07	10:00	67° 32.00'	9° 31.16'	277.7	JAGO	information
PS70/034-2	16.06.07	10:42	67° 32.76'	9° 30.49'	410.1	GC	surface
PS70/034-2	16.06.07	10:50	67° 32.76'	9° 30.49'	409.5	GC	at sea bottom
PS70/034-2	16.06.07	11:02	67° 32.75'	9° 30.54'	409.0	GC	on deck
PS70/034-3	16.06.07	11:17	67° 32.74'	9° 30.54'	407.4	GC	surface
PS70/034-3	16.06.07	11:23	67° 32.73'	9° 30.56'	403.2	GC	at sea bottom
PS70/034-3	16.06.07	11:34	67° 32.74'	9° 30.53'	407.9	GC	on deck
PS70/035-1	16.06.07	12:15	67° 30.46'	9° 25.38'	332.5	GC	surface
PS70/035-1	16.06.07	12:20	67° 30.46'	9° 25.38'	334.4	GC	at sea bottom
PS70/035-1	16.06.07	12:34	67° 30.48'	9° 25.40'	331.9	GC	on deck
PS70/035-2	16.06.07	12:53	67° 30.49'	9° 25.40'	327.4	GC	surface
PS70/035-2	16.06.07	12:58	67° 30.48'	9° 25.41'	327.3	GC	at sea bottom
PS70/035-2	16.06.07	13:09	67° 30.49'	9° 25.39'	328.4	GC	on deck
PS70/035-3	16.06.07	13:24	67° 30.53'	9° 25.34'	343.3	GC	surface
PS70/035-3	16.06.07	13:30	67° 30.53'	9° 25.35'	343.8	GC	at sea bottom
PS70/035-3	16.06.07	13:49	67° 30.50'	9° 24.98'	358.9	GC	on deck
PS70/035-4	16.06.07	14:08	67° 30.32'	9° 24.67'	336.7	JAGO	information

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/035-4	16.06.07	14:17	67° 30.31'	9° 24.80'	330.6	JAGO	to Water
PS70/035-4	16.06.07	14:42	67° 30.28'	9° 24.99'	323.3	JAGO	information
PS70/035-4	16.06.07	18:12	67° 30.25'	9° 25.03'	311.8	JAGO	information
PS70/035-4	16.06.07	18:31	67° 30.11'	9° 24.98'	290.2	JAGO	on Deck
PS70/035-4	16.06.07	18:35	67° 30.07'	9° 24.90'	285.4	JAGO	information
PS70/036-1	16.06.07	19:43	67° 32.70'	9° 30.55'	396.5	BC	surface
PS70/036-1	16.06.07	19:53	67° 32.70'	9° 30.56'	398.9	BC	at sea bottom
PS70/036-1	16.06.07	20:07	67° 32.73'	9° 30.56'	400.0	BC	on deck
PS70/037-1	16.06.07	20:50	67° 35.50'	9° 20.13'	901.4	CTD/RO	surface
PS70/037-1	16.06.07	21:21	67° 35.37'	9° 20.09'	891.7	CTD/RO	at depth
PS70/037-1	16.06.07	21:40	67° 35.09'	9° 19.94'	871.0	CTD/RO	on deck
PS70/037-2	16.06.07	21:43	67° 35.04'	9° 19.91'	869.4	BC	surface
PS70/037-2	16.06.07	22:14	67° 35.15'	9° 19.22'	889.1	BC	at sea bottom
PS70/037-2	16.06.07	22:39	67° 35.16'	9° 18.83'	901.5	BC	on deck
PS70/038-1	16.06.07	23:18	67° 37.71'	9° 10.33'	1209.0	CTD/RO	surface
PS70/038-1	16.06.07	23:53	67° 37.71'	9° 10.37'	1209.0	CTD/RO	at depth
PS70/038-1	17.06.07	00:14	67° 37.73'	9° 10.39'	1208.0	CTD/RO	on deck
PS70/038-2	17.06.07	00:18	67° 37.75'	9° 10.37'	1209.0	GKG	surface
PS70/038-2	17.06.07	00:37	67° 37.77'	9° 10.29'	1214.0	GKG	at sea bottom
PS70/038-2	17.06.07	01:04	67° 37.72'	9° 10.27'	1210.0	GKG	on deck
PS70/039-1	17.06.07	01:46	67° 40.12'	9° 3.11'	1509.0	CTD/RO	surface
PS70/039-1	17.06.07	02:30	67° 40.17'	9° 3.06'	1517.0	CTD/RO	at depth
PS70/039-1	17.06.07	02:53	67° 40.16'	9° 3.08'	1512.0	CTD/RO	on deck
PS70/039-2	17.06.07	02:59	67° 40.17'	9° 3.06'	1514.0	BC	surface
PS70/039-2	17.06.07	03:23	67° 40.15'	9° 3.00'	1514.0	BC	at sea bottom
PS70/039-2	17.06.07	03:55	67° 40.17'	9° 2.94'	1515.0	BC	on deck
PS70/040-1	18.06.07	07:23	70° 42.74'	18° 39.55'	370.6	CTD/RO	surface
PS70/040-1	18.06.07	07:33	70° 42.71'	18° 39.28'	382.3	CTD/RO	at depth
PS70/040-1	18.06.07	07:48	70° 42.70'	18° 39.02'	392.6	CTD/RO	on deck
PS70/040-2	18.06.07	08:05	70° 42.87'	18° 40.01'	375.6	HS_PS	start track
PS70/040-2	18.06.07	08:52	70° 46.92'	18° 40.04'	294.2	HS_PS	profile end
PS70/040-3	18.06.07	09:17	70° 45.30'	18° 40.26'	291.7	BC	surface
PS70/040-3	18.06.07	09:24	70° 45.32'	18° 40.11'	281.7	BC	at sea bottom
PS70/040-3	18.06.07	09:34	70° 45.40'	18° 40.08'	262.7	BC	on deck
PS70/040-4	18.06.07	10:09	70° 45.35'	18° 40.04'	263.0	JAGO	information
PS70/040-4	18.06.07	10:18	70° 45.30'	18° 39.95'	274.4	JAGO	to Water
PS70/040-4	18.06.07	13:14	70° 45.28'	18° 40.28'	292.2	JAGO	information
PS70/040-4	18.06.07	13:27	70° 45.19'	18° 40.21'	284.1	JAGO	information
PS70/040-4	18.06.07	13:47	70° 45.07'	18° 40.59'	293.6	JAGO	on Deck
PS70/040-4	18.06.07	13:52	70° 45.00'	18° 40.66'	292.7	JAGO	information
PS70/040-5	18.06.07	14:15	70° 44.99'	18° 38.05'	313.5	HS_PS	start track
PS70/040-5	18.06.07	14:31	70° 46.00'	18° 40.65'	329.8	HS_PS	alter course
PS70/040-5	18.06.07	14:33	70° 46.13'	18° 40.87'	329.4	HS_PS	continue the profile
PS70/040-5	18.06.07	15:37	70° 51.41'	18° 40.65'	202.6	HS_PS	alter course
PS70/040-5	18.06.07	15:45	70° 51.23'	18° 41.30'	205.7	HS_PS	continue the profile
PS70/040-5	18.06.07	17:27	70° 42.71'	18° 41.19'	339.1	HS_PS	alter course
PS70/040-5	18.06.07	17:35	70° 42.81'	18° 40.67'	360.5	HS_PS	continue the profile
PS70/040-5	18.06.07	18:22	70° 46.57'	18° 40.35'	308.3	HS_PS	profile end

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/040-6	18.06.07	19:00	70° 45.35'	18° 39.90'	268.4	VGRAB	to Water
PS70/040-6	18.06.07	19:11	70° 45.36'	18° 39.88'	265.0	VGRAB	at bottom
PS70/040-6	18.06.07	19:17	70° 45.34'	18° 39.82'	266.1	VGRAB	on Deck
PS70/040-7	18.06.07	19:24	70° 45.38'	18° 39.94'	264.9	VGRAB	to Water
PS70/040-7	18.06.07	19:34	70° 45.37'	18° 39.95'	266.2	VGRAB	at bottom
PS70/040-7	18.06.07	19:41	70° 45.30'	18° 39.78'	269.9	VGRAB	on Deck
PS70/040-8	18.06.07	19:53	70° 45.38'	18° 39.96'	265.5	VGRAB	to Water
PS70/040-8	18.06.07	20:03	70° 45.36'	18° 39.92'	265.3	VGRAB	at bottom
PS70/040-8	18.06.07	20:10	70° 45.33'	18° 39.64'	268.3	VGRAB	on Deck
PS70/040-9	18.06.07	20:26	70° 45.38'	18° 39.94'	265.3	VGRAB	to Water
PS70/040-9	18.06.07	20:36	70° 45.38'	18° 39.87'	264.3	VGRAB	at bottom
PS70/040-9	18.06.07	20:41	70° 45.33'	18° 39.71'	265.4	VGRAB	on Deck
PS70/040-10	18.06.07	21:00	70° 45.46'	18° 40.48'	280.8	VGRAB	to Water
PS70/040-10	18.06.07	21:10	70° 45.48'	18° 40.43'	272.2	VGRAB	at bottom
PS70/040-10	18.06.07	21:16	70° 45.49'	18° 40.22'	264.8	VGRAB	on Deck
PS70/041-1	18.06.07	21:30	70° 45.19'	18° 39.12'	275.8	HS_PS	start track
PS70/041-1	19.06.07	02:01	70° 42.65'	18° 42.74'	359.0	HS_PS	alter course
PS70/041-1	19.06.07	02:11	70° 42.95'	18° 43.23'	355.2	HS_PS	continue the profile
PS70/041-1	19.06.07	03:47	70° 51.01'	18° 42.61'	209.1	HS_PS	alter course
PS70/041-1	19.06.07	04:00	70° 50.96'	18° 43.02'	208.2	HS_PS	continue the profile
PS70/041-1	19.06.07	05:37	70° 42.75'	18° 43.94'	352.4	HS_PS	alter course
PS70/041-1	19.06.07	05:51	70° 42.68'	18° 44.61'	365.7	HS_PS	continue the profile
PS70/041-1	19.06.07	06:23	70° 45.23'	18° 44.71'	334.5	HS_PS	profile end
PS70/041-2	19.06.07	06:49	70° 45.35'	18° 39.99'	272.4	JAGO	information
PS70/041-2	19.06.07	06:59	70° 45.28'	18° 39.97'	278.8	JAGO	to Water
PS70/041-2	19.06.07	07:24	70° 45.25'	18° 39.90'	279.3	JAGO	information
PS70/041-2	19.06.07	10:23	70° 45.45'	18° 39.13'	308.6	JAGO	on Deck
PS70/041-2	19.06.07	10:27	70° 45.42'	18° 38.95'	311.1	JAGO	information
PS70/041-3	19.06.07	10:59	70° 45.29'	18° 39.84'	271.6	GC	surface
PS70/041-3	19.06.07	11:05	70° 45.30'	18° 39.83'	270.4	GC	at sea bottom
PS70/041-3	19.06.07	11:14	70° 45.29'	18° 39.86'	272.2	GC	on deck
PS70/041-4	19.06.07	11:20	70° 45.29'	18° 39.90'	273.0	GC	surface
PS70/041-4	19.06.07	11:26	70° 45.30'	18° 39.83'	269.7	GC	at sea bottom
PS70/041-4	19.06.07	11:35	70° 45.29'	18° 39.81'	271.6	GC	on deck
PS70/041-5	19.06.07	12:02	70° 45.35'	18° 39.86'	266.8	GC	surface
PS70/041-5	19.06.07	12:08	70° 45.34'	18° 39.84'	266.0	GC	at sea bottom
PS70/041-5	19.06.07	12:16	70° 45.35'	18° 39.82'	264.6	GC	on deck
PS70/041-6	19.06.07	12:30	70° 45.34'	18° 39.81'	266.1	GC	surface
PS70/041-6	19.06.07	12:35	70° 45.34'	18° 39.84'	265.9	GC	at sea bottom
PS70/041-6	19.06.07	12:44	70° 45.35'	18° 39.90'	266.7	GC	on deck
PS70/041-7	19.06.07	13:08	70° 45.28'	18° 38.47'	302.9	HS_PS	start track
PS70/041-7	19.06.07	13:48	70° 41.94'	18° 38.10'	371.7	HS_PS	profile end
PS70/042-1	19.06.07	14:22	70° 45,43'	18° 40,60'	285,3	JAGO	information
PS70/042-1	19.06.07	14:31	70° 45,42'	18° 40,50'	284,6	JAGO	to Water
PS70/042-1	19.06.07	15:01	70° 45,40'	18° 40,51'	284,2	JAGO	information
PS70/042-1	19.06.07	17:16	70° 45,38'	18° 40,74'	288,6	JAGO	information
PS70/042-1	19.06.07	17:30	70° 45,30'	18° 40,97'	290,2	JAGO	on Deck
PS70/042-1	19.06.07	17:33	70° 45,27'	18° 41,04'	287,8	JAGO	information

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/042-2	19.06.07	18:25	70° 46,06'	18° 41,92’	286,1	VIDEO	in water
PS70/042-2	19.06.07	18:37	70° 46,03'	18° 41,85’	286,0	VIDEO	start profile
PS70/042-2	19.06.07	19:56	70° 45,73'	18° 41,02’	275,6	VIDEO	end profile
PS70/042-2	19.06.07	20:06	70° 45,67'	18° 40,95’	273,8	VIDEO	on deck
PS70/042-3	19.06.07	20:41	70° 47,11'	18° 40,01’	280,2	HS_PS	continue the profile
PS70/042-3	19.06.07	21:26	70° 50,97'	18° 40,10’	206,2	HS_PS	alter course
PS70/042-3	19.06.07	21:43	70° 51,02'	18° 39,58’	206,3	HS_PS	continue the profile
PS70/042-3	19.06.07	22:52	70° 45,18'	18° 39,54’	279,5	HS_PS	alter course
PS70/042-3	19.06.07	23:05	70° 45,32'	18° 39,12’	296,4	HS_PS	continue the profile
PS70/042-3	20.06.07	00:12	70° 51,00'	18° 39,14’	207,2	HS_PS	alter course
PS70/042-3	20.06.07	00:38	70° 51,01'	18° 43,51’	206,6	HS_PS	continue the profile
PS70/042-3	20.06.07	01:50	70° 45,22'	18° 44,74’	335,6	HS_PS	alter course
PS70/042-3	20.06.07	02:04	70° 45,37'	18° 45,26’	331,8	HS_PS	continue the profile
PS70/042-3	20.06.07	03:13	70° 51,00'	18° 44,09’	206,4	HS_PS	alter course
PS70/042-3	20.06.07	03:26	70° 51,02'	18° 44,54’	203,9	HS_PS	continue the profile
PS70/042-3	20.06.07	05:06	70° 42,76'	18° 45,54’	371,1	HS_PS	alter course
PS70/042-3	20.06.07	05:17	70° 42,69'	18° 46,32’	362,2	HS_PS	continue the profile
PS70/042-3	20.06.07	05:39	70° 44,55'	18° 46,33’	383,2	HS_PS	profile end
PS70/043-1	20.06.07	06:08	70° 45,94'	18° 41,53’	266,9	JAGO	information
PS70/043-1	20.06.07	06:19	70° 45,92'	18° 41,72’	260,5	JAGO	to Water
PS70/043-1	20.06.07	08:30	70° 45,68'	18° 40,97’	275,5	JAGO	on Deck
PS70/043-1	20.06.07	08:34	70° 45,62'	18° 40,84’	275,3	JAGO	on Deck
PS70/043-2	20.06.07	08:54	70° 45,78'	18° 40,92’	288,5	VIDEO	in water
PS70/043-2	20.06.07	09:09	70° 45,81'	18° 40,94’	294,2	VIDEO	start profile
PS70/043-2	20.06.07	10:14	70° 45,48'	18° 39,92’	278,4	VIDEO	end profile
PS70/043-2	20.06.07	10:24	70° 45,52'	18° 39,78’	291,2	VIDEO	on deck
PS70/043-3	20.06.07	11:30	70° 45,24'	18° 38,31’	307,8	HS_PS	start track
PS70/043-3	20.06.07	14:40	70° 42,72'	18° 46,41’	364,5	HS_PS	alter course
PS70/043-3	20.06.07	14:52	70° 42,72'	18° 47,18’	355,0	HS_PS	continue the profile
PS70/043-3	20.06.07	16:03	70° 49,11'	18° 46,34’	239,3	HS_PS	profile break
PS70/043-3	20.06.07	16:25	70° 48,12'	18° 46,67’	265,9	HS_PS	continue the profile
PS70/043-3	20.06.07	17:04	70° 51,26'	18° 45,01’	193,4	HS_PS	alter course
PS70/043-3	20.06.07	17:17	70° 51,00'	18° 46,10’	194,2	HS_PS	continue the profile
PS70/043-3	20.06.07	18:57	70° 42,61'	18° 47,88’	349,5	HS_PS	alter course
PS70/043-3	20.06.07	19:10	70° 42,74'	18° 48,78’	351,7	HS_PS	continue the profile
PS70/043-3	20.06.07	19:27	70° 44,07'	18° 48,59’	365,2	HS_PS	Reboot Hydrosweep
PS70/043-3	20.06.07	19:53	70° 43,68'	18° 48,68’	376,4	HS_PS	continue the profile
PS70/043-3	20.06.07	21:15	70° 51,11'	18° 46,54’	190,3	HS_PS	alter course

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/043-3	20.06.07	21:28	70° 50,99'	18° 47,02'	187,4	HS_PS	continue the profile
PS70/043-3	20.06.07	22:46	70° 42,71'	18° 49,50'	352,4	HS_PS	profile end
PS70/044-1	24.06.07	08:51	72° 0,04'	14° 44,32'	1294,0	CTD/RO	surface
PS70/044-1	24.06.07	09:23	72° 0,10'	14° 44,66'	1296,0	CTD/RO	at depth
PS70/044-1	24.06.07	09:43	71° 59,99'	14° 44,33'	1291,0	CTD/RO	on deck
PS70/045-1	24.06.07	09:54	71° 59,99'	14° 44,73'	1292,0	HS_PS	start track
PS70/045-1	24.06.07	11:05	72° 0,68'	14° 42,45'	1301,0	HS_PS	profile end
PS70/046-1	24.06.07	11:35	72° 0,09'	14° 43,47'	1291,0	ROV	Information
PS70/046-1	24.06.07	13:21	72° 0,16'	14° 43,22'	1291,0	ROV	surface
PS70/046-1	24.06.07	17:38	72° 0,43'	14° 43,15'	1293,0	ROV	Information
PS70/046-1	24.06.07	19:21	72° 0,70'	14° 42,59'	1300,0	ROV	on deck
PS70/047-1	24.06.07	19:41	72° 0,14'	14° 44,02'	1290,0	MUC	surface
PS70/047-1	24.06.07	20:06	72° 0,17'	14° 43,88'	1293,0	MUC	at sea bottom
PS70/047-1	24.06.07	20:09	72° 0,17'	14° 43,86'	1291,0	MUC	information
PS70/047-1	24.06.07	20:35	72° 0,25'	14° 43,83'	1290,0	MUC	on deck
PS70/048-1	24.06.07	20:46	72° 0,20'	14° 43,71'	1292,0	LADER	surface
PS70/049-1	24.06.07	21:23	72° 0,30'	14° 43,50'	1291,0	MUC	surface
PS70/049-1	24.06.07	21:53	72° 0,29'	14° 43,45'	1291,0	MUC	at sea bottom
PS70/049-1	24.06.07	21:55	72° 0,29'	14° 43,45'	1291,0	MUC	information
PS70/049-1	24.06.07	22:22	72° 0,40'	14° 43,57'	1291,0	MUC	on deck
PS70/050-1	24.06.07	22:56	72° 0,32'	14° 43,41'	1289,0	MUC	surface
PS70/050-1	24.06.07	23:26	72° 0,30'	14° 43,45'	1293,0	MUC	at sea bottom
PS70/050-1	24.06.07	23:56	72° 0,29'	14° 43,50'	1291,0	MUC	on deck
PS70/051-1	25.06.07	05:02	72° 0,33'	14° 43,21'	1291,0	COLOSSOS	
PS70/051-1	25.06.07	06:30	72° 0,30'	14° 43,20'	1290,0	COLOSSOS	
PS70/051-1	25.06.07	06:32	72° 0,30'	14° 43,20'	1293,0	COLOSSOS	
PS70/051-1	25.06.07	06:33	72° 0,30'	14° 43,19'	1290,0	COLOSSOS	
PS70/051-1	25.06.07	06:47	72° 0,30'	14° 43,14'	1293,0	COLOSSOS	
PS70/051-1	25.06.07	07:13	72° 0,30'	14° 43,33'	1293,0	COLOSSOS	
PS70/052-1	25.06.07	07:49	72° 0,30'	14° 43,30'	1292,0	ROV	surface
PS70/052-1	25.06.07	09:05	72° 0,29'	14° 43,22'	1291,0	ROV	at depth
PS70/051-1	25.06.07	15:55	72° 0,31'	14° 43,34'	1290,0	COLOSSOS	
PS70/051-1	25.06.07	15:55	72° 0,31'	14° 43,34'	1290,0	COLOSSOS	
PS70/051-1	25.06.07	16:12	72° 0,35'	14° 43,18'	1283,8	COLOSSOS	
PS70/052-1	25.06.07	16:15	72° 0,35'	14° 43,16'	1284,5	ROV	coming back to the surface
PS70/052-1	25.06.07	17:46	72° 0,19'	14° 43,29'	1288,1	ROV	on deck
PS70/051-1	25.06.07	18:20	71° 58,65'	14° 44,19'	1306,0	COLOSSOS	
PS70/053-1	25.06.07	18:52	72° 0,38'	14° 43,99'	1292,0	PC	surface
PS70/053-1	25.06.07	19:30	72° 0,38'	14° 44,03'	1294,0	PC	at sea bottom
PS70/053-1	25.06.07	20:05	72° 0,38'	14° 44,09'	1291,0	PC	on Deck
PS70/054-1	25.06.07	20:51	72° 0,36'	14° 44,05'	1293,0	GC	surface
PS70/054-1	25.06.07	21:17	72° 0,37'	14° 44,10'	1292,0	GC	at sea bottom
PS70/054-1	25.06.07	21:37	72° 0,43'	14° 43,96'	1292,0	GC	on deck
PS70/055-1	25.06.07	22:13	72° 0,80'	14° 44,50'	1287,0	HS_PS	start track
PS70/055-1	25.06.07	22:39	71° 59,63'	14° 39,94'	1333,0	HS_PS	profile end
PS70/056-1	25.06.07	22:59	71° 59,96'	14° 41,05'	1321,0	GC	surface
PS70/056-1	25.06.07	23:15	71° 59,96'	14° 41,10'	1318,0	GC	at sea bottom
PS70/056-1	25.06.07	23:38	71° 59,96'	14° 41,12'	1318,0	GC	on deck

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/057-1	26.06.07	01:30	72° 0,28'	14° 43,46'	1291,0	MUC	surface
PS70/057-1	26.06.07	01:54	72° 0,29'	14° 43,37'	1289,0	MUC	at sea bottom
PS70/057-1	26.06.07	02:23	72° 0,32'	14° 43,31'	1292,0	MUC	on deck
PS70/058-1	26.06.07	02:48	72° 0,10'	14° 44,62'	1294,0	HS_PS	start track
PS70/058-1	26.06.07	03:05	71° 58,96'	14° 42,15'	1322,0	HS_PS	profile end
PS70/059-1	26.06.07	03:39	72° 0,25'	14° 43,42'	1292,0	CTD/RO	surface
PS70/059-1	26.06.07	04:16	72° 0,34'	14° 43,32'	1293,0	CTD/RO	at depth
PS70/059-1	26.06.07	04:42	72° 0,30'	14° 43,70'	1291,0	CTD/RO	on deck
PS70/060-1	26.06.07	05:09	72° 0,38'	14° 43,91'	1291,0	CTD/RO	surface
PS70/060-1	26.06.07	05:34	72° 0,35'	14° 43,41'	1291,0	CTD/RO	at depth
PS70/060-1	26.06.07	05:57	72° 0,44'	14° 43,44'	1292,0	CTD/RO	on deck
PS70/061-1	26.06.07	06:40	72° 0,28'	14° 43,52'	1293,0	TRAPF	surface
PS70/062-1	26.06.07	07:08	72° 0,34'	14° 43,24'	1289,0	TRAPF	surface
PS70/063-1	26.06.07	07:50	71° 59,02'	14° 45,66'	1295,0	MUC	surface
PS70/063-1	26.06.07	08:13	71° 59,02'	14° 45,48'	1296,0	MUC	at sea bottom
PS70/063-1	26.06.07	08:37	71° 59,18'	14° 45,42'	1297,0	MUC	on deck
PS70/064-1	26.06.07	12:34	71° 40,30'	13° 4,77'	1999,0	MUC	surface
PS70/064-1	26.06.07	12:59	71° 40,43'	13° 4,74'	1999,0	MUC	at sea bottom
PS70/064-1	26.06.07	13:27	71° 40,63'	13° 4,71'	1989,0	MUC	on deck
PS70/065-1	26.06.07	13:35	71° 40,80'	13° 4,90'	1984,0	MUC	surface
PS70/065-1	26.06.07	14:00	71° 40,92'	13° 4,92'	1992,0	MUC	at sea bottom
PS70/065-1	26.06.07	14:30	71° 41,16'	13° 4,61'	1989,0	MUC	on deck
PS70/066-1	26.06.07	21:35	71° 59,12'	14° 39,00'	1340,0	HS_PS	start track
PS70/066-1	27.06.07	04:30	71° 59,94'	14° 41,16'	1316,0	HS_PS	profile end
PS70/067-1	27.06.07	05:06	71° 59,48'	14° 43,22'	1305,0	GC	surface
PS70/067-1	27.06.07	05:12	71° 59,51'	14° 43,21'	1306,0	GC	information
PS70/067-1	27.06.07	05:43	71° 59,53'	14° 43,11'	1305,0	GC	at sea bottom
PS70/067-1	27.06.07	05:45	71° 59,54'	14° 43,17'	1305,0	GC	off ground hoisting
PS70/067-1	27.06.07	06:17	71° 59,51'	14° 43,28'	1307,0	GC	on deck
PS70/048-1	27.06.07	06:40	72° 0,12'	14° 43,34'	1294,0	LADER	released
PS70/048-1	27.06.07	06:58	72° 0,18'	14° 43,63'	1293,0	LADER	released
PS70/048-1	27.06.07	07:22	72° 0,22'	14° 43,81'	1293,0	LADER	Information
PS70/048-1	27.06.07	07:55	71° 59,80'	14° 43,74'	1299,0	LADER	on Deck
PS70/068-1	27.06.07	08:47	72° 0,28'	14° 43,75'	1293,0	PC	surface
PS70/068-1	27.06.07	09:26	72° 0,30'	14° 43,73'	1290,0	PC	at sea bottom
PS70/068-1	27.06.07	10:06	72° 0,29'	14° 43,83'	1291,0	PC	on Deck
PS70/069-1	27.06.07	10:16	72° 0,29'	14° 43,76'	1294,0	GC	surface
PS70/069-1	27.06.07	10:43	72° 0,28'	14° 43,65'	1295,0	GC	at sea bottom
PS70/069-1	27.06.07	11:04	72° 0,30'	14° 43,79'	1293,0	GC	on deck
PS70/070-1	27.06.07	11:13	72° 0,28'	14° 43,69'	1293,0	POS	Begin
PS70/070-1	27.06.07	11:16	72° 0,29'	14° 43,82'	1293,0	POS	Surveillance
PS70/070-1	27.06.07	11:58	72° 0,31'	14° 43,90'	1291,0	POS	End
PS70/071-1	27.06.07	12:08	72° 0,24'	14° 43,78'	1293,0	GC	surface
PS70/071-1	27.06.07	12:42	72° 0,28'	14° 43,73'	1293,0	GC	at sea bottom
PS70/071-1	27.06.07	12:52	72° 0,27'	14° 43,73'	1293,0	GC	off ground hoisting
PS70/071-1	27.06.07	13:19	72° 0,26'	14° 43,72'	1293,0	GC	on deck
PS70/072-1	27.06.07	14:01	72° 0,25'	14° 43,62'	1292,0	GC	surface
PS70/072-1	27.06.07	14:23	72° 0,32'	14° 43,76'	1292,0	GC	at sea bottom
PS70/072-1	27.06.07	14:33	72° 0,33'	14° 43,79'	1290,0	GC	off ground hoisting
PS70/072-1	27.06.07	14:58	72° 0,35'	14° 43,59'	1290,0	GC	on deck
PS70/073-1	27.06.07	15:03	72° 0,31'	14° 43,40'	1291,0	LANDER	surface

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/074-1	27.06.07	15:40	72° 0,34'	14° 43,84'	1290,0	GC	surface
PS70/074-1	27.06.07	16:35	72° 0,29'	14° 43,62'	1293,0	GC	information
PS70/074-1	27.06.07	17:10	72° 0,31'	14° 43,72'	1293,0	GC	information
PS70/074-1	27.06.07	17:36	72° 0,28'	14° 43,70'	1293,0	GC	at sea bottom
PS70/074-1	27.06.07	17:43	72° 0,31'	14° 43,74'	1290,0	GC	off ground hoisting
PS70/074-1	27.06.07	18:08	72° 0,33'	14° 43,77'	1290,0	GC	on deck
PS70/075-1	27.06.07	18:39	72° 0,30'	14° 43,53'	1292,0	GC	surface
PS70/075-1	27.06.07	19:32	72° 0,32'	14° 43,63'	1293,0	GC	at sea bottom
PS70/075-1	27.06.07	19:42	72° 0,34'	14° 43,60'	1291,0	GC	off ground hoisting
PS70/075-1	27.06.07	20:05	72° 0,33'	14° 43,62'	1292,0	GC	on deck
PS70/076-1	27.06.07	20:38	72° 0,05'	14° 44,35'	1295,0	MUC	surface
PS70/076-1	27.06.07	21:06	72° 0,05'	14° 44,12'	1299,0	MUC	at sea bottom
PS70/076-1	27.06.07	21:26	71° 59,96'	14° 43,93'	1301,0	MUC	on deck
PS70/077-1	27.06.07	21:49	71° 59,48'	14° 43,77'	1304,0	GC	surface
PS70/077-1	27.06.07	22:18	71° 59,54'	14° 43,50'	1302,0	GC	at sea bottom
PS70/077-1	27.06.07	22:44	71° 59,52'	14° 43,61'	1305,0	GC	on deck
PS70/078-1	27.06.07	23:55	71° 59,87'	14° 40,85'	1326,0	HS_PS	start track
PS70/078-1	28.06.07	06:01	72° 0,97'	14° 45,20'	1269,0	HS_PS	profile end
PS70/062-1	28.06.07	06:36	72° 0,30'	14° 42,84'	1295,0	TRAPF	released
PS70/061-1	28.06.07	07:32	71° 59,86'	14° 44,00'	1295,0	TRAPF	on deck
PS70/062-1	28.06.07	07:39	71° 59,80'	14° 44,61'	1292,0	TRAPF	Information
PS70/062-1	28.06.07	08:22	72° 0,00'	14° 43,77'	1296,0	TRAPF	on deck
PS70/079-1	28.06.07	08:49	72° 0,31'	14° 43,77'	1292,0	MUC	surface
PS70/079-1	28.06.07	09:07	72° 0,36'	14° 43,74'	1292,0	MUC	at sea bottom
PS70/079-1	28.06.07	09:22	72° 0,32'	14° 43,66'	1290,0	MUC	on deck
PS70/080-1	28.06.07	11:30	72° 0,63'	14° 42,86'	1298,0	GC	surface
PS70/080-1	28.06.07	11:54	72° 0,66'	14° 42,84'	1298,0	GC	at sea bottom
PS70/080-1	28.06.07	12:20	72° 0,57'	14° 42,80'	1298,0	GC	on deck
PS70/081-1	28.06.07	12:43	72° 0,34'	14° 42,90'	1292,0	PC	surface
PS70/081-1	28.06.07	13:19	72° 0,35'	14° 42,74'	1298,0	PC	at sea bottom
PS70/081-1	28.06.07	13:56	72° 0,36'	14° 42,86'	1295,0	PC	on Deck
PS70/082-1	28.06.07	14:32	72° 0,39'	14° 42,93'	1294,0	GC	surface
PS70/082-1	28.06.07	14:55	72° 0,37'	14° 42,81'	1293,0	GC	at sea bottom
PS70/082-1	28.06.07	15:21	72° 0,38'	14° 42,82'	1297,0	GC	on deck
PS70/083-1	28.06.07	15:43	72° 0,37'	14° 43,10'	1290,0	WOOD	
PS70/083-1	28.06.07	16:43	72° 0,46'	14° 43,15'	1298,0	WOOD	
PS70/083-1	28.06.07	17:06	72° 0,36'	14° 43,21'	1289,0	WOOD	
PS70/084-1	28.06.07	17:13	72° 0,35'	14° 43,24'	1291,0	WOOD	
PS70/084-1	28.06.07	17:56	72° 0,44'	14° 43,85'	1289,0	WOOD	
PS70/084-1	28.06.07	18:12	72° 0,42'	14° 43,59'	1291,0	WOOD	
PS70/084-1	28.06.07	18:37	72° 0,41'	14° 43,64'	1291,0	WOOD	
PS70/085-1	28.06.07	18:59	72° 0,07'	14° 44,06'	1298,0	BC	surface
PS70/085-1	28.06.07	19:21	72° 0,11'	14° 44,11'	1294,0	BC	at sea bottom
PS70/085-1	28.06.07	19:40	72° 0,21'	14° 43,99'	1291,0	BC	on deck
PS70/086-1	28.06.07	19:54	72° 0,26'	14° 43,56'	1294,0	BC	surface
PS70/086-1	28.06.07	20:16	72° 0,24'	14° 43,57'	1293,0	BC	at sea bottom
PS70/086-1	28.06.07	20:34	72° 0,24'	14° 43,49'	1292,0	BC	on deck
PS70/087-1	28.06.07	21:24	71° 59,65'	14° 54,55'	1196,0	HS_PS	start track
PS70/087-1	29.06.07	04:10	71° 56,31'	14° 40,98'	1319,0	HS_PS	profile end
PS70/088-1	29.06.07	05:01	72° 0,31'	14° 43,18'	1292,0	COLOSSOS	

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/088-1	29.06.07	06:22	72° 0,33'	14° 43,11’	1290,0	COLOSSOS	
PS70/088-1	29.06.07	06:28	72° 0,32'	14° 43,10’	1289,0	COLOSSOS	
PS70/088-1	29.06.07	06:30	72° 0,31'	14° 43,09’	1290,0	COLOSSOS	
PS70/088-1	29.06.07	06:35	72° 0,32'	14° 43,09’	1291,0	COLOSSOS	
PS70/088-1	29.06.07	06:51	72° 0,33'	14° 43,01’	1289,0	COLOSSOS	
PS70/089-1	29.06.07	07:09	72° 0,30'	14° 42,83’	1291,0	ROV	surface
PS70/089-1	29.06.07	08:07	72° 0,38'	14° 43,09’	1291,0	ROV	at depth
PS70/088-1	29.06.07	18:13	72° 0,31'	14° 42,89’	1294,0	COLOSSOS	
PS70/088-1	29.06.07	19:01	72° 0,37'	14° 42,86’	0,0	COLOSSOS	
PS70/089-1	29.06.07	20:23	72° 0,34'	14° 42,84’	1296,0	ROV	on deck
PS70/088-1	29.06.07	20:48	71° 59,93'	14° 45,16’	1290,0	COLOSSOS	
PS70/073-1	29.06.07	20:55	71° 59,83'	14° 45,23’	1288,0	LADER	released
PS70/073-1	29.06.07	21:33	72° 0,19'	14° 44,16’	1294,0	LADER	on Deck
PS70/090-1	29.06.07	22:10	72° 0,08'	14° 42,24’	1301,0	GC	surface
PS70/090-1	29.06.07	22:45	72° 0,09'	14° 42,07’	1302,0	GC	at sea bottom
PS70/090-1	29.06.07	23:11	72° 0,12'	14° 41,94’	1304,0	GC	on deck
PS70/091-1	29.06.07	23:37	72° 0,30'	14° 43,58’	1292,0	GC	surface
PS70/091-1	29.06.07	23:43	72° 0,32'	14° 43,60’	1290,0	GC	information
PS70/091-1	30.06.07	00:18	72° 0,32'	14° 43,47’	1291,0	GC	at sea bottom
PS70/091-1	30.06.07	00:28	72° 0,31'	14° 43,44’	1293,0	GC	off ground hoisting
PS70/091-1	30.06.07	00:50	72° 0,33'	14° 43,52’	1290,0	GC	information
PS70/091-1	30.06.07	00:56	72° 0,31'	14° 43,53’	1291,0	GC	on deck
PS70/092-1	30.06.07	01:18	72° 0,31'	14° 43,59’	1291,0	GC	surface
PS70/092-1	30.06.07	01:25	72° 0,31'	14° 43,61’	1292,0	GC	information
PS70/092-1	30.06.07	01:53	72° 0,31'	14° 43,41’	1293,0	GC	at sea bottom
PS70/092-1	30.06.07	02:29	72° 0,32'	14° 43,53’	1290,0	GC	on deck
PS70/093-1	30.06.07	02:54	72° 0,27'	14° 43,42’	1290,0	GC	surface
PS70/093-1	30.06.07	02:59	72° 0,26'	14° 43,45’	1292,0	GC	information
PS70/093-1	30.06.07	03:17	72° 0,31'	14° 43,47’	1291,0	GC	at sea bottom
PS70/093-1	30.06.07	03:56	72° 0,30'	14° 43,32’	1293,0	GC	on deck
PS70/094-1	30.06.07	04:21	72° 0,31'	14° 43,54’	1291,0	GC	surface
PS70/094-1	30.06.07	04:25	72° 0,32'	14° 43,51’	1292,0	GC	information
PS70/094-1	30.06.07	04:53	72° 0,29'	14° 43,46’	1292,0	GC	at sea bottom
PS70/094-1	30.06.07	05:02	72° 0,26'	14° 43,43’	1292,0	GC	off ground hoisting
PS70/094-1	30.06.07	05:30	72° 0,36'	14° 43,36’	1292,0	GC	on deck
PS70/095-1	30.06.07	06:34	72° 0,30'	14° 43,15’	1290,0	COLOSSOS	
PS70/095-1	30.06.07	08:23	72° 0,34'	14° 43,01’	1294,0	COLOSSOS	
PS70/095-1	30.06.07	08:24	72° 0,34'	14° 43,00’	1294,0	COLOSSOS	
PS70/096-1	30.06.07	08:55	72° 0,31'	14° 42,69’	1297,0	ROV	surface
PS70/095-1	30.06.07	15:14	72° 0,39'	14° 42,88’	1296,0	COLOSSOS	
PS70/096-1	30.06.07	16:47	72° 0,35'	14° 43,10’	1291,0	ROV	on deck
PS70/095-1	30.06.07	17:18	72° 0,70'	14° 45,64’	1270,0	COLOSSOS	
PS70/097-1	30.06.07	17:59	72° 0,46'	14° 44,22’	1293,0	GC	surface
PS70/097-1	30.06.07	18:34	72° 0,48'	14° 43,92’	1290,0	GC	at sea bottom
PS70/097-1	30.06.07	19:01	72° 0,45'	14° 44,07’	1295,0	GC	on deck
PS70/098-1	30.06.07	19:23	72° 0,42'	14° 44,05’	1293,0	GC	surface
PS70/098-1	30.06.07	19:49	72° 0,45'	14° 44,00’	1293,0	GC	at sea bottom
PS70/098-1	30.06.07	20:14	72° 0,49'	14° 43,89’	1298,0	GC	on deck
PS70/099-1	30.06.07	20:40	72° 0,36'	14° 43,50’	1291,0	TRAPF	surface

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/100-1	30.06.07	20:48	72° 0,28'	14° 43,45’	1292,0	MUC	surface
PS70/100-1	30.06.07	21:32	72° 0,18'	14° 42,89’	1292,0	MUC	at sea bottom
PS70/100-1	30.06.07	21:56	72° 0,19'	14° 43,26’	1292,0	MUC	on deck
PS70/101-1	30.06.07	22:03	72° 0,20'	14° 43,14’	1290,0	MUC	surface
PS70/101-1	30.06.07	22:43	72° 0,19'	14° 43,04’	0,0	MUC	at sea bottom
PS70/101-1	30.06.07	23:08	72° 0,20'	14° 43,08’	1291,0	MUC	on deck
PS70/102-1	30.06.07	23:40	72° 0,45'	14° 44,02’	1293,0	GC	surface
PS70/102-1	01.07.07	00:04	72° 0,44'	14° 43,98’	1293,0	GC	at sea bottom
PS70/102-1	01.07.07	00:28	72° 0,42'	14° 44,11’	1294,0	GC	on deck
PS70/103-1	01.07.07	00:43	72° 0,44'	14° 44,28’	1295,0	OS	surface
PS70/103-1	01.07.07	01:39	72° 0,44'	14° 43,93’	1285,0	OS	at depth
PS70/103-1	01.07.07	04:05	72° 0,48'	14° 43,22’	1297,0	OS	on deck
PS70/104-1	01.07.07	04:47	72° 0,11'	14° 43,25’	1293,0	COLOSSOS	
PS70/104-1	01.07.07	06:10	72° 0,13'	14° 43,17’	1289,0	COLOSSOS	
PS70/104-1	01.07.07	06:18	72° 0,08'	14° 43,15’	1283,6	COLOSSOS	
PS70/104-1	01.07.07	06:21	72° 0,07'	14° 43,18’	1285,4	COLOSSOS	
PS70/104-1	01.07.07	06:37	72° 0,08'	14° 43,16’	1284,0	COLOSSOS	
PS70/105-1	01.07.07	07:20	72° 0,10'	14° 43,06’	1292,0	ROV	surface
PS70/105-1	01.07.07	08:32	72° 0,12'	14° 43,16’	1291,0	ROV	at depth
PS70/104-1	01.07.07	19:46	72° 0,11'	14° 42,95’	0,0	COLOSSOS	
PS70/104-1	01.07.07	20:10	72° 0,11'	14° 42,58’	1301,0	COLOSSOS	
PS70/105-1	01.07.07	20:50	72° 0,07'	14° 42,82’	1299,0	ROV	on deck
PS70/104-1	01.07.07	21:14	71° 59,75'	14° 44,83’	1291,0	COLOSSOS	
PS70/106-1	01.07.07	21:40	72° 0,19'	14° 43,25’	1291,0	MUC	surface
PS70/106-1	01.07.07	22:06	72° 0,18'	14° 43,23’	1289,0	MUC	at sea bottom
PS70/106-1	01.07.07	22:34	72° 0,17'	14° 43,27’	1290,0	MUC	on deck
PS70/107-1	01.07.07	22:55	72° 0,20'	14° 43,24’	1294,0	MUC	surface
PS70/107-1	01.07.07	23:23	72° 0,18'	14° 43,24’	1290,0	MUC	at sea bottom
PS70/107-1	01.07.07	23:46	72° 0,22'	14° 43,24’	1291,0	MUC	on deck
PS70/108-1	02.07.07	00:19	72° 0,20'	14° 43,27’	1291,0	MUC	surface
PS70/108-1	02.07.07	00:44	72° 0,20'	14° 43,23’	1292,0	MUC	at sea bottom
PS70/108-1	02.07.07	01:10	72° 0,16'	14° 43,34’	1294,0	MUC	on deck
PS70/109-1	02.07.07	02:00	71° 59,75'	14° 42,75’	1302,0	GC	surface
PS70/109-1	02.07.07	02:41	71° 59,79'	14° 42,64’	1303,0	GC	at sea bottom
PS70/109-1	02.07.07	03:09	71° 59,79'	14° 42,68’	1301,0	GC	on deck
PS70/110-1	02.07.07	03:36	72° 0,34'	14° 43,73’	1293,0	GC	surface
PS70/110-1	02.07.07	04:05	72° 0,38'	14° 43,50’	1291,0	GC	at sea bottom
PS70/110-1	02.07.07	04:28	72° 0,30'	14° 43,48’	1291,0	GC	on deck
PS70/111-1	02.07.07	05:58	72° 0,18'	14° 43,81’	1293,0	COLOSSOS	
PS70/111-1	02.07.07	07:34	72° 0,12'	14° 43,86’	1293,0	COLOSSOS	
PS70/111-1	02.07.07	07:35	72° 0,12'	14° 43,85’	1292,0	COLOSSOS	
PS70/111-1	02.07.07	07:55	72° 0,14'	14° 44,08’	1293,0	COLOSSOS	
PS70/112-1	02.07.07	08:13	72° 0,15'	14° 43,89’	1293,0	ROV	surface
PS70/112-1	02.07.07	09:25	72° 0,18'	14° 43,99’	1292,0	ROV	at depth
PS70/111-1	02.07.07	17:44	72° 0,15'	14° 44,12’	1294,0	COLOSSOS	
PS70/112-1	02.07.07	17:46	72° 0,15'	14° 44,13’	1293,0	ROV	coming back to the surface
PS70/111-1	02.07.07	18:05	72° 0,18'	14° 44,30’	1294,0	COLOSSOS	
PS70/112-1	02.07.07	19:15	72° 0,17'	14° 44,98’	1289,0	ROV	on deck

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/111-1	02.07.07	19:45	71° 59,49'	14° 46,29'	1284,0	COLOSSOS	
PS70/113-1	02.07.07	20:09	72° 0,37'	14° 43,57'	1290,0	PC	surface
PS70/113-1	02.07.07	20:48	72° 0,38'	14° 43,71'	1291,0	PC	at sea bottom
PS70/113-1	02.07.07	21:21	72° 0,45'	14° 43,87'	1289,0	PC	on Deck
PS70/114-1	02.07.07	21:37	72° 0,13'	14° 43,94'	1294,0	GC	surface
PS70/114-1	02.07.07	22:11	72° 0,22'	14° 43,91'	1293,0	GC	at sea bottom
PS70/114-1	02.07.07	22:21	72° 0,23'	14° 43,90'	1294,0	GC	off ground hoisting
PS70/114-1	02.07.07	22:46	72° 0,22'	14° 43,84'	1294,0	GC	on deck
PS70/115-1	02.07.07	23:25	72° 0,35'	14° 43,65'	1292,0	GC	surface
PS70/115-1	02.07.07	23:55	72° 0,38'	14° 43,61'	1290,0	GC	at sea bottom
PS70/115-1	03.07.07	00:05	72° 0,38'	14° 43,61'	1291,0	GC	off ground hoisting
PS70/115-1	03.07.07	00:30	72° 0,40'	14° 43,64'	1292,0	GC	on deck
PS70/116-1	03.07.07	01:07	72° 0,29'	14° 43,67'	1294,0	GC	surface
PS70/116-1	03.07.07	01:50	72° 0,33'	14° 43,56'	1292,0	GC	at sea bottom
PS70/116-1	03.07.07	01:59	72° 0,33'	14° 43,53'	1292,0	GC	off ground hoisting
PS70/116-1	03.07.07	02:36	72° 0,33'	14° 43,53'	1291,0	GC	on deck
PS70/117-1	03.07.07	03:06	72° 0,05'	14° 43,75'	1296,0	GC	surface
PS70/117-1	03.07.07	03:32	72° 0,16'	14° 43,88'	1293,0	GC	at sea bottom
PS70/117-1	03.07.07	03:57	72° 0,22'	14° 43,83'	1292,0	GC	on deck
PS70/118-1	03.07.07	04:40	72° 0,34'	14° 43,15'	1291,0	COLOSSOS	
PS70/118-1	03.07.07	06:10	72° 0,39'	14° 43,16'	1292,0	COLOSSOS	
PS70/118-1	03.07.07	06:19	72° 0,33'	14° 43,14'	1290,0	COLOSSOS	
PS70/118-1	03.07.07	06:22	72° 0,32'	14° 43,11'	1290,0	COLOSSOS	
PS70/118-1	03.07.07	06:38	72° 0,35'	14° 43,21'	1291,0	COLOSSOS	
PS70/119-1	03.07.07	06:40	72° 0,34'	14° 43,17'	1292,0	ROV	surface
PS70/119-1	03.07.07	07:52	72° 0,26'	14° 43,08'	1293,0	ROV	at depth
PS70/118-1	03.07.07	18:52	72° 0,39'	14° 43,66'	1291,0	COLOSSOS	
PS70/119-1	03.07.07	19:04	72° 0,38'	14° 43,75'	1290,0	ROV	coming back to the surface
PS70/118-1	03.07.07	19:16	72° 0,42'	14° 43,70'	1292,0	COLOSSOS	
PS70/119-1	03.07.07	20:26	72° 0,31'	14° 43,73'	1292,0	ROV	on deck
PS70/118-1	03.07.07	21:01	72° 0,01'	14° 46,37'	1278,0	COLOSSOS	
PS70/120-1	03.07.07	21:34	72° 0,32'	14° 43,25'	1289,0	GC	surface
PS70/120-1	03.07.07	22:07	72° 0,37'	14° 43,39'	1291,0	GC	at sea bottom
PS70/120-1	03.07.07	22:07	72° 0,37'	14° 43,39'	1291,0	GC	off ground hoisting
PS70/120-1	03.07.07	22:31	72° 0,36'	14° 43,23'	1291,0	GC	on deck
PS70/121-1	03.07.07	23:05	72° 0,31'	14° 41,95'	1302,0	GC	surface
PS70/121-1	03.07.07	23:57	72° 0,30'	14° 42,08'	1299,0	GC	at sea bottom
PS70/121-1	03.07.07	23:57	72° 0,30'	14° 42,08'	1299,0	GC	off ground hoisting
PS70/121-1	04.07.07	00:23	72° 0,29'	14° 42,13'	1299,0	GC	on deck
PS70/122-1	04.07.07	00:43	72° 0,12'	14° 43,28'	1294,0	GC	surface
PS70/122-1	04.07.07	01:02	72° 0,16'	14° 43,24'	1292,0	GC	at sea bottom
PS70/122-1	04.07.07	01:03	72° 0,15'	14° 43,26'	1294,0	GC	off ground hoisting
PS70/122-1	04.07.07	01:27	72° 0,13'	14° 43,26'	1291,0	GC	on deck
PS70/123-1	04.07.07	01:54	72° 0,15'	14° 42,70'	1291,1	OS	surface
PS70/123-1	04.07.07	02:28	72° 0,22'	14° 42,75'	1288,9	OS	at depth
PS70/123-1	04.07.07	03:29	72° 0,16'	14° 41,64'	1304,9	OS	on deck
PS70/099-1	04.07.07	03:38	72° 0,30'	14° 43,29'	1285,2	TRAPF	released
PS70/099-1	04.07.07	03:49	72° 0,31'	14° 43,40'	1293,0	TRAPF	Hydrophon to the water

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/099-1	04.07.07	03:50	72° 0,31'	14° 43,40’	1292,0	TRAPF	released
PS70/099-1	04.07.07	03:52	72° 0,32'	14° 43,40’	1295,0	TRAPF	Hydrophon out of the water
PS70/099-1	04.07.07	04:07	72° 0,32'	14° 43,40’	1291,0	TRAPF	Aborted, trap not afloat
PS70/124-1	04.07.07	04:45	72° 0,21'	14° 42,14’	1298,0	COLOSSOS	
PS70/124-1	04.07.07	06:27	72° 0,11'	14° 43,74’	1290,0	COLOSSOS	
PS70/125-1	04.07.07	07:30	72° 0,05'	14° 43,78’	1293,0	ROV	surface
PS70/125-1	04.07.07	08:40	72° 0,14'	14° 43,59’	1289,0	ROV	Information
PS70/124-1	04.07.07	18:18	72° 0,16'	14° 43,38’	1292,0	COLOSSOS	
PS70/124-1	04.07.07	18:39	72° 0,16'	14° 43,40’	1293,0	COLOSSOS	
PS70/125-1	04.07.07	19:26	72° 0,21'	14° 43,67’	1294,0	ROV	on deck
PS70/124-1	04.07.07	19:56	72° 0,34'	14° 45,52’	1282,0	COLOSSOS	
PS70/126-1	04.07.07	20:20	72° 0,32'	14° 43,23’	1289,0	PC	surface
PS70/126-1	04.07.07	20:56	72° 0,38'	14° 43,41’	1291,0	PC	at sea bottom
PS70/126-1	04.07.07	21:29	72° 0,56'	14° 44,43’	1292,0	PC	on Deck
PS70/127-1	04.07.07	21:50	72° 0,30'	14° 43,49’	1293,0	TRAPF	surface
PS70/128-1	04.07.07	22:11	72° 0,32'	14° 43,64’	1289,0	OS	surface
PS70/128-1	04.07.07	22:49	72° 0,31'	14° 43,71’	1285,2	OS	at depth
PS70/128-1	05.07.07	01:01	72° 0,19'	14° 40,52’	1318,7	OS	at depth
PS70/128-1	05.07.07	01:34	72° 0,30'	14° 40,87’	1314,0	OS	on deck
PS70/129-1	05.07.07	01:56	72° 0,28'	14° 43,56’	1287,2	GC	surface
PS70/129-1	05.07.07	02:37	72° 0,28'	14° 43,61’	1295,0	GC	at sea bottom
PS70/129-1	05.07.07	02:47	72° 0,30'	14° 43,60’	1292,0	GC	off ground hoisting
PS70/129-1	05.07.07	03:13	72° 0,29'	14° 43,46’	1292,0	GC	on deck
PS70/130-1	05.07.07	03:43	72° 0,30'	14° 43,58’	1292,0	GC	surface
PS70/130-1	05.07.07	04:10	72° 0,26'	14° 43,59’	1293,0	GC	at sea bottom
PS70/130-1	05.07.07	04:19	72° 0,27'	14° 43,58’	1297,0	GC	off ground hoisting
PS70/130-1	05.07.07	04:45	72° 0,26'	14° 43,75’	1292,0	GC	on deck
PS70/131-1	05.07.07	05:15	72° 0,29'	14° 43,95’	1290,0	COLOSSOS	
PS70/131-1	05.07.07	06:45	72° 0,30'	14° 43,95’	1291,0	COLOSSOS	
PS70/131-1	05.07.07	06:47	72° 0,28'	14° 43,92’	1288,0	COLOSSOS	
PS70/131-1	05.07.07	06:51	72° 0,29'	14° 43,90’	1291,0	COLOSSOS	
PS70/131-1	05.07.07	07:06	72° 0,33'	14° 43,83’	1291,0	COLOSSOS	
PS70/132-1	05.07.07	07:17	72° 0,33'	14° 43,44’	1289,0	ROV	surface
PS70/099-1	05.07.07	18:06	72° 0,37'	14° 43,83’	1296,0	TRAPF	released
PS70/099-1	05.07.07	18:55	72° 0,30'	14° 43,81’	1291,0	TRAPF	on deck
PS70/131-1	05.07.07	19:06	72° 0,26'	14° 43,86’	1291,0	COLOSSOS	
PS70/132-1	05.07.07	19:07	72° 0,27'	14° 43,86’	1292,0	ROV	coming back to the surface
PS70/132-1	05.07.07	20:25	72° 0,35'	14° 43,77’	1291,0	ROV	on deck
PS70/131-1	05.07.07	20:47	72° 0,23'	14° 44,72’	1293,0	COLOSSOS	
PS70/133-1	05.07.07	21:16	72° 0,06'	14° 43,28’	1294,0	PC	surface
PS70/133-1	05.07.07	21:49	72° 0,14'	14° 43,35’	1291,0	PC	at sea bottom
PS70/133-1	05.07.07	22:24	72° 0,26'	14° 43,35’	1292,0	PC	on Deck
PS70/134-1	05.07.07	22:42	72° 0,27'	14° 43,39’	1291,0	GKG	surface
PS70/134-1	05.07.07	22:59	72° 0,26'	14° 43,29’	1292,0	GKG	at sea bottom
PS70/134-1	05.07.07	23:20	72° 0,27'	14° 43,31’	1292,0	GKG	on deck
PS70/135-1	05.07.07	23:21	72° 0,27'	14° 43,32’	1291,0	GKG	surface
PS70/135-1	05.07.07	23:55	72° 0,27'	14° 43,18’	1291,0	GKG	at sea bottom

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/135-1	06.07.07	00:14	72° 0,28'	14° 43,16’	1292,0	GKG	on deck
PS70/136-1	06.07.07	00:24	72° 0,27'	14° 43,13’	1292,0	GKG	surface
PS70/136-1	06.07.07	00:41	72° 0,28'	14° 43,14’	1293,0	GKG	at sea bottom
PS70/136-1	06.07.07	01:00	72° 0,27'	14° 43,23’	1290,0	GKG	on deck
PS70/137-1	06.07.07	01:18	72° 0,22'	14° 43,32’	1292,0	GC	surface
PS70/137-1	06.07.07	01:40	72° 0,22'	14° 43,49’	1294,0	GC	at sea bottom
PS70/137-1	06.07.07	01:49	72° 0,23'	14° 43,49’	1293,0	GC	off ground hoisting
PS70/137-1	06.07.07	02:14	72° 0,22'	14° 43,45’	1293,0	GC	on deck
PS70/138-1	06.07.07	02:44	72° 0,23'	14° 43,45’	1294,0	GC	surface
PS70/138-1	06.07.07	03:06	72° 0,20'	14° 43,41’	1293,0	GC	at sea bottom
PS70/138-1	06.07.07	03:16	72° 0,20'	14° 43,38’	1292,0	GC	off ground hoisting
PS70/138-1	06.07.07	03:39	72° 0,22'	14° 43,47’	1294,0	GC	on deck
PS70/139-1	06.07.07	05:28	72° 0,22'	14° 43,36’	1293,0	COLOSSOS	
PS70/139-1	06.07.07	07:06	72° 0,23'	14° 43,29’	1293,0	COLOSSOS	
PS70/139-1	06.07.07	07:08	72° 0,24'	14° 43,23’	1294,0	COLOSSOS	
PS70/139-1	06.07.07	07:11	72° 0,23'	14° 43,18’	1289,0	COLOSSOS	
PS70/139-1	06.07.07	07:29	72° 0,24'	14° 43,19’	1292,0	COLOSSOS	
PS70/140-1	06.07.07	07:38	72° 0,25'	14° 43,12’	1293,0	ROV	surface
PS70/140-1	06.07.07	08:49	72° 0,25'	14° 43,36’	1291,0	ROV	Information
PS70/127-1	06.07.07	15:40	72° 0,30'	14° 43,81’	1291,0	TRAPF	released
PS70/127-1	06.07.07	15:58	72° 0,31'	14° 43,89’	1293,0	TRAPF	Information
PS70/139-1	06.07.07	17:10	72° 0,22'	14° 43,59’	1297,0	COLOSSOS	
PS70/140-1	06.07.07	17:11	72° 0,22'	14° 43,59’	1292,0	ROV	coming back to the surface
PS70/139-1	06.07.07	17:34	72° 0,11'	14° 43,82’	1293,0	COLOSSOS	
PS70/140-1	06.07.07	19:24	72° 0,07'	14° 43,62’	1294,0	ROV	on deck
PS70/139-1	06.07.07	19:55	71° 59,47'	14° 41,67’	1315,0	COLOSSOS	
PS70/127-1	06.07.07	20:38	71° 58,62'	14° 38,75’	1346,0	TRAPF	on deck
PS70/141-1	07.07.07	01:50	72° 0,44'	12° 3,70’	2010,0	MUC	surface
PS70/141-1	07.07.07	02:11	72° 0,45'	12° 3,93’	2004,0	MUC	at sea bottom
PS70/141-1	07.07.07	02:37	72° 0,53'	12° 3,74’	2008,0	MUC	on deck
PS70/142-1	07.07.07	13:13	73° 58,56'	12° 44,06’	1995,0	MUC	surface
PS70/142-1	07.07.07	13:33	73° 58,55'	12° 44,13’	1995,0	MUC	at sea bottom
PS70/142-1	07.07.07	13:58	73° 58,55'	12° 44,01’	1998,0	MUC	on deck
PS70/143-1	10.07.07	06:49	79° 0,95'	4° 21,65’	2586,0	MOR	released
PS70/143-1	10.07.07	08:03	79° 1,23'	4° 21,82’	2575,0	MOR	on deck
PS70/143-1	10.07.07	10:06	79° 2,59'	4° 23,63’	2457,0	MOR	on deck
PS70/143-1	10.07.07	10:06	79° 2,59'	4° 23,63’	2457,0	MOR	surface
PS70/144-1	10.07.07	10:16	79° 2,67'	4° 24,28’	2447,0	CTD/RO	surface
PS70/144-1	10.07.07	11:22	79° 3,21'	4° 25,38’	2416,0	CTD/RO	at depth
PS70/144-1	10.07.07	12:05	79° 3,52'	4° 25,83’	2385,0	CTD/RO	on deck
PS70/145-1	10.07.07	13:12	79° 4,77'	4° 7,06’	2493,3	LANDER	released
PS70/145-1	10.07.07	14:41	79° 5,38'	4° 4,95’	2506,0	LANDER	on Deck
PS70/146-1	10.07.07	15:15	79° 3,99'	4° 10,89’	2476,0	GKG	surface
PS70/146-1	10.07.07	15:47	79° 3,97'	4° 10,90’	2470,0	GKG	at sea bottom
PS70/146-1	10.07.07	16:25	79° 3,94'	4° 10,85’	2474,0	GBG	on deck
PS70/147-1	10.07.07	16:35	79° 3,94'	4° 10,73’	2475,0	MUC	surface
PS70/147-1	10.07.07	17:21	79° 3,92'	4° 10,55’	2477,0	MUC	at sea bottom
PS70/147-1	10.07.07	18:01	79° 3,92'	4° 10,41’	2481,0	MUC	on deck
PS70/148-1	10.07.07	19:55	79° 3,98'	4° 10,96’	2473,0	GKG	surface

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/148-1	10.07.07	20:41	79° 4,03'	4° 11,55’	2463,0	GKG	at sea bottom
PS70/148-1	10.07.07	21:21	79° 4,44'	4° 12,21’	2437,0	GKG	on deck
PS70/149-1	10.07.07	21:37	79° 3,84'	4° 11,34’	2476,0	CTD/RO	surface
PS70/149-1	10.07.07	22:33	79° 4,46'	4° 10,56’	2457,0	CTD/RO	at depth
PS70/149-1	10.07.07	23:17	79° 4,87'	4° 9,60’	2457,0	CTD/RO	on deck
PS70/150-1	11.07.07	00:33	79° 6,28'	4° 36,42’	1977,0	CTD/RO	surface
PS70/150-1	11.07.07	01:18	79° 6,24'	4° 36,23’	1994,0	CTD/RO	at depth
PS70/150-1	11.07.07	01:48	79° 6,29'	4° 36,28’	1980,0	CTD/RO	on deck
PS70/151-1	11.07.07	01:57	79° 6,27'	4° 36,01’	1989,0	MUC	surface
PS70/151-1	11.07.07	02:35	79° 6,15'	4° 34,81’	2037,0	MUC	at sea bottom
PS70/151-1	11.07.07	03:06	79° 6,13'	4° 34,29’	2053,0	MUC	on deck
PS70/152-1	11.07.07	03:47	79° 7,90'	4° 53,20’	1564,0	TRAPF	surface
PS70/153-1	11.07.07	06:07	79° 4,59'	4° 6,60’	2513,0	LANDER	surface
PS70/154-1	11.07.07	06:39	79° 4,51'	4° 6,65’	2516,0	LANDER	surface
PS70/155-1	11.07.07	07:06	79° 4,71'	4° 6,66’	2509,0	LANDER	surface
PS70/156-1	11.07.07	07:54	79° 4,46'	4° 5,83’	2529,0	ROV	surface
PS70/156-1	11.07.07	09:39	79° 4,48'	4° 6,41’	2520,0	ROV	at depth
PS70/154-1	11.07.07	13:47	79° 4,46'	4° 6,85’	2512,0	LANDER	released
PS70/156-1	11.07.07	13:52	79° 4,46'	4° 6,82’	2516,0	ROV	coming back to the surface
PS70/154-1	11.07.07	14:26	79° 4,47'	4° 6,85’	2515,0	LANDER	Information
PS70/156-1	11.07.07	16:06	79° 4,55'	4° 6,38’	2515,0	ROV	on deck
PS70/154-1	11.07.07	17:09	79° 5,61'	3° 57,04’	2580,0	LANDER	on Deck
PS70/157-1	11.07.07	17:54	79° 4,48'	4° 8,58’	2493,0	LANDER	surface
PS70/157-1	11.07.07	17:58	79° 4,48'	4° 8,62’	2491,0	LANDER	Information
PS70/158-1	11.07.07	19:27	79° 7,81'	4° 54,74’	1548,0	CTD/RO	surface
PS70/158-2	11.07.07	19:45	79° 7,73'	4° 54,19’	1563,0	HN	surface
PS70/158-2	11.07.07	19:56	79° 7,65'	4° 54,10’	1574,0	HN	on deck
PS70/158-1	11.07.07	20:07	79° 7,64'	4° 53,76’	1579,0	CTD/RO	at depth
PS70/158-1	11.07.07	20:39	79° 7,57'	4° 52,78’	1601,0	CTD/RO	on deck
PS70/159-1	11.07.07	20:52	79° 7,88'	4° 54,02’	1555,0	MUC	surface
PS70/159-1	11.07.07	21:19	79° 7,82'	4° 53,65’	1565,0	MUC	at sea bottom
PS70/159-1	11.07.07	21:46	79° 7,75'	4° 53,45’	1573,0	MUC	on deck
PS70/160-1	11.07.07	23:41	79° 8,07'	5° 59,62’	1306,0	BWS	surface
PS70/160-1	12.07.07	00:31	79° 8,08'	5° 59,31’	1307,0	BWS	at sea bottom
PS70/160-1	12.07.07	00:40	79° 8,11'	5° 59,27’	1305,0	BWS	off bottom
PS70/160-1	12.07.07	01:18	79° 8,09'	5° 59,36’	1305,0	BWS	on deck
PS70/161-1	12.07.07	01:26	79° 8,09'	5° 59,41’	1305,0	CTD/RO	surface
PS70/161-1	12.07.07	01:59	79° 8,07'	5° 59,41’	1305,0	CTD/RO	at depth
PS70/162-1	12.07.07	02:01	79° 8,07'	5° 59,39’	1304,0	PLA	surface
PS70/162-1	12.07.07	02:06	79° 8,07'	5° 59,34’	1306,0	PLA	on deck
PS70/161-1	12.07.07	02:25	79° 8,05'	5° 59,14’	1307,0	CTD/RO	on deck
PS70/163-1	12.07.07	02:34	79° 8,08'	5° 59,27’	1306,0	MUC	surface
PS70/163-1	12.07.07	02:59	79° 8,07'	5° 59,45’	1304,0	MUC	at sea bottom
PS70/163-1	12.07.07	03:24	79° 8,11'	5° 59,61’	1306,0	MUC	on deck
PS70/164-1	12.07.07	07:59	78° 36,91'	5° 0,18’	2372,0	OFOS	surface
PS70/164-1	12.07.07	08:50	78° 36,98'	5° 0,38’	2374,0	OFOS	at depth
PS70/164-1	12.07.07	11:04	78° 37,00'	5° 5,96’	2351,0	OFOS	Start Hoisting
PS70/164-1	12.07.07	12:05	78° 36,96'	5° 5,56’	2352,0	OFOS	on deck
PS70/165-1	12.07.07	12:24	78° 35,02'	5° 5,03’	2344,0	MOR	released
PS70/165-1	12.07.07	12:29	78° 34,94'	5° 4,78’	2348,0	MOR	on the surface

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/165-1	12.07.07	13:06	78° 35,07'	5° 4,17'	2351,0	MOR	on deck
PS70/165-1	12.07.07	13:11	78° 35,07'	5° 4,00'	2349,0	MOR	on deck
PS70/165-1	12.07.07	13:12	78° 35,07'	5° 3,97'	2351,0	MOR	on deck
PS70/165-1	12.07.07	13:23	78° 35,13'	5° 3,63'	2352,0	MOR	on deck
PS70/166-1	12.07.07	13:40	78° 35,19'	5° 3,13'	2355,0	MOR	released
PS70/165-1	12.07.07	13:45	78° 35,19'	5° 2,89'	2356,0	MOR	on deck
PS70/165-1	12.07.07	13:52	78° 35,23'	5° 2,66'	2356,0	MOR	on deck
PS70/165-1	12.07.07	13:53	78° 35,23'	5° 2,64'	2358,0	MOR	on deck
PS70/166-1	12.07.07	14:07	78° 35,61'	5° 3,03'	2355,0	MOR	on the surface
PS70/166-1	12.07.07	14:33	78° 36,52'	5° 3,29'	2348,0	MOR	action
PS70/166-1	12.07.07	14:37	78° 36,51'	5° 3,11'	2349,0	MOR	action
PS70/166-1	12.07.07	14:38	78° 36,50'	5° 3,08'	2352,0	MOR	on deck
PS70/167-1	12.07.07	14:57	78° 36,11'	5° 3,70'	2352,0	TRAPF	surface
PS70/168-1	12.07.07	16:23	78° 36,29'	5° 3,48'	2353,0	LANDER	surface
PS70/169-1	12.07.07	19:49	79° 4,14'	4° 16,22'	2409,0	BWS	surface
PS70/169-1	12.07.07	21:07	79° 4,42'	4° 14,35'	2414,0	BWS	at sea bottom
PS70/169-1	12.07.07	21:16	79° 4,43'	4° 14,33'	2416,0	BWS	off bottom
PS70/169-1	12.07.07	22:16	79° 4,64'	4° 14,01'	2410,0	BWS	on deck
PS70/170-1	12.07.07	22:55	79° 1,95'	4° 10,09'	2640,0	OFOS	surface
PS70/170-1	12.07.07	23:51	79° 2,27'	4° 11,44'	2613,0	OFOS	at depth
PS70/170-1	13.07.07	02:38	79° 3,89'	4° 17,22'	2422,0	OFOS	Start Hoisting
PS70/170-1	13.07.07	03:34	79° 3,76'	4° 18,28'	2422,0	OFOS	on deck
PS70/171-1	13.07.07	08:32	78° 36,22'	5° 5,13'	2353,0	ROV	surface
PS70/171-1	13.07.07	08:41	78° 36,29'	5° 4,97'	2348,0	ROV	Information
PS70/171-1	13.07.07	08:50	78° 36,32'	5° 4,66'	2349,0	ROV	on deck
PS70/171-1	13.07.07	09:47	78° 36,19'	5° 5,09'	2352,0	ROV	surface
PS70/171-1	13.07.07	16:15	78° 36,27'	5° 4,37'	2349,0	ROV	coming back to the surface
PS70/171-1	13.07.07	17:51	78° 36,25'	5° 4,20'	2349,0	ROV	on deck
PS70/172-1	13.07.07	18:14	78° 36,55'	5° 3,94'	2348,0	BWS	surface
PS70/172-1	13.07.07	19:30	78° 36,59'	5° 3,96'	2350,0	BWS	at sea bottom
PS70/172-1	13.07.07	19:41	78° 36,60'	5° 3,98'	2351,0	BWS	off bottom
PS70/172-1	13.07.07	20:36	78° 36,65'	5° 3,85'	2349,0	BWS	on deck
PS70/173-1	13.07.07	20:53	78° 36,56'	5° 3,98'	2348,0	CTD/RO	surface
PS70/173-2	13.07.07	21:41	78° 36,67'	5° 3,75'	2354,0	HN	surface
PS70/173-1	13.07.07	21:46	78° 36,67'	5° 3,70'	2353,0	CTD/RO	at depth
PS70/173-2	13.07.07	22:23	78° 36,68'	5° 3,81'	2348,0	HN	on deck
PS70/173-1	13.07.07	22:24	78° 36,68'	5° 3,82'	2350,0	CTD/RO	on deck
PS70/174-1	13.07.07	22:32	78° 36,66'	5° 3,90'	2350,0	MUC	surface
PS70/174-1	13.07.07	23:16	78° 36,54'	5° 3,82'	2354,0	MUC	at sea bottom
PS70/174-1	13.07.07	23:51	78° 36,57'	5° 3,82'	2352,0	MUC	on deck
PS70/175-1	14.07.07	01:15	78° 46,85'	5° 19,93'	2476,0	MUC	surface
PS70/175-1	14.07.07	01:53	78° 46,85'	5° 19,98'	2477,0	MUC	at sea bottom
PS70/175-1	14.07.07	02:28	78° 46,84'	5° 19,98'	2476,0	MUC	on deck
PS70/168-1	14.07.07	03:44	78° 36,55'	5° 4,74'	2354,0	LANDER	released
PS70/168-1	14.07.07	04:15	78° 36,45'	5° 4,56'	2351,0	LANDER	Information
PS70/168-1	14.07.07	04:37	78° 36,19'	5° 2,95'	2357,0	LANDER	on Deck
PS70/176-1	14.07.07	04:51	78° 36,26'	5° 4,02'	2351,0	COLOSSOS	
PS70/176-1	14.07.07	07:37	78° 36,26'	5° 4,24'	0,0	COLOSSOS	
PS70/176-1	14.07.07	08:08	78° 36,26'	5° 4,14'	0,0	COLOSSOS	
PS70/177-1	14.07.07	08:28	78° 36,27'	5° 4,42'	2340,2	ROV	surface

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/176-1	14.07.07	21:30	78° 36,24'	5° 4,52'	2351,0	COLOSSOS	
PS70/177-1	14.07.07	21:35	78° 36,23'	5° 4,58'	2348,0	ROV	coming back to the surface
PS70/177-1	14.07.07	23:20	78° 36,15'	5° 3,82'	2351,0	ROV	on deck
PS70/167-1	14.07.07	23:45	78° 35,92'	5° 0,48'	2366,0	TRAPF	released
PS70/176-1	14.07.07	23:57	78° 35,84'	5° 0,31'	2370,0	COLOSSOS	
PS70/167-1	15.07.07	00:41	78° 36,06'	5° 3,83'	2353,0	TRAPF	on deck
PS70/178-1	15.07.07	00:59	78° 36,60'	5° 4,07'	2346,0	CTD/RO	surface
PS70/178-2	15.07.07	01:24	78° 36,60'	5° 4,13'	2352,0	HN	surface
PS70/178-1	15.07.07	01:26	78° 36,60'	5° 4,15'	2347,0	CTD/RO	at depth
PS70/178-2	15.07.07	01:34	78° 36,60'	5° 4,18'	2348,0	HN	on deck
PS70/178-1	15.07.07	01:49	78° 36,60'	5° 4,20'	2347,0	CTD/RO	on deck
PS70/179-1	15.07.07	04:00	78° 55,10'	5° 0,14'	2641,0	MUC	surface
PS70/179-1	15.07.07	04:46	78° 55,10'	4° 59,90'	2641,0	MUC	at sea bottom
PS70/179-1	15.07.07	05:32	78° 55,08'	4° 59,66'	2642,0	MUC	on deck
PS70/155-1	15.07.07	07:10	79° 4,88'	4° 6,10'	2506,0	LANDER	Information
PS70/155-1	15.07.07	07:20	79° 4,85'	4° 6,77'	0,0	LANDER	released
PS70/155-1	15.07.07	07:25	79° 4,80'	4° 6,96'	0,0	LANDER	Information
PS70/155-1	15.07.07	07:28	79° 4,77'	4° 6,95'	0,0	LANDER	Information
PS70/155-1	15.07.07	07:36	79° 4,76'	4° 6,77'	2493,0	LANDER	Information
PS70/155-1	15.07.07	07:47	79° 4,73'	4° 6,44'	2509,0	LANDER	Information
PS70/155-1	15.07.07	08:04	79° 5,14'	4° 6,37'	2495,0	LANDER	on Deck
PS70/180-1	15.07.07	09:13	79° 7,76'	4° 54,36'	1556,0	GKG	surface
PS70/180-1	15.07.07	09:32	79° 7,80'	4° 54,20'	1558,0	GKG	at sea bottom
PS70/152-1	15.07.07	09:43	79° 7,84'	4° 54,01'	1557,0	TRAPF	released
PS70/180-1	15.07.07	09:53	79° 7,83'	4° 53,92'	1559,0	GKG	on deck
PS70/152-1	15.07.07	10:30	79° 7,83'	4° 52,63'	1580,0	TRAPF	on deck
PS70/181-1	15.07.07	14:01	78° 34,83'	5° 4,58'	2346,0	MOR	surface
PS70/181-1	15.07.07	14:05	78° 34,80'	5° 4,45'	2348,0	MOR	surface
PS70/181-1	15.07.07	14:14	78° 34,80'	5° 4,22'	2353,0	MOR	surface
PS70/181-1	15.07.07	14:18	78° 34,81'	5° 4,11'	2350,0	MOR	surface
PS70/181-1	15.07.07	14:42	78° 34,78'	5° 3,56'	2356,0	MOR	surface
PS70/181-1	15.07.07	15:03	78° 34,78'	5° 2,95'	2357,0	MOR	surface
PS70/181-1	15.07.07	15:08	78° 34,78'	5° 2,79'	2357,0	MOR	surface
PS70/181-1	15.07.07	15:14	78° 34,80'	5° 2,63'	2358,0	MOR	surface
PS70/181-1	15.07.07	15:15	78° 34,80'	5° 2,63'	2358,0	MOR	Hydrophone into the water
PS70/181-1	15.07.07	15:22	78° 34,81'	5° 2,81'	2360,0	MOR	on the ground
PS70/181-1	15.07.07	15:22	78° 34,81'	5° 2,81'	2360,0	MOR	released
PS70/181-1	15.07.07	15:23	78° 34,82'	5° 2,83'	2360,0	MOR	Hydrophone on Deck
PS70/182-1	15.07.07	16:08	78° 36,44'	5° 4,63'	2352,0	MOR	surface
PS70/182-1	15.07.07	16:10	78° 36,44'	5° 4,62'	2353,0	MOR	slipped
PS70/183-1	15.07.07	20:36	79° 3,93'	3° 41,89'	2981,0	MUC	surface
PS70/183-1	15.07.07	21:28	79° 3,92'	3° 41,86'	2990,0	MUC	at sea bottom
PS70/183-1	15.07.07	22:11	79° 3,88'	3° 41,86'	3003,0	MUC	on deck
PS70/184-1	15.07.07	22:41	79° 3,52'	3° 33,96'	3593,1	MUC	surface
PS70/184-1	15.07.07	23:36	79° 3,60'	3° 34,81'	3548,0	MUC	at sea bottom
PS70/184-1	16.07.07	00:25	79° 3,65'	3° 34,97'	3529,0	MUC	on deck
PS70/185-1	16.07.07	02:39	79° 1,01'	4° 20,69'	2591,0	LANDER	surface
PS70/186-1	16.07.07	03:34	79° 6,51'	4° 36,10'	1927,0	GKG	surface

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/186-1	16.07.07	03:58	79° 6,52'	4° 36,13’	1923,0	GKG	at sea bottom
PS70/186-1	16.07.07	04:22	79° 6,51'	4° 36,05’	1924,0	GKG	on deck
PS70/187-1	16.07.07	04:41	79° 6,89'	4° 38,52’	1777,0	TRAPF	surface
PS70/188-1	16.07.07	06:45	79° 7,94'	6° 5,19’	1289,0	MUC	surface
PS70/188-1	16.07.07	07:09	79° 8,00'	6° 5,32’	1291,0	MUC	at sea bottom
PS70/188-1	16.07.07	07:28	79° 8,01'	6° 5,08’	1290,0	MUC	on deck
PS70/189-1	16.07.07	07:40	79° 7,93'	6° 5,23’	1290,0	GKG	surface
PS70/189-1	16.07.07	07:57	79° 7,93'	6° 5,26’	1290,0	GKG	at sea bottom
PS70/189-1	16.07.07	08:13	79° 7,99'	6° 5,50’	1291,0	GKG	on deck
PS70/190-1	16.07.07	08:23	79° 7,97'	6° 5,35’	1290,0	MUC	surface
PS70/190-1	16.07.07	08:48	79° 7,88'	6° 5,31’	1287,0	MUC	at sea bottom
PS70/190-1	16.07.07	09:05	79° 7,85'	6° 5,25’	1288,0	MUC	on deck
PS70/191-1	16.07.07	10:29	79° 8,03'	6° 5,62’	1291,0	LANDER	surface
PS70/192-1	16.07.07	10:46	79° 7,95'	6° 5,14’	1288,0	MUC	surface
PS70/192-1	16.07.07	11:09	79° 7,94'	6° 5,10’	1288,0	MUC	at sea bottom
PS70/191-1	16.07.07	11:25	79° 7,95'	6° 5,06’	1289,0	LANDER	released
PS70/192-1	16.07.07	11:29	79° 7,95'	6° 5,06’	1287,0	MUC	on deck
PS70/191-1	16.07.07	11:55	79° 7,78'	6° 4,37’	1290,0	LANDER	on Deck
PS70/191-2	16.07.07	12:33	79° 8,02'	6° 5,51’	1291,0	LANDER	surface
PS70/193-1	16.07.07	14:53	79° 16,94'	4° 19,61’	2404,0	MUC	surface
PS70/193-1	16.07.07	15:30	79° 16,97'	4° 19,70’	2406,0	MUC	at sea bottom
PS70/193-1	16.07.07	16:10	79° 17,00'	4° 19,63’	2406,0	MUC	on deck
PS70/194-1	16.07.07	17:21	79° 24,55'	4° 41,74’	2551,0	MUC	surface
PS70/194-1	16.07.07	18:00	79° 24,57'	4° 41,80’	2552,0	MUC	at sea bottom
PS70/194-1	16.07.07	18:33	79° 24,58'	4° 41,10’	2551,0	MUC	on deck
PS70/195-1	16.07.07	20:09	79° 36,42'	5° 9,57’	2796,0	CTD/RO	surface
PS70/195-2	16.07.07	20:27	79° 36,39'	5° 9,08’	2800,0	HN	surface
PS70/195-2	16.07.07	20:43	79° 36,44'	5° 8,94’	2798,0	HN	on deck
PS70/195-1	16.07.07	21:17	79° 36,44'	5° 8,82’	2803,0	CTD/RO	at depth
PS70/195-1	16.07.07	22:15	79° 36,30'	5° 9,28’	2805,0	CTD/RO	on deck
PS70/196-1	16.07.07	22:28	79° 36,31'	5° 9,24’	2801,0	BWS	surface
PS70/196-1	16.07.07	23:49	79° 36,45'	5° 9,04’	2802,0	BWS	at sea bottom
PS70/196-1	17.07.07	01:28	79° 36,42'	5° 8,65’	2811,0	BWS	on deck
PS70/197-1	17.07.07	02:29	79° 36,28'	5° 9,71’	2801,0	MUC	surface
PS70/197-1	17.07.07	03:14	79° 36,32'	5° 9,23’	2804,0	MUC	at sea bottom
PS70/197-1	17.07.07	03:55	79° 36,30'	5° 9,05’	2809,0	MUC	on deck
PS70/198-1	17.07.07	03:56	79° 36,30'	5° 9,04’	2810,0	MOR	released
PS70/198-1	17.07.07	04:04	79° 36,27'	5° 9,00’	2805,0	MOR	on the surface
PS70/198-1	17.07.07	04:37	79° 36,24'	5° 6,93’	2829,0	MOR	on deck
PS70/198-1	17.07.07	04:44	79° 36,24'	5° 6,55’	2829,0	MOR	on deck
PS70/198-1	17.07.07	04:45	79° 36,24'	5° 6,52’	2833,0	MOR	on deck
PS70/198-1	17.07.07	05:07	79° 36,33'	5° 5,69’	2839,0	MOR	on deck
PS70/198-1	17.07.07	05:26	79° 36,30'	5° 4,65’	2862,0	MOR	on deck
PS70/198-1	17.07.07	05:31	79° 36,28'	5° 4,27’	2861,0	MOR	on deck
PS70/198-1	17.07.07	05:37	79° 36,25'	5° 3,83’	2865,0	MOR	on deck
PS70/198-1	17.07.07	05:40	79° 36,25'	5° 3,62’	2865,0	MOR	mooring on deck
PS70/199-1	17.07.07	07:30	79° 44,71'	4° 30,85’	2618,0	CTD/RO	surface
PS70/199-1	17.07.07	08:36	79° 44,43'	4° 29,07’	2637,0	CTD/RO	at depth
PS70/199-2	17.07.07	09:11	79° 44,11'	4° 28,81’	2695,0	HN	surface
PS70/199-1	17.07.07	09:23	79° 43,98'	4° 28,77’	2717,0	CTD/RO	on deck
PS70/199-2	17.07.07	09:25	79° 43,96'	4° 28,76’	2718,0	HN	on deck

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/200-1	17.07.07	09:37	79° 44,34'	4° 26,69'	2627,0	MUC	surface
PS70/200-1	17.07.07	10:21	79° 44,19'	4° 25,66'	2644,0	MUC	at sea bottom
PS70/200-1	17.07.07	11:08	79° 43,89'	4° 24,28'	2672,0	MUC	on deck
PS70/201-1	17.07.07	11:35	79° 44,45'	4° 29,86'	2669,0	MOR	surface
PS70/201-1	17.07.07	11:38	79° 44,42'	4° 29,79'	2673,0	MOR	surface
PS70/201-1	17.07.07	11:48	79° 44,36'	4° 29,65'	2665,0	MOR	surface
PS70/201-1	17.07.07	11:53	79° 44,32'	4° 29,55'	2685,0	MOR	surface
PS70/201-1	17.07.07	12:18	79° 44,12'	4° 29,08'	2706,0	MOR	surface
PS70/201-1	17.07.07	13:00	79° 43,92'	4° 28,60'	2715,0	MOR	surface
PS70/201-1	17.07.07	13:08	79° 43,86'	4° 28,46'	2719,0	MOR	surface
PS70/201-1	17.07.07	13:20	79° 43,80'	4° 28,15'	2720,0	MOR	Hydrophone into the water
PS70/201-1	17.07.07	13:22	79° 43,79'	4° 28,10'	2718,0	MOR	slipped
PS70/201-1	17.07.07	13:22	79° 43,79'	4° 28,10'	2718,0	MOR	Hydrophone on Deck
PS70/202-1	17.07.07	16:36	79° 35,88'	5° 9,51'	2802,0	OFOS	surface
PS70/202-1	17.07.07	17:25	79° 35,81'	5° 10,11'	2795,0	OFOS	at depth
PS70/202-1	17.07.07	17:31	79° 35,82'	5° 10,02'	2800,0	OFOS	action
PS70/202-1	17.07.07	22:07	79° 34,10'	5° 14,83'	2681,0	OFOS	Start Hoisting
PS70/202-1	17.07.07	23:08	79° 34,00'	5° 14,37'	2689,0	OFOS	on deck
PS70/191-2	18.07.07	03:38	79° 7,98'	6° 5,73'	1292,0	LANDER	released
PS70/191-2	18.07.07	03:57	79° 7,85'	6° 5,24'	1288,0	LANDER	Information
PS70/191-2	18.07.07	04:15	79° 7,86'	6° 4,41'	1286,0	LANDER	on Deck
PS70/187-1	18.07.07	06:35	79° 6,82'	4° 38,51'	1803,0	TRAPF	released
PS70/187-1	18.07.07	07:25	79° 7,11'	4° 39,30'	1804,0	TRAPF	on deck
PS70/185-1	18.07.07	08:22	79° 0,79'	4° 20,86'	2594,0	LANDER	released
PS70/185-1	18.07.07	09:02	79° 0,95'	4° 21,03'	2583,0	LANDER	Information
PS70/185-1	18.07.07	09:19	79° 1,39'	4° 21,87'	2560,0	LANDER	on Deck
PS70/203-1	18.07.07	10:48	79° 4,58'	4° 6,41'	0,0	POS	Begin
PS70/203-1	18.07.07	12:38	79° 4,60'	4° 6,80'	0,0	POS	End
PS70/203-2	18.07.07	12:55	79° 4,63'	4° 8,70'	0,0	POS	Begin
PS70/203-1	18.07.07	13:52	79° 4,76'	4° 6,34'	0,0	POS	End
PS70/203-2	18.07.07	13:52	79° 4,76'	4° 6,34'	0,0	POS	End
PS70/204-1	18.07.07	15:09	79° 1,06'	4° 20,46'	2581,2	POS	Surveillance
PS70/204-1	18.07.07	15:24	79° 1,12'	4° 20,67'	2577,0	POS	End
PS70/205-1	18.07.07	16:34	79° 5,62'	4° 7,77'	2449,0	LANDER	surface
PS70/206-1	18.07.07	17:26	79° 5,70'	4° 10,50'	2402,0	LANDER	surface
PS70/206-1	18.07.07	17:26	79° 5,70'	4° 10,50'	2402,0	LANDER	Information
PS70/207-1	18.07.07	19:46	79° 8,06'	5° 59,81'	1297,0	OFOS	surface
PS70/207-1	18.07.07	20:23	79° 7,97'	5° 59,62'	1299,0	OFOS	at depth
PS70/207-1	19.07.07	01:39	79° 8,04'	5° 46,40'	1322,0	OFOS	Start Hoisting
PS70/207-1	19.07.07	02:11	79° 8,05'	5° 46,34'	1323,0	OFOS	on deck
PS70/208-1	19.07.07	04:39	79° 0,91'	4° 20,80'	2589,0	ROV	surface
PS70/208-1	19.07.07	07:02	79° 0,96'	4° 20,61'	2598,0	ROV	at depth
PS70/208-1	19.07.07	08:34	79° 0,98'	4° 20,08'	2592,0	ROV	coming back to the surface
PS70/208-1	19.07.07	10:17	79° 0,98'	4° 20,35'	2594,0	ROV	on deck
PS70/208-1	19.07.07	10:28	79° 1,02'	4° 20,48'	2592,0	MOR	Hydrophone into the water
PS70/208-1	19.07.07	10:34	79° 0,96'	4° 20,94'	2592,0	MOR	released
PS70/208-1	19.07.07	10:35	79° 0,95'	4° 21,02'	2590,0	MOR	Hydrophone on Deck

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/208-1	19.07.07	11:45	79° 1,08'	4° 21,81’	2573,0	MOR	on deck
PS70/208-1	19.07.07	11:53	79° 1,03'	4° 22,43’	2575,0	MOR	on deck
PS70/205-1	19.07.07	12:40	79° 5,67'	4° 7,90’	2438,0	LANDER	released
PS70/205-1	19.07.07	13:33	79° 6,16'	4° 8,84’	2386,0	LANDER	on Deck
PS70/209-1	19.07.07	13:52	79° 5,68'	4° 7,63’	2444,0	GKG	surface
PS70/209-1	19.07.07	14:21	79° 5,74'	4° 7,60’	2446,0	GKG	at sea bottom
PS70/209-1	19.07.07	14:54	79° 5,72'	4° 7,47’	2450,0	GKG	on deck
PS70/210-1	19.07.07	15:07	79° 5,69'	4° 7,44’	2456,0	MUC	surface
PS70/210-1	19.07.07	15:44	79° 5,69'	4° 7,46’	2451,0	MUC	at sea bottom
PS70/210-1	19.07.07	16:20	79° 5,79'	4° 7,86’	2434,0	MUC	on deck
PS70/211-1	19.07.07	17:27	79° 3,56'	3° 28,65’	4051,0	MUC	surface
PS70/211-1	19.07.07	18:29	79° 3,59'	3° 28,50’	4065,0	MUC	at sea bottom
PS70/211-1	19.07.07	19:22	79° 3,58'	3° 28,51’	4064,0	MUC	on deck
PS70/212-1	19.07.07	19:55	79° 3,68'	3° 19,04’	5125,0	MUC	surface
PS70/212-1	19.07.07	21:18	79° 3,79'	3° 18,80’	5140,0	MUC	at sea bottom
PS70/212-1	19.07.07	22:29	79° 3,73'	3° 18,65’	5133,0	MUC	on deck
PS70/213-1	19.07.07	22:38	79° 3,78'	3° 18,67’	5142,0	CTD/RO	surface
PS70/213-2	19.07.07	23:32	79° 3,79'	3° 18,64’	5142,0	HN	surface
PS70/213-2	19.07.07	23:51	79° 3,69'	3° 18,51’	5129,0	HN	on deck
PS70/213-1	20.07.07	00:31	79° 3,67'	3° 18,58’	5130,0	CTD/RO	at depth
PS70/213-1	20.07.07	02:01	79° 3,63'	3° 18,07’	5134,0	CTD/RO	on deck
PS70/214-1	20.07.07	04:13	79° 4,52'	4° 8,73’	2490,0	COLOSSOS	
PS70/214-1	20.07.07	06:31	79° 4,38'	4° 9,16’	2484,0	COLOSSOS	
PS70/214-1	20.07.07	07:01	79° 4,44'	4° 9,38’	2478,0	COLOSSOS	
PS70/215-1	20.07.07	07:31	79° 4,58'	4° 8,54’	2487,0	ROV	surface
PS70/215-1	20.07.07	09:43	79° 4,54'	4° 8,99’	2480,0	ROV	at depth
PS70/215-1	20.07.07	21:02	79° 4,53'	4° 8,79’	2502,0	ROV	coming back to the surface
PS70/214-1	20.07.07	21:16	79° 4,55'	4° 9,26’	2482,0	COLOSSOS	
PS70/215-1	20.07.07	22:53	79° 4,58'	4° 8,94’	2484,0	ROV	on deck
PS70/214-1	20.07.07	23:16	79° 5,02'	4° 7,49’	2482,0	COLOSSOS	
PS70/206-1	20.07.07	23:35	79° 5,77'	4° 10,45’	2400,0	LANDER	released
PS70/206-1	21.07.07	00:27	79° 5,91'	4° 10,68’	2378,0	LANDER	on Deck
PS70/216-1	21.07.07	00:53	79° 4,59'	4° 10,79’	2449,0	LANDER	surface
PS70/217-1	21.07.07	01:44	79° 0,90'	4° 20,69’	2597,0	CTD/RO	surface
PS70/217-1	21.07.07	02:41	79° 0,95'	4° 21,05’	2590,0	CTD/RO	at depth
PS70/217-1	21.07.07	03:28	79° 0,99'	4° 21,20’	2587,0	CTD/RO	on deck
PS70/157-1	21.07.07	04:14	79° 4,55'	4° 9,30’	2473,0	LANDER	released
PS70/157-1	21.07.07	04:50	79° 4,43'	4° 8,79’	2491,0	LANDER	Information
PS70/157-1	21.07.07	05:16	79° 4,99'	4° 8,36’	2470,0	LANDER	Information
PS70/157-1	21.07.07	05:20	79° 4,99'	4° 8,47’	2470,0	LANDER	on Deck
PS70/218-1	21.07.07	06:12	79° 0,79'	4° 21,02’	2597,0	MOR	action
PS70/218-1	21.07.07	06:17	79° 0,84'	4° 20,90’	2595,0	MOR	surface
PS70/218-1	21.07.07	06:22	79° 0,84'	4° 20,85’	2594,0	MOR	action
PS70/218-1	21.07.07	06:28	79° 0,84'	4° 20,79’	2594,0	MOR	action
PS70/218-1	21.07.07	06:52	79° 0,83'	4° 20,66’	2596,0	MOR	action
PS70/218-1	21.07.07	06:55	79° 0,83'	4° 20,66’	2596,0	MOR	action
PS70/218-1	21.07.07	07:02	79° 0,83'	4° 20,65’	2598,0	MOR	action
PS70/218-1	21.07.07	07:25	79° 0,82'	4° 20,62’	2599,0	MOR	action
PS70/218-1	21.07.07	07:29	79° 0,82'	4° 20,60’	2598,0	MOR	action
PS70/218-1	21.07.07	07:34	79° 0,81'	4° 20,59’	2597,0	MOR	action

Station	Date	Time	Lat	Lon E	Depth (m)	Gear	Comment
PS70/218-1	21.07.07	07:47	79° 0,82'	4° 20,62’	2598,0	MOR	at depth
PS70/218-1	21.07.07	07:50	79° 0,81'	4° 20,63’	2598,0	MOR	releaser on deck
PS70/219-1	21.07.07	09:48	79° 7,95'	2° 50,57’	5586,0	LANDER	surface
PS70/220-1	21.07.07	11:20	79° 3,71'	3° 40,17’	3119,0	GKG	surface
PS70/220-1	21.07.07	12:00	79° 3,73'	3° 39,77’	3123,0	GKG	at sea bottom
PS70/220-1	21.07.07	12:40	79° 3,70'	3° 39,61’	3131,0	GKG	on deck
PS70/153-1	21.07.07	13:22	79° 4,69'	4° 6,90’	2504,0	LANDER	released
PS70/153-1	21.07.07	14:01	79° 4,73'	4° 6,92’	2505,0	LANDER	Information
PS70/153-1	21.07.07	14:21	79° 4,89'	4° 6,91’	2497,0	LANDER	on Deck
PS70/221-1	21.07.07	22:10	79° 8,03'	2° 50,59’	5593,0	BWS	surface
PS70/221-1	22.07.07	00:46	79° 8,07'	2° 50,57’	5585,0	BWS	at sea bottom
PS70/221-1	22.07.07	00:57	79° 8,08'	2° 50,59’	5595,0	BWS	off bottom
PS70/221-1	22.07.07	02:41	79° 8,12'	2° 50,31’	5585,0	BWS	on deck
PS70/222-1	22.07.07	02:52	79° 8,14'	2° 50,41’	5585,0	MUC	surface
PS70/222-1	22.07.07	04:19	79° 8,21'	2° 50,77’	5590,0	MUC	at sea bottom
PS70/222-1	22.07.07	06:05	79° 8,24'	2° 50,63’	5588,0	MUC	on deck
PS70/216-1	22.07.07	08:08	79° 4,52'	4° 8,30’	2496,0	LANDER	released
PS70/216-1	22.07.07	09:15	79° 5,04'	4° 9,88’	2449,0	LANDER	on Deck
PS70/223-1	22.07.07	09:25	79° 5,11'	4° 9,10’	2456,0	LANDER	surface
PS70/219-1	22.07.07	11:59	79° 7,89'	2° 50,23’	0,0	LANDER	released
PS70/223-1	22.07.07	12:29	79° 7,64'	2° 50,50’	5548,0	LANDER	Information
PS70/219-1	22.07.07	13:44	79° 7,26'	2° 50,91’	5519,9	LANDER	on Deck
PS70/224-1	22.07.07	22:18	78° 0,02'	6° 30,01’	2045,0	MUC	surface
PS70/224-1	22.07.07	22:45	77° 59,95'	6° 29,70’	2039,0	MUC	at sea bottom
PS70/224-1	22.07.07	23:14	77° 59,88'	6° 28,93’	2032,0	MUC	on deck
PS70/225-1	23.07.07	06:55	76° 57,48'	3° 26,88’	3299,0	MOR	on deck
PS70/226-1	23.07.07	12:00	76° 0,08'	6° 17,82’	2262,0	MUC	surface
PS70/226-1	23.07.07	12:36	76° 0,02'	6° 18,11’	2255,0	MUC	at sea bottom
PS70/226-1	23.07.07	13:16	75° 59,98'	6° 18,36’	2248,0	MUC	on deck

Abbreviations

AUV	Autonomous Underwater Vehicle
BWS	Bottom Water Sampler
COLOSSOS	Lift system
CTD/RO	Conductivity-Temperature-Depth / Rosette
DAPC	Dynamic Autoclave Piston Corer
GC	Gravity Corer
GKG	Giant box corer
HF	Heat Flow (temperature lance)
HN	Hand Net
HS_PS	Hydrosweep - Parasound
JAGO	Manned Submersible
Lander	Free falling Lander
MOR	Mooring
MUC	Multicorer
OFOS	Ocean Floor Observing System
PC	Piston Corer (syn. DAPC)

PHC	Photon Counter
ROV	Remotely Operated Vehicle
TRAPF	Fish trap
VGRAB	van Veen grab
VIDEO	Towed Video system

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