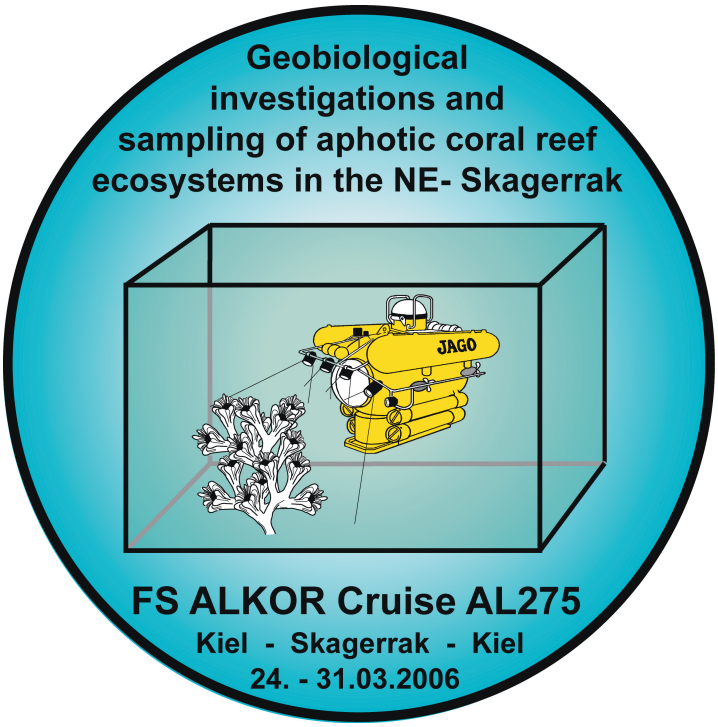
IFM-GEOMAR REPORT

IFM-GEOMAR
Leibniz-Institut für Meereswissenschaften
an der Universität Kiel

FS ALKOR
Fahrtbericht / Cruise Report AL 275

Geobiological investigations and sampling of aphotic coral reef ecosystems in the NE- Skagerrak

Kiel - Kiel
24.03. - 30.03.2006



Berichte aus dem Leibniz-Institut
für Meereswissenschaften an der
Christian-Albrechts-Universität zu Kiel

Nr. 10
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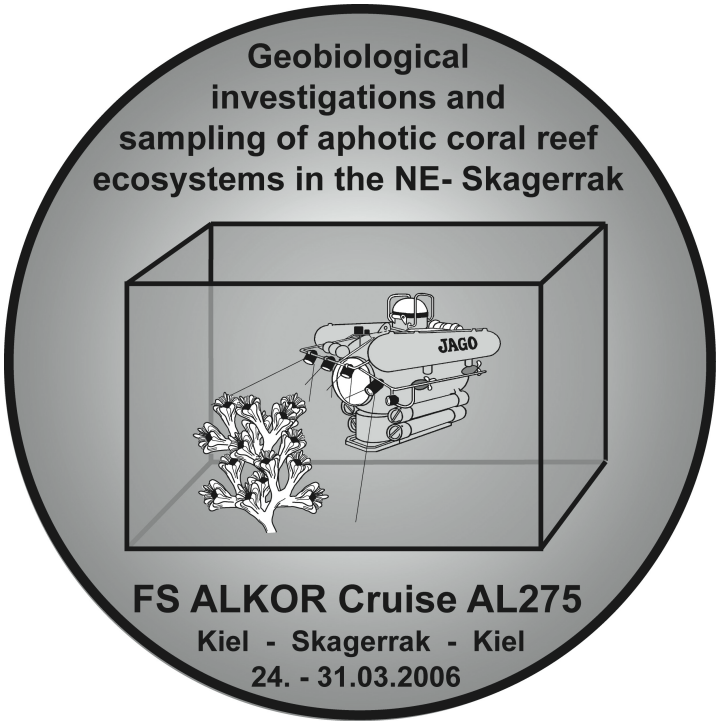

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Content **Page**

This cruise report consists of 36 pages including cover:

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1. Scientific crew

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02. Cordts, D.	TV-Reporter	Free Journalist
03. Form, A.	Scientist	IFM-GEOMAR, FB 2
04. Gruber, M.	Technician	Aquarium, IFM-GEOMAR
05. Hissmann, K.	Scientist	IFM-GEOMAR FB 1, Jago-Team
06. Meyerhoefer, M.	Scientist	IFM-GEOMAR, FB 2
07. Oettmeier, C.	Student	IFM-GEOMAR, FB 2
08. Rüggeberg, A.	Scientist	IFM-GEOMAR, FB 1
09. Schauer, J.	Technician	IFM-GEOMAR FB 1, Jago-Team
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2. Research Programme *- Armin Form, Andres Rüggeberg*

Short introduction

As a result of the CO_2-emissions and the resultant ocean acidification (decreasing pH and carbonate ion concentration), the impact on marine organism that build their skeletons and protective shells with calcium carbonate (e.g., mollusks, sea urchins, pteropods, foraminifera, coccolithophorids and stony corals) becomes more and more detrimental. In the last few years, many experiments with tropical reef building (hermatypic) corals have shown, that a lowering of the carbonate ion concentration reduces calcification rates and therefore growth significantly (e.g., Gattuso et al. 1999; Langdon et al. 2000, 2003; Marubini et al. 2001, 2002). By the middle of this century, many tropical coral reefs may well erode faster than they can rebuild. However, nothing is known about the effects of ocean acidification on cold-water corals. This gap of information has to be closed urgently, because cold-water corals are living in an environment (high geographical latitude, cold and deep waters) already close to a critical carbonate ion concentration below calcium carbonate solves. Actual projections indicate that about 70% of the currently known *Lophelia* reef structures will be in serious danger until the end of the century (Guinotte et al. 2006). Hermatypic cold-water corals, such as *Lophelia pertusa* are forming complex three dimensional structures in a more or less plain deep sea area and therefore are hosting communities of associated species and sometimes reveal a high level of endemism. In particular they form the breeding grounds for many deep-sea animals including fish of high commercial importance. Nevertheless, knowledge about the biology and ecological importance of the cold-water corals is still in its infancy and future research will be urgently needed.

In order to start filling this actual gap of knowledge an interdisciplinary research project with cold-water corals was prefaced at the IFM-GEOMAR, Kiel. For a series of future laboratory experiments, living fragments of the hermatypic cold-water coral *Lophelia pertusa* will be needed and therefore have to be collected during cruise AL275.

Deep-water Coral Reefs and Scientific Objectives

Deep-water coral ecosystems are widely distributed along the continental margins of the NE-Atlantic, where the colonial azooxanthellate *Lophelia pertusa* (Scleractinia) is the major reef constructing coral. This coral species (Fig. 1) has the potential to build substantial reefs in the aphotic zone. The corals live in aphotic deeper environments under the absence of light. The transfer of food and nutrients from the fertile surface to the deeper waters nourishes the coral ecosystem. Local environmental conditions measured in and near coral ecosystems show some common features along the European continental margin:

(1) the availability of hard substrate to settle on (dropstone boulders, exhumed carbonate hardgrounds, larger calcareous skeletons, and outcropping rock exposures),
(2) the preferred location on pre-existing topographic highs (moraine ridges, iceberg ploughmark levees, flutes, carbonate mounds, submerged oceanic banks, and seamount flanks),
(3) the existence of periodic vigorous currents driven by tidal rectification to prevent sedimentation of particles,
(4) an ambient water temperature window between 3° and 14°C,
(5) fully aerobic to slightly oxygen-depleted conditions.

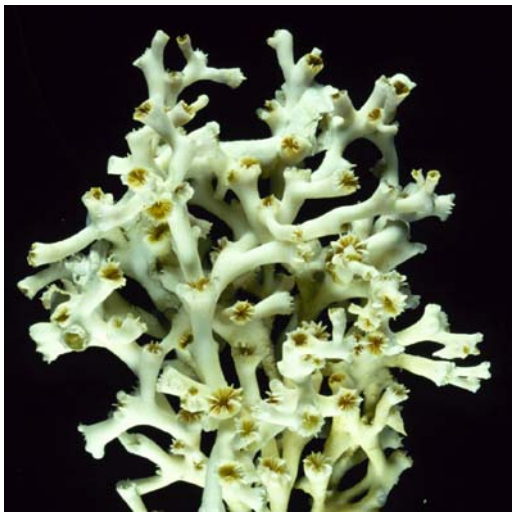


Figure 1. The cold-water, reef-building scleractinian *Lophelia pertusa* (Photo: A. Freiwald).

Previous work on deep-water corals in the study area

Wahrberg and Eliason obtained first report of cold-water coral occurrences in the eastern Skagerrak in 1926. Later on Jägerskiöld (1971) provided a compilation of the benthic communities found in this area. The Swedish occurrences are intensely studied by T. Lundälv (TMBL, Sweden) who discovered new coral reefs both alive and dead in Norwegian waters of the southern Oslofjord entrance (Lundälv 2003). One of the larger reef complexes in the area, the Tisler Reef, was taken under governmental protection immediately after the discovery and received the “Gift to the Earth” award from the WWF in June 2003. R/V ALKOR cruise AL232 performed detailed bathymetric maps of coral reefs sites around the Søster Islands, southern Oslofjord and obtained geological sampling around the reef structures as well as under water investigations using the Swedish ROV Phantom of TMBL.

Major cruise objectives

In general, the occurrence of deep-water corals in the eastern Skagerrak region differs in some aspects from the coral reefs found under open Atlantic conditions: (1) The known reefs exist in quite shallow water depths of around 80 to 120 m, (2) the existence of an estuarine circulation creates pronounced salinity-stratified water bodies with a brackish water layer on top underflown by the intruding waters from the Atlantic through the deep Norwegian Channel. This low-salinity cap forms an environmental barrier for the deep-water corals.

The scientific objectives and methods of the ALK-275 cruise were:

- To collect live cold-water coral *Lophelia pertusa* and associated reef fauna around the Soester Islands, southern Oslofjord.

- To analyse the physical and chemical water mass properties (temperature, salinity, oxygen, light transmission, chlorophyll fluorescence, organic matter (POC, PON, Redfield ratios), DIC; nitrate, nitrite, silicate and phosphate) passing the narrow gateways into the Oslofjord and bathing the cold-water coral reefs.

3. Narrative of the cruise - *Armin Form*

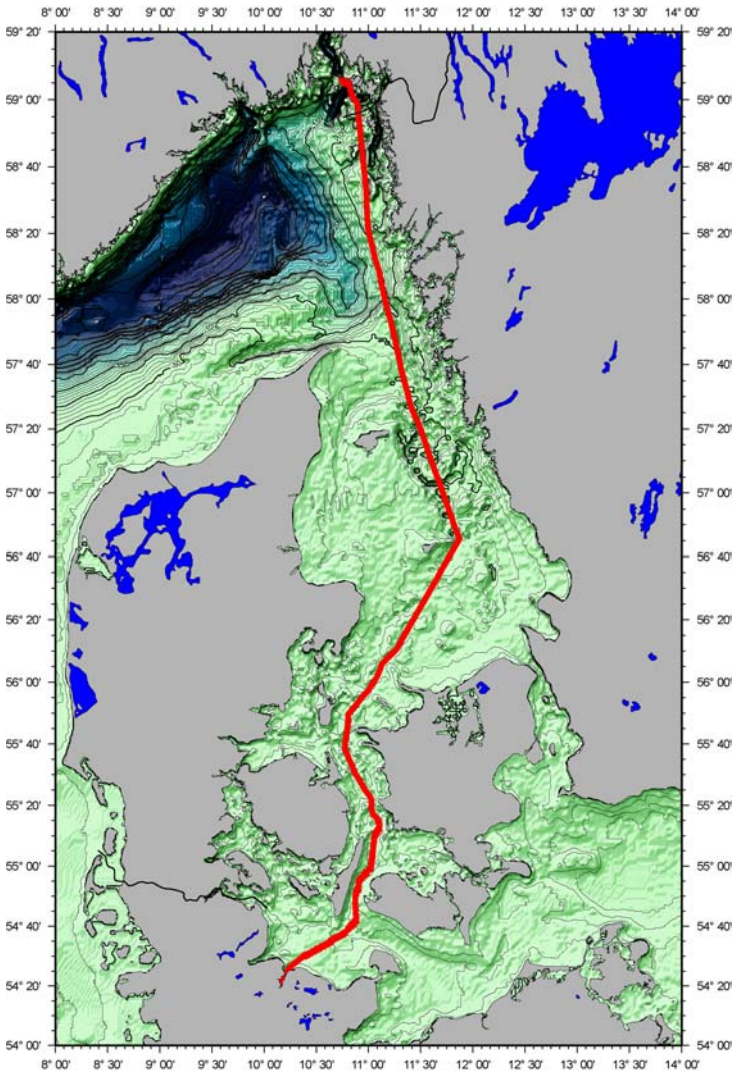


Figure 2: Cruise track of R/V ALKOR cruise AL 275.

24th March 2006

After loading the scientific equipment and the manned submersible JAGO, RV ALKOR departed from the Bollhörnkai in Kiel at 21.30h. Five scientists from IFM-GEOMAR, two technicians, two free journalists and one student boarded the vessel (see *1. Scientific Crew*). The vessel left the Kiel Fjord and headed towards the Great Belt and continued its journey through the Kattegat.

25th March 2006

We continued our journey through the Kattegat and Skagerrak. In the late evening we arrived at our first station east of Søster Island in the Eastern Oslofjord Inlet (Fig. 3).

26th March 2006

At 8.36h we started sampling living *Lophelia pertusa* colonies with submersible JAGO ***(Stat. 420-1***, see Appendix 1***)***. When JAGO was in a save distance from RV ALKOR we took one CTD at 9.40h ***(Stat. 420-2)*** and a second CTD at 10.22h ***(Stat. 420-3)*** for plotting a conductivity-temperature-depth-profile from the station and for further water analysis. In the early evening we continued our sampling and data-collecting with a second JAGO dive from 16.24h to 18.30h ***(Stat. 421-1)*** and a third CTD in between at 17.04h ***(Stat. 421-2)***.

27th March 2006

We continued our sampling of living *Lophelia* east of Søster Island with two JAGO dives, number three from 8.54h to 11.20h ***(Stat. 422)*** and number four from 14.17h to 18.26h ***(Stat. 423)***. In the evening we pumped several hundreds litres of seawater with a submersible dive-pump in to the aquaria-tank of RV ALKOR ***(Stat. 424)***. Activities on this day were finished at 23.12h.

28th March 2006

At 8.24h we continued our work with JAGO dive number five ***(Stat. 425-1)*** and a CTD at 9.00 o'clock ***(Stat. 425-2)***. After JAGO was back on deck at 10.24h we took a second CTD at 10.36h. After lunch we performed the sixth JAGO dive on this area from 13.10h to 14.26h ***(Stat. 426)*** and tried a seventh dive at 15.10h but due to problems with the ALKOR main deck crane this was cancelled at 15.36h. In the evening we took the third *CTD* ***(Stat. 427)*** for this day (18.26h) and afterwards (19.30h – 22.00h) we pumped again seawater in to the aquaria-tank of RV ALKOR ***(Stat. 428)***.

29th March 2006

In the morning at 8.36h our last JAGO dive (7) to the east of Søster Island was conducted ***(Stat. 429)***. After JAGO was back on deck at 11.06h we changed position to the Western Trough of Oslo Fjord where we performed our last JAGO dive (8) from 13.42h to 16.00 o'clock ***(Stat. 430)***.
At 16.18h we finished our scientific program for that cruise and started our voyage back to Kiel.

30th March 2006

We continued our journey through the southern Kattegat, Great Belt and Kiel Bight. RV ALKOR docked in the late evening at the Bollhörnkai in Kiel where JAGO and some other scientific equipment disembarked.

31st March 2006

At 7.00h RV ALKOR shifted to IFM-GEOMAR Pier in Kiel thus finishing ALKOR Cruise 275.

4. Technical details

4.1 Research Submersible "JAGO" - *JAGO Team Jürgen Schauer & Karen Hissmann*

"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 a cabin pressure of one atmosphere.

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 to accomplish almost any underwater work 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.

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 shippers own 20' standard sea freight container.

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 for Marine Sciences IFM-GEOMAR in Kiel.

JAGO has made more than 900 dives throughout the World's Oceans and in deep lakes, at hot vents, in cold waters off Iceland, Spitsbergen and New Zealand, in tropical seas off Indonesia, the Caribbean and in the Indian Ocean. It was used to explore seamounts in the Western Pacific, submarine canyons off South Africa and descended to the anaerobic realms of the Black Sea. JAGO has been used by some hundred different observers, mainly scientists of various disciplines in the field of marine biology, microbiology, geology, palaeontology, sedimentology, biogeochemistry, oceanography, environmental conservation, by film teams, photographers and marine engineers.

Most suitable for deployment and recovery of the submersible are support vessels with low working deck of less than 2 metres like the RV POSEIDON or the RV ALKOR. Both vessels are managed by IFM-GEOMAR. RV ALKOR operates mainly in the Baltic and North Sea from Kiel as port of embarking and des-embarking. The deck crane of the vessel, manufactured by NMF Hamburg, has a SWL of 5 tons at its inner boom (outreach of 2.4-7.5 m), and a SWL of 2.5 tons at the outer boom (outreach 2.4-12.5 m). JAGO handling requires a SWL of minimum 5 tons. The submersible was therefore lifted with the crane cable running through a sheave at the end of the inner boom. The outreach of the crane at that position is sufficient for out- and inboarding of the submersible at very calm sea conditions, but already a slight swell affects save handling. The weather conditions in the southern part of the Oslo Fjord were excellent during most of the cruise and allowed deployment of the sub on four days at location.

The RV POSEIDON is the most suitable support vessel for the submersible within the German fleet of research vessels. The RV ALKOR is suitable with restrictions caused by the limitations of the crane.

JAGO has been used for cold-water coral research in Norway during previous cruises (POS228 off mid Norway in 1997, POS253 off mid Norway in 1999 and POS325 off north Norway in 2005). During AL275 the submersible was mainly used to collect live corals at reef locations that were mapped with multibeam and groundtruthed by ROV during AL232 in 2003. Most dives were performed in the southern part of the Eastern Oslo Fjord Inlet (EOI) east of the South Soester Island at a reef mound with a dense population of live *Lophelia pertusa* corals. Corals were carefully sampled with the manipulator arm of the submersible and stored in a sampling basket attached to the front of the sub. By selective sampling only those coral colonies were collected that appeared vital and healthy, preferably those that could be picked up together with a piece of rocky substrate to which the colonies are attached. The reefs and different growth forms of the corals were well documented on video (miniDV and HD). Water samples were taken with Niskin bottles that were attached to the lower front of the submersible in close vicinity to the coral colonies. In total, eight dives were performed in depths between 85 and 153 metres (Appendix 2). Ground currents, probably caused by the tides, were strong at times and constricted sampling during some of the dives. In total, 17.5 hours were spent underwater on 8 project dives. Eight different cruise participants had the chance for a personal view on the sea floor and the reef habitats. Dive tracks (Lat./Long. positions; Tab. 1) for each dive are available and were plotted on the multibeam charts (Fig. 6).

The handling of the submersible from on board the ALKOR was well performed by the assistance of Captain Marc Petrikowski and his crew, and the skilful "hookmen" Andres Rüggeberg and Armin Form.

General Specifications

- Length o.a.: 3.2 m
- Beam o.a.: 2.0 m
- Height o.a.: 2.5 m
- Weight: 3033 kg
- Draft: 1.6 m
- Displacement: 3200 litre
- Operating depth: 400 m
- Pressure hull: Thickness of cylinder 15 mm, half-spheres 18 mm, Material TST E 355 - H II - 1.45.71 steel
- Viewports: Material acrylic plastic, thickness 50-80 mm, diameter of front bow-window 70 cm, hatch-window 45 cm
- Crew: 2 persons
- Propulsion: 4 reversible stern-thrusters (horizontal), 2 side-thrusters (360° rotable)
- Cruising speed: approx. 1 knot
- Energy supply: 3 battery sets, capacity: 540 Ah - 24 Volt DC
- Manipulator: hydraulic, 8 functions and exchangeable claws, max. lifting capacity approx. 5 kg
- Navigation: LXT underwater tracking system, fluxgate-compass, D-GPS satellite-navigator, vertical und horizontal sonar, depth gauges, pinger positioning
- Communication: underwater telephone (ORCATRON, 10 & 27 kHz, range approx. 8 km), VHF-radio (20 channels)
- Emergency systems: “Dead Man” controlled ballast release system, manual ballast release, positive buoyancy capacity of min. 600 kg in maximum diving depth, emergency buoy with rescue installation, life support 96 hours (2 persons)

- Other equipment: 5 halogen-projectors, 2 flash-lights, water-, gas-, plankton-, and sediment sampling, physical instruments and sensors; digital video-, und still cameras for documentation; VEMCO-ultrasonic-transmitter receiver

Table 1. Detailed dive log of JAGO dives during RV ALKOR cruise AL275.

Project Dive #	Date	Location	Time submerged	Time surfacing	Total dive time (min)	Touch down position	Lift off position	Min-Max Depth (m)	Pilot	Observer	Video tapes #
1	26.03.06	S. Soester Isl.	9:39	12:13	154	N 59.05.73 E 10.47.88	N 59.05.79 E 10.47.92	85-107	J. Schauer	A. Form	1
2	26.03.06	S. Soester Isl.	17:26	19:13	107	N 59.05.68 E 10.47.88	N 59.05.65 E 10.47.92	87-107	J. Schauer	A. Rüggeberg	2
3	27.03.06	S. Soester Isl.	8:53	11:10	137	N 59.05.55 E 10.47.82	N 59.05.66 E 10.47.95	91-147	J. Schauer	U. Riebesell	3
4	27.03.06	S. Soester Isl.	14:20	18:11	231	N 59.05.66 E 10.47.77	N 59.05.66 E 10.47.86	80-108	J. Schauer	K. Hissmann	4, HD
5	28.03.06	S. Soester Isl.	8:27	10:12	105	N 59.05.60 E 10.47.74	N 59.05.64 E 10.47.87	93-134	J. Schauer	D. Cords	HD
6	28.03.06	S. Soester Isl.	13:11	14:26	75	N 59.05.81 E 10.47.82	N 59.05.77 E 10.47.91	85-122	J. Schauer	J. Wellhörn	
7	29.03.06	S. Soester Isl.	8:42	10:45	123	N 59.05.54 E 10.47.82	N 59.05.41 E 10.47.74	140-153	J. Schauer	C. Oetmeyer	
8	29.03.06	W. Oslo Fjord	13:43	15:43	120	N 59.04.56 E 10.44.13	N 59.04.54 E 10.44.17	100-120	J. Schauer	M. Gruber	4
8 dives					1052 (17.5 h)			85-153			

4.2 CTD/Rosette Hydro-Bios Kiel - *Michael Meierhöfer*

The CTD system used is a Hydro-Bios Kiel multi-parameter sensor built into a rosette housing capable of holding 12 10-litre water sampler bottles (Niskin-type). Pre-cruise laboratory calibrations of conductivity, temperature and pressure sensors were performed. All parameters yielded coefficients for a linear fit. Technical details of the sensors are summarized in table 2. Additionally, a detector for the fluorescence of Chlorophyll-a and sensors for dissolved oxygen and sound velocity were equipped.

Table 2. Technical details of multi-parameter sensor of the CTD system Hydro-Bios Kiel.

Standard sensor	**Pressure**	**Temperature**	**Conductivity**
Measurement range	0 – 3000 dbar	-2 … +32°C	0 … 65 mS/cm
Resolution	0.05 dbar	0.0005°C	0.001 mS/cm
Precision	±0.1 %	0.0005°C	0.01 mS/cm
AD-transformation	16 bit, 16 µs		
EC conformity (CE)	EN 50081-1, EN 50082-1		

Measurements and sampling

Four CTD Profiles were carried out in the study areas. Water samples were taken for particulate organic carbon and nitrogen (POC / PON), inorganic nutrients (nitrate, nitrite, silicate and phosphate), total alkalinity, dissolved inorganic carbon and photosynthetic pigments.

Seven additional benthic water samples were taken by a five litre Niskin – bottle attached to the submersible JAGO.

5. Research area: The Norwegian Cold-water Coral study sites - *Andres Rüggeberg*

In Norwegian waters two major cold-water coral areas were chosen to sample cold-water coral *Lophelia pertusa* and associated reef fauna: the Oslofjord inlets east and west of the Soester Islands (Fig. 3-5).

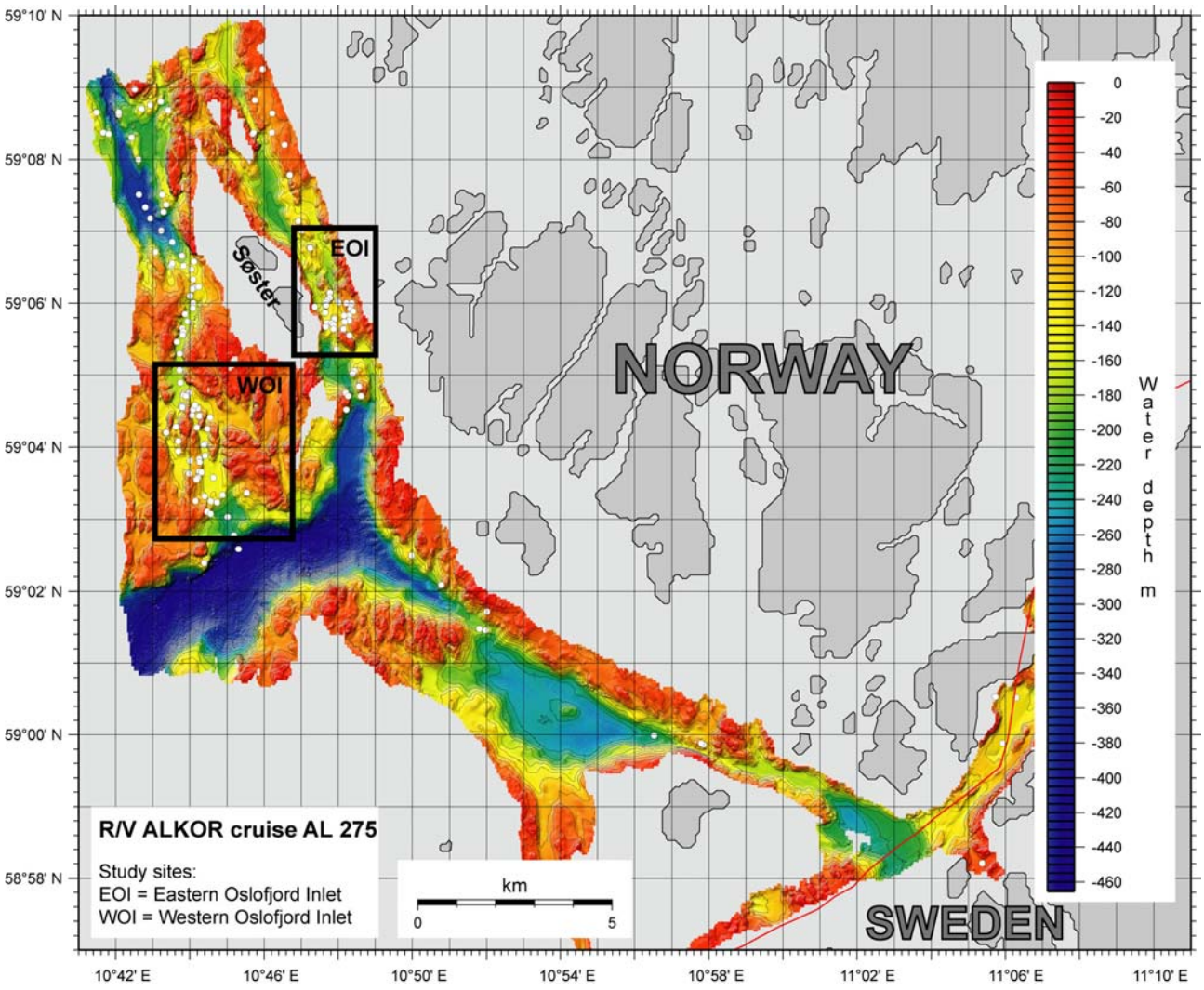


Figure 3: Overview of the Norwegian research area with the Western and Eastern Oslofjord Inlets (WOI and EOI) around Soester Islands (Bathy-metric map provided by R/V ALKOR cruise AL 232, Pfannkuche & cruise participants, 2004).

Of particular interest were about 7 nm-long inlets that pass the Soester Islands on both sides. These inlets are connected to the main Oslofjord Trough in the north, and the eastward continuation of the Norwegian Channel in the south (Fig. 3). Both inlets exhibit complex seabed topography with steep inclined rock outcrops, mud-rich troughs and drumlins as the major elements.

The Eastern Oslofjord Inlet (EOI) consists of 140 to 200 m deep troughs separated by narrow thresholds generally less than 120 m deep (Fig. 4). Two larger areas in the EOI are rich in corals: the inlet due east of the southern Soester Island (marked with a black box in figure 4) and a narrow confined channel about 1.5nm north of the northern Soester Island.

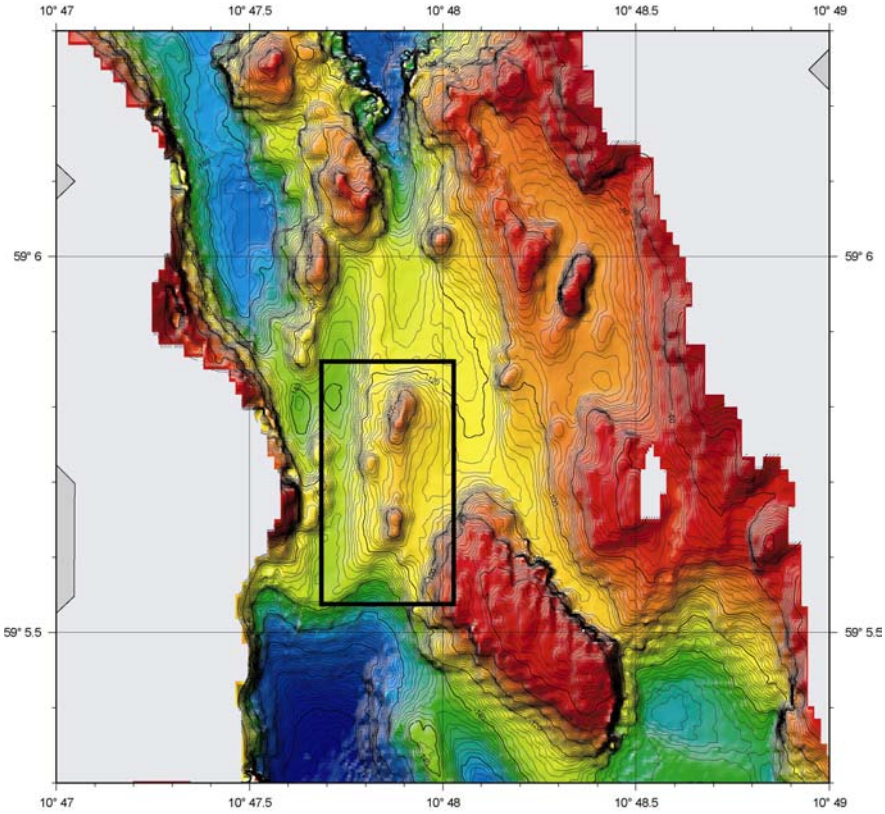
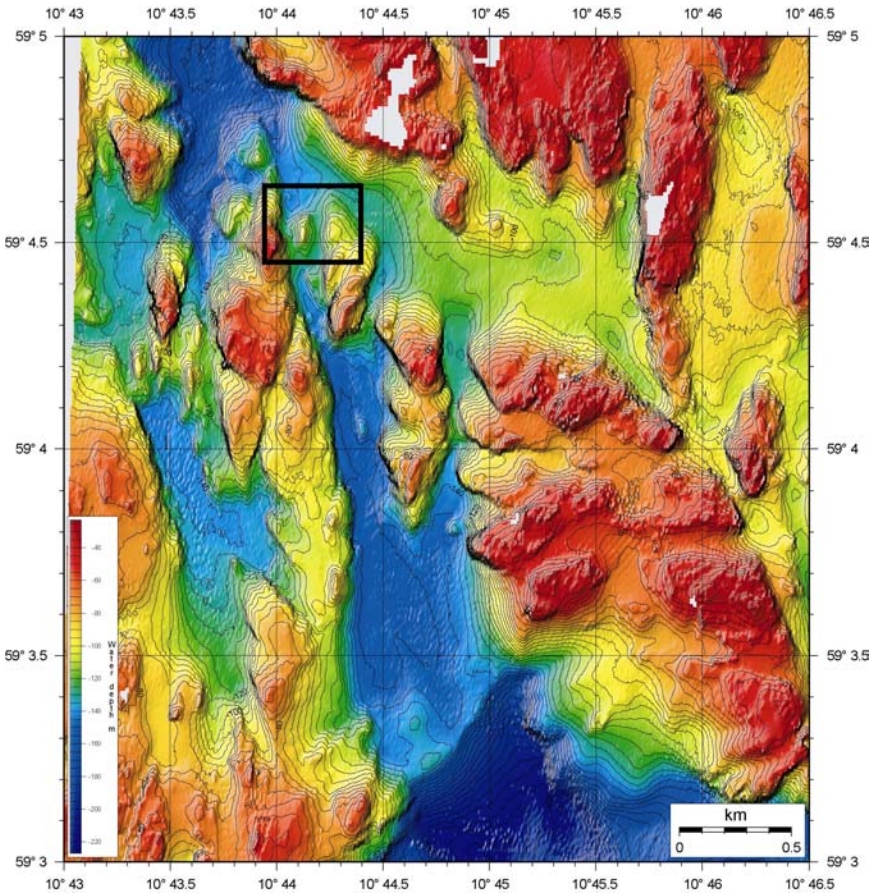


Figure 4: Multibeam map showing the narrow southern part of the EOI, due east of South Soester Island. Nearly all of the ridges are covered by corals. The black box indicates the investigated ridge, where seven of eight dives were conducted (see Fig. 6a).

The Western Oslofjord Inlet (WOI) shows the same features like the EOI but the troughs are generally deeper with up to 320 m (Fig. 5). These narrow thresholds are often accentuated by moraine deposits with consolidated clays, boulder-rich drumlins and exposed rocks, all seabed types generally attract a diverse epibenthic community including corals.

Figure 5: Multibeam map of the southern section of the WOI. The black box indicates investigated area of the eighth JAGO dive (Station AL275-430, see Fig. 6b).



6. Scientific report and first results

6.1 JAGO dives to coral reefs of Eastern Oslofjord Inlet - *Andres Rüggeberg, Armin Form*

Seven dives with manned submersible JAGO were performed on the N-S oriented ridge-like structure with two mounds of the inner EOI (Fig. 5 and 6a). Dives 2 and 6 concentrated on the northern mound, while the other dives investigated the southern mound. During dive 7 southward flowing currents were too strong to reach the area of interest.

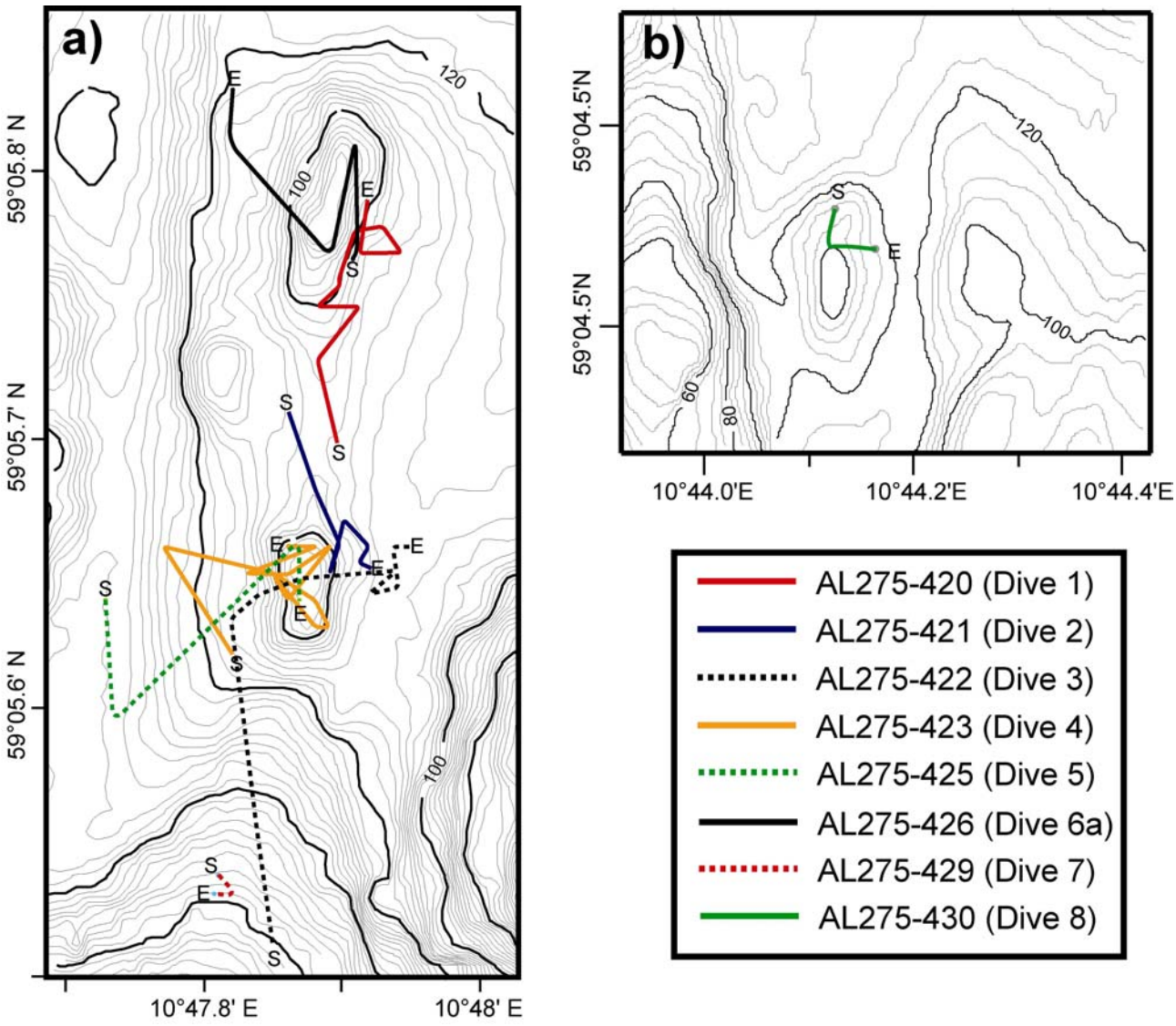


Figure 6. Dive tracks of JAGO dives during cruise AL275: **a)** dives 1 to 7 at Eastern Oslofjord Inlet, and **b)** dive 8 at Western Oslofjord Inlet (S = Start of dive, E = End of dive).

During all dives thickets of cold-water coral *Lophelia pertusa* with associated reef fauna (crabs, sponges, molluscs, brachiopods, gastropods, bryozoans) were carefully selected and sampled. Most coral samples came from the southern mound, where collecting was performed at the reef base with the lowest impact to the ecosystem ("surgical sampling"). During the dives video and photo documentation were performed (Tab. 1), which will be analysed to create facies maps of the investigated reef structures. When JAGO was back on deck of RV ALKOR, all samples were directly set into the seawater tanks.

6.2 JAGO dives to coral reefs of Western Oslofjord Inlet - *Andres Rüggeberg, Armin Form*

One dive with manned submersible JAGO concentrated on the small mound of the central channel SW of southern Soester Island (Fig. 5 and 6b). Again, small coral colonies were collected together with associated reef fauna.

6.3 Heltering on Bord - *Armin Form, Michael Gruber*

In a first step all samples were carefully transferred from the collecting basket on the JAGO submerse into large buckets filled with fresh and clean seawater.
After a period of acclimatisation the living *Lophelia* fragments and their associated fauna were transferred from the buckets into prepared large transportation tanks in the wet laboratory of RV ALKOR.

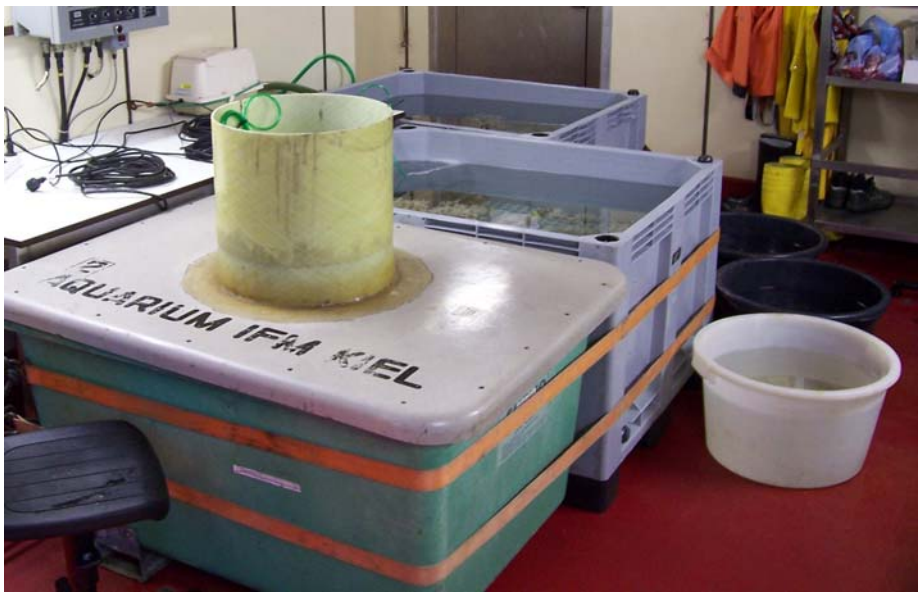


Figure 7. Transportation tanks in the wet laboratory of RV ALKOR. Photo: M. Gruber

Each of the three 750 litres tanks was equipped with a powerful dive-pump for strong water current, an air-stone which was supported with fresh air through an air-pump and with a fibre glass lattice (5 * 5cm grid size) on the bottom for sample fixation.
The water in the transportation tanks was fresh seawater from the previously filled aquaria tanks of RV ALKOR. Due to biological processes and warming-up the water were renewed at regular intervals.

6.4 Physical and Biological Oceanography - *Michael Meierhöfer*

During the cruise we investigated the physical parameters of the water column and the physical environmental conditions over the coral reefs at the two diving sites (EOI and WOI). First interpretations of the data show a well-stratified water column at both sites with low temperatures and very low salinities (1–2°C and >24<27 psu, respectively) at the surface and below 25 m water depth equal and uniform temperatures and salinities (~ 7°C and ~ 36 psu, respectively; see figures 8, 9 and Appendix 4). A pronounced mixed layer of ~ 8 m thickness was observed at the WOI (Fig. 8). The *Lophelia* reefs of the Estern and Western Oslofjord Inlet thrive in Atlantic waters with seasonal changes in winter and summer temperatures of ~ 7°C and 8.5°C (Pfannkuche & Cruise Participants 2004) and

winter and summer salinities of 36 psu and 35 psu (Pfannkuche & Cruise Participants 2004).

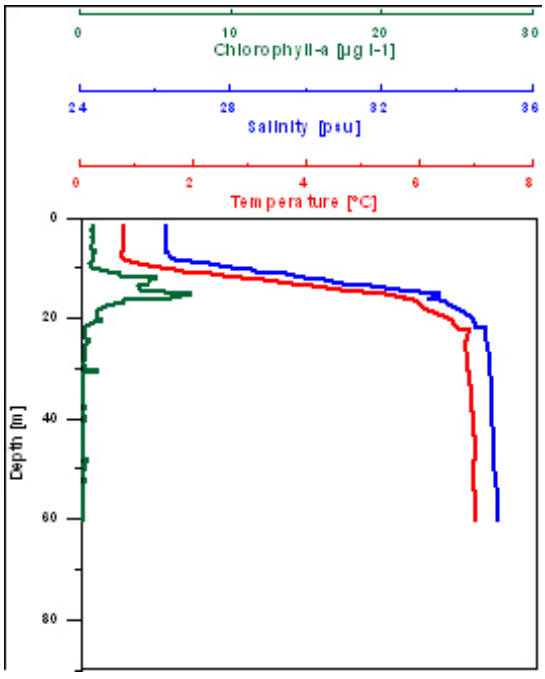


Figure 8. CTD and fluorescence profiles at station AL275-427, Western Oslofjord Inlet.

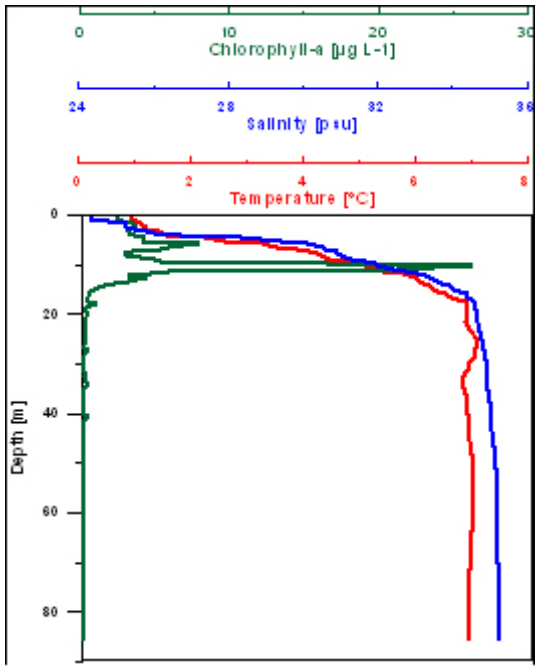


Figure 9. CTD and fluorescence profiles at station AL275-420-2, Eastern Oslofjord Inlet.

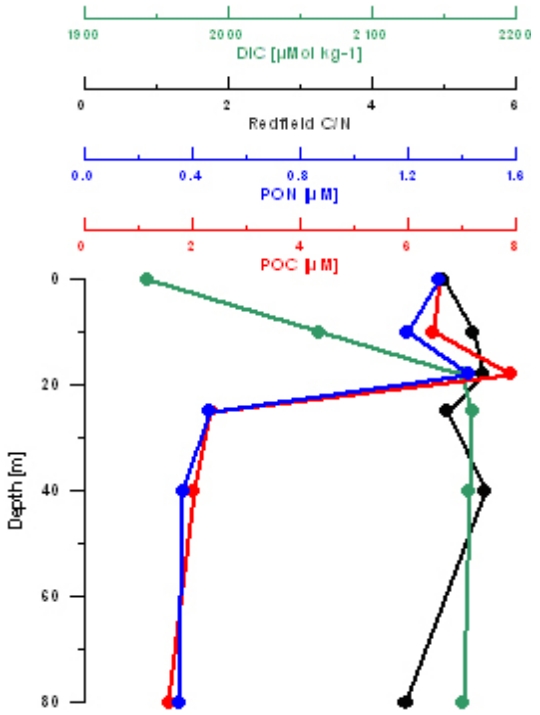


Figure 10. Profiles of particulate organic carbon and nitrogen, Redfield – Ratios and Dissolved Inorganic Carbon DIC at station AL275-420-2.

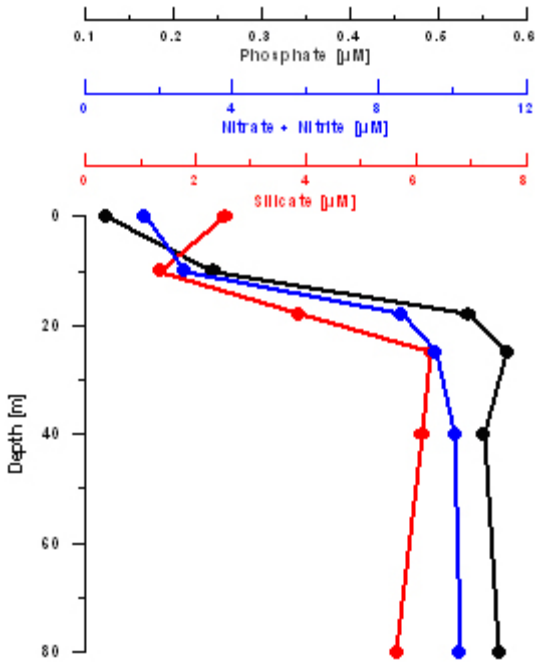


Figure 11. Profiles of inorganic nutrients at station AL275-420-2.

Chlorophyll fluorescence profiles indicated a well-defined subsurface maximum at both sites with very high values at the EOI (Figs. 8 and 9). The phytoplankton spring bloom seemed to be finished or at its end in this area. This is supported by the following facts (see Fig. 10 and 11):

- relative high concentrations of POC and PON in the upper layers
- low Redfield ratios, indicating relative fresh organic matter
- strongly reduced concentrations of DIC in the upper layers, resulting from the primary production
- depleted nutrients in the euphotic zone

The seven water samples taken by the submersible JAGO directly at the coral reefs showed uniform DIC concentrations of around 2200µM and high nutrient values (nitrate and nitrite: 9.8 – 11.1µM, silicate: 5.7 – 6.5µM and phosphate: 0.6 – 1.3µM). The loads of organic matter on the other hand varied strongly (POC: 1.8 – 14.4µM, PON: 0.3 – 1.5µM; Redfield ratios: 5.3 – 10.2). These variations originated obviously from transport processes of the strong tidal currents encountered in the area.

7. Acknowledgements

The scientific party of RV ALKOR cruise AL275 gratefully acknowledge the very good co-operation and technical assistance of the captain and his crew who substantially contributed to the overall success of this expedition.
We deeply acknowledge work permissions for the NE-Skagerrak granted by the coastal state Norway.
Additionally, we appreciated the previous studies of RV ALKOR cruise AL232 and the use of detailed bathymetric maps, which were very helpful to plan and conduct the whole cruise including site selection for manned submersible dives.

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Appendix 1. Station list of RV ALKOR cruse AL275

Station AL275-	Gear	#	Date	Start of Station Time	Latitude (N)	Longitude (E)	End of Station Time	Latitude (N)	Longitude (E)	Water depth (m)
420-1	Jago	1	26.03.06	08:36	59°05.70’	10°47.89’	12:13	59°05.79’	10°47.92’	111–120
420-2	CTD	1		09:40	59°05,90’	10°50,00’				122
420-3	CTD	2		10:22	59°05.80’	10°48.00’				107
421-1	Jago	2		17:26	59°05.68’	10°47.88’	19:13	59°05.65’	10°47.92’	90–125
421-1	CTD	3		17:04	59°05.70’	10°47.70’				106
422	Jago	3	27.03.06	08:53	59°05.55’	10°47.82’	11:10	59°05.66’	10°47.95’	161–108
423	Jago	4		14:20	59°05.66’	10°47.77’	18:11	59°05.66’	10°47.86’	109–101
424	DWP	1		19:26	59°04.50’	10°44.10’	23:12	59°04.50’	10°44.10’	124
425-1	Jago	5	28.03.06	08:27	59°05.60’	10°47.77’	10:12	59°05.64’	10°47.87’	123–111
425-2	CTD	4		09:00	59°05.70’	10°47.90’				98
425-3	CTD	5		10:36	59°05.70’	10°47.80’				102
426	Jago	6		13:11	59°05.81’	10°47.82’	14:26	59°05.77’	10°47.91’	134–96
427	CTD	6		18:26	59°04.60’	10°44.10’				99
428	DWP	2		19:30	59°04.50’	10°44.10’	22:00	59°04.50’	10°44.10’	131
429	Jago	7	29.03.06	08:42	59°05.54’	10°47.82’	10:45	59°05.41’	10°47.74’	146–120
430	Jago	8		13:43	59°04.56’	10°44.13’	15:42	59°04.54’	10°44.17’	118–150

Jago = manned submersible JAGO, CTD = water sampler with temperature, conductivity, pressure, dissolved oxygen, and chlorophyll flourescence sensors, DWP = deep-water pump

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Appendix 2: JAGO Dive tracks – ALKOR 275 Norway 2006

(LT = Local Time, MES; Pos.1 = coral mound at 59°05.92'N, 10°47.78'E; Pos.2 = coral mound at 59°05.64'N, 10°47.87'E)

Sunday, 26.03.2006

JAGO Dive 922 (1) = **AL275-420-1** J. Schauer, A. Form
East of Søster Island (Pos.1) MiniDV Tape 1

Time (LT)	Depth (m)	Latitude (N)	Longitude (E)	Comments
09:39	0	59°05.699'	10°47.894'	Submerged, freshwater layer, thermocline with high density of plankton at 10 and 25 m
09:56	107	59°05.73'	10°47.88'	at bottom, current from south 160°
10:02	105	59°05.75'	10°47.91'	first coral rubble
10:05	95	59°05.75'	10°47.88'	first living corals
10:10		59°05.76'	10°47.895'	
10:14	90	59°05.758'	10°47.896'	small pieces of broken living corals, growth pattern of coral colonies similar to Stjernsund: short branches, relatively strong current from south pushing JAGO towards slope
10:20	90	59°05.778'	10°47.906'	strong bottom current, good corals, first trial to sample corals
10:36		59°05.78'	10°47.927'	
10:58	85	59°05.77'	10°47.94'	sampling corals
11:01	85	59°05.77'	10°47.936'	took three coral samples at same position
11:19	85	59°05.77'	10°47.91'	water samples with Niskin bottles
11:45	87	59°05.79'	10°47.916'	start ascent
12:13	0			surfaced

JAGO Dive 923 (2) = **AL275-421-1** J. Schauer, A. Rüggeberg
East of Søster Island (Pos.2) MiniDV Tape 2

Time (LT)	Depth (m)	Latitude (N)	Longitude (E)	Comments
17:26	0	59°05.71'	10°47.86'	submerged
17:36	107	59°05.681'	10°47.88'	at bottom, low current, first coral rubble
17:43	98	59°05.661'	10°47.897'	first living *Lophelia* corals
17:49	93	59°05.65'	10°47.89'	very nice *Lophelia* reef
17:53	87			at top of small seamount, nice reef, exclusively white Lophelia corals, sponges
18:01	91	59°05.67'	10°47.90'	
18:10		59°05.665'	10°47.898'	
18:25	95	59°05.60'	10°47.918'	took very nice *Lophelia* coral sample
18:40	94	59°05.654'	10°47.911'	took second coral samples, continue sampling
18:58	93	59°05.652'	10°47.92'	sampling basket full with pieces of corals, start ascent soon
19:03	93			lift off bottom
19:13	0			surfaced

Monday, 27.03.2006

JAGO Dive 924 (3) = **AL275-422** J. Schauer, U. Riebesell
East of Søster Island (Pos.2) MiniDV Tape 3

Time (LT)	Depth (m)	Latitude (N)	Longitude (E)	Comments
8:26	0	59°05.52'	10°47.816'	submerged
9:14	147	59°05.548'	10°47.839'	at bottom
9:23		59°05.595'	10°47.827'	
9:28	120	59°05.633'	10°47.818'	
9:35	100	59°05.642'	10°47.838'	
9:41	91	59°05.648'	10°47.869'	
9:58		59°05.65'	10°47.936'	
10:06		59°05.643'	10°47.92'	
10:28	102	59°05.645'	10°47.939'	
10:49		59°05.66'	10°47.935'	still at same position, sampling basket full, filming
10:54		59°05.66'	10°47.947'	start ascent
11:20	0			surfaced

JAGO Dive 925 (4) = **AL275-423** J. Schauer, K. Hissmann
East of Søster Island (Pos.2) MiniDV Tape 4 (30 min.) + HD

Time (LT)	Depth (m)	Latitude (N)	Longitude (E)	Comments
14:20	0	59°05.62'	10°47.82'	submerged
14:30	118	59°05.66'	10°47.77'	at bottom south of coral mound, on gravel field with lots of ascidians
14:54	100	59°05.65'	10°47.85'	
14:58	108	59°05.64'	10°47.88'	coral rubble, single small *Lophelia* colonies
15:12		59°05.63'	10°47.89'	
15:25	100	59°05.63'	10°47.88'	in the centre of reef, current experiment with coloured water
15:35		59°05.63'	10°47.88'	
15:57		59°05.65'	10°47.85'	
16:10		59°05.64'	10°47.86'	
16:36	94	59°05.66'	10°47.89'	
16:56		59°05.65'	10°47.86'	
17:27		59°05.65'	10°47.83'	
17:42		59°05.66'	10°47.88'	
18:03	80	59°05.66'	10°47.86'	start ascent

Tuesday, 28.03.2006

JAGO Dive 926 (5) = **AL275-425-1** J. Schauer, D. Cordts
East of Søster Island (Pos.2)

Time (LT)	Depth (m)	Latitude (N)	Longitude (E)	Comments
8:27	0	59°05.64	10°47.73	submerged
8:40	134	59°05.597	10°47.737	at bottom, strong current from north
9:07	104	59°05.66	10°47.868	first corals
9:34		59°05.64	10°47.87	stationary for filming
9:55		59°05.64	10°47.87	still stationary for filming
9:59	93	59°05.64	10°47.87	start ascent
10:12	0			surfaced

JAGO Dive 927a (6a) = **AL275-426-1** J. Schauer, J. Wellhöner
East of Søster Island (Pos.1)

Time (LT)	Depth (m)	Latitude (N)	Longitude (E)	Comments
13:11	0	59°05.83'	10°47.82'	submerged
13:26	122	59°05.811'	10°47.818'	at bottom
13:35	105	59°05.78'	10°47.87'	below coral reef
13:39	90	59°05.77'	10°47.89'	until now only coral rubble, no living corals yet
13:51		59°05.809'	10°47.909'	only dead corals
13:56	85	59°05.77'	10°47.91'	living corals
14:18	85	59°05.767'	10°47.907'	collected corals, start ascent
14:26	0			surfaced

JAGO Dive 927b (6b) = **AL275-426-2** J. Schauer, J. Wellhöner
Open water – due to problems with main deck crane on RV ALKOR

Time (LT)	Depth (m)	Latitude (N)	Longitude (E)	Comments
15:10	0			submerged down to 30 m, drifting in water column
15:36	0			surfaced

Wednesday, 29.03.2006

JAGO Dive 928 (7) = **AL275-429** J. Schauer, C. Oettmeier
East of Søster Island (Pos.2)

Time (LT)	Depth (m)	Latitude (N)	Longitude (E)	Comments
8:42	0	59°05.62'	10°47.85'	submerged, strong surface current from S to N below 40 m and deeper strong current from S to N
8:53	140	59°05.537'	10°47.81'	at bottom, very strong bottom current N to S
9:09	153	59°05.53'	10°47.82'	impossible to move against current in direction of coral mound stabilised at bottom and test plankton net
10:20	153	59°05.53'	10°47.807'	still at same position, collecting plankton
10:28	150	59°05.41'	10°47.74'	still strong current, start ascent
10:45	0			surfaced

JAGO Dive 929 (8) = **AL275-430** J. Schauer, M. Gruber
Western Trough of Oslo Fjord

Time (LT)	Depth (m)	Latitude (N)	Longitude (E)	Comments
13:43	0	59°04.51'	10°44.088'	submerged
13:55	120	59°04.558'	10°44.126'	at bottom
14:01	110	59°04.54'	10°44.13'	strong bottom current, very nice coral reef
15:01	110	59°04.54'	10°44.12'	still strong current, stationary in middle of coral reef
15:09	110	59°04.54'	10°44.12'	still strong current, stationary, collecting corals (beautiful pieces)
15:17	100	59°04.538'	10°44.165'	start ascent with full sampling basket
15:43	0			surfaced

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Appendix 3: Detailed JAGO Dive protocols

Sunday, 26.03.2006

JAGO Dive 922 (1) = **AL275-420-1** J. Schauer, A. Form
East of Søster Island (Pos.1) MiniDV Tape 1

Time (LT)	Depth (m)	Latitude (N)	Longitude (E)	Tape Time (start at 0:00)	Comments
09:39	0	59°05.699	10°47.894		
	5				Fresh water layer
	15				Thermocline with high density of diatoms
09:56	107	59°05.73	10°47.88	00:37	At bottom, current from south 160° soft bottom, few coral rubble
				00:58	First sponges, echinodermates (*Henricia* spp.) and Anthozoa on hard substrate
				02:12	Coral rubble increases, first ascidians and some *Munida rugosa*.
				02:56	On soft bottom: Bonella viridis
10:02	105	59°05.75	10°47.91	04:04	
				05:21	HDG = 30°
				06:10	High abundance of ascidians on coral rubble
10:05	95	59°05.75	10°47.88	06:55	First living Lophelia (Fig. _01)
				09:30	Coral patches with high diversity of associated reef fauna (sponges, ascidians) (Fig._02)
10:10	95	59°05.76	10°47.895		
				11:14	Large live coral patches (1 m Ø)
10:14	90	59°05.758	10°47.896	12:44	Small pieces of broken living corals, compact morphotype
				13:05	Strong current from south
				14:09	Brachiopods between ascidians on dead coral framework
	92			15:10	Next position
10:20	90	59°05.778	10°47.906	19:21	Strong bottom currents
				22:20	Top of reef structure
				26:00	Next position, reef flank, search for sampling site
				30:00	Turbidity in water for current approximation (Clip_03)
				30:33	Next position
				31:41	Turbidity in front of corals for current approximation (Clip_04)
				33:30	First sample
10:36		59°05.78	10°47.927		
				34:20	Next position
10:58	85	59°05.77	10°47.94	35:30	Second small sample
11:01	85	59°05.77	10°47.936	37:43	Next samples
				40:00	Lophelia sample (Fig._05)
11:19	84	59°05.77	10°47.91	41:50	Next position, top of reef water samples with niskin bottles
				47:10	*Cancer pagurus* (Fig._06)
				51:00	Below living reef, dead coral framework, many ascidians
11:45	87	59°05.79	10°47.916	54:00	Start ascending
12:13	0				Surfaced

JAGO Dive 923 (2) = **AL275-421-1** J. Schauer, A. Rüggeberg
East of Søster Island (Pos.2) MiniDV Tape 2

Time (LT)	Depth (m)	Latitude (N)	Longitude (E)	Tape Time (start at 0:00)	Comments
17:26	0	59°05.71'	10°47.86'		submerged
17:36	107	59°05.681'	10°47.88'		at bottom, low current, first coral rubble and sponges, T = 6.7 °C
	105			00:08	HDG = 187° uphill with low slope, coral fragments, sponges, ascidians, sea urchins, star fishes, hardly any fish, soft sediments in between, marine snow and copepods
	102			01:37	Getting shallower, dense cover of ascidians
				02:08	Turn to left uphill, anemones
				03:26	Soft sediment with crab and brachiopods, colour correction on camera until 04:22, currents from 300°
	101			04:48	Dense cover of ascidians
				05:12	Still flight uphill, crab
				05:55	First tumbled boulder with live corals, sponges, dead coral rubble, boulder must have fallen downslope
17:43	98	59°05.661'	10°47.897'		first living *Lophelia* corals
				06:44	Same coral boulder, high density of sponges
				07:45	Some tube worms, fish, small live *Lophelia* colonies from upslope
				08:12	Bigger coral colony with ascidians at deeper, outer and dead part, tube worms, live corals on dead coral framework at upper part, sponges in between
	96			08:47	T = 6.7 °C, steep flank with higher coral and sponge density
				09:30	Dense coral growth with living outer satellite colonies, centre part dead coral framework, patches of coral colonies 1 to 2 m in diameter, soft sediment between patches with *Bonella*
	93			10:30	Within coral reef, several parallel ridges of reefs
17:49	93	59°05.65'	10°47.89'		very nice *Lophelia* reef
				11:40	Reef height ~50 to 100 cm
				12:05	*Geodia* and *Mycale* sponges
	88			13:15	High reef density, Photo: 13:40
				14:00	Density of sponges increases, also size of sponges
	87			14:21	Top of reef
17:53	87				at top of small seamount, nice reef, exclusively white *Lophelia* corals, sponges
				14:40	Crab on top of live *Lophelia*
				15:30	Roof of reef, surrounded by steep flanks
	87			15:45	Still on top
				16:00	Start of decent to reef base
				16:59	Big area of reef ecosystem, significant impact of bioerosion
				19:00	Still on top
				19:15	At mound flank, slope 30-40°
	89			20:00	HDG = 285

Time (LT)	Depth (m)	Latitude (N)	Longitude (E)	Tape Time (start at 0:00)	Comments
	91.5			20:27	Still dense coral cover, smaller and fragile form of *Lophelia*
18:01	91	59°05.67'	10°47.90'	21:30	
				23:00	Nice live corals
				23:14	Sea urchin, star fish in yellow and red-white
	95			23:43	Below reef, colonies of ascidians, stopped for sampling
				25:00	Start sampling 1, small colony of live *Lophelia*, a bit broken
				25:50	Change of position, flight over coral rubble and soft sediment, colonies of ascidians, small *Lophelia* patches
	94			26:36	Tumbled coral boulder with ascidians, below soft sediment
				27:22	Nice close-up of *Lophelia* polyps until 27:35
				28:05	Stopped sample try and moved to further position
18:10		59°05.665'	10°47.898'		
				30:40	Start sampling 2 of *Lophelia* colony with ascidians, good example of "chirurgical" sampling
				31:55	Sample in manipulator (photo?)
				32:18	Sample in basket
				32:40	Big coral colony sample and associated fauna (back of basket)
18:25	95	59°05.60'	10°47.918'		took very nice *Lophelia* coral sample
				33:50	After sampling - low impact!
				34:20	Guarding crab on sediment, filtering sediment
				35:05	Brachiopod (35:17)
				35:36	Close-up of guarding crab until 36:40
				37:00	Low current intensity, particles fall from above
				37:15	New flight to coral patch with sponges and ascidians
				37:58	small, robust growth from of *Lophelia*, below fossil corals with ascidians and sea spider
				38:40	Cancelled sampling, to massive
				39:45	Low current energy due to drift of marine snow
18:34	94			40:11	HDG = 215°, soft sediment with *Bonella*, ascidians, small *Lophelia* colonies
				41:07	Took picture
				41:32	Small coral colony with ascidian sampled
				42:54	"Franzosendorsch" swims in front of corals, moving across sediment to small cave below tube worms, ascidians and corals
				44:48	Yellow sponge, brachiopods, ascidians, tube worms hanging down, fish
				45:48	Yellow sponge with prawn, fish (photo?)
				46:00	Small coral colony sampled with brachiopods
				47:10	Sampling of small coral colony, *Munida* was sitting below
18:40	94	59°05.654'	10°47.911'		took second coral samples, continue sampling
				48:15	Same position, sampling trial cancelled

Appendix 3

Time (LT)	Depth (m)	Latitude (N)	Longitude (E)	Tape Time (start at 0:00)	Comments
				49:10	Patch further right of cave, move back to left
				50:37	New position, dead coral framework with ascidians, some live corals
				51:09	New position, flight over coral colonies, many small bonsai colonies tumbled down
				53:10	Guarding crab below coral framework
				53:22	Close-up of tube worms, light on and one disappears at 53:32
				53:55	Guarding crab hides
				54:36	Sampling of *Lophelia* at sponge (removed) and yellow star fish (lost)
18:53	94			55:44	After sampling look around sampling area, Photo: 56:21, 56:42
				57:21	New position, sampling of small Lophelia colony
18:58	93	59°05.652’	10°47.92’		sampling basket full with pieces of corals, start ascent soon
				58:08	Sample basket full with picture
	94			58:36	Picture of “Wilson ring”
				60:18	Last sample left in manipulator
	87			61:06	Flight over reef with fishes, star ascent
19:03	93				lift off bottom
19:13	0				Surfaced

Monday, 27.03.2006

JAGO Dive 924 (3) = **AL275-422** J. Schauer, U. Riebesell
East of Søster Island (Pos.2) MiniDV Tape 3

Time (LT)	Depth (m)	Latitude (N)	Longitude (E)	Tape Time (start at 0:00)	Comments
08:26	0	59°05.52'	10°47.816'		Submerged
09:14	147	59°05.548'	10°47.839'	00:06	At bottom, many pebbles on soft bottom, flight upslope towards north
				02:15	Some bigger dropstones sometimes bigger than 1 m, few sponges (Fig._14)
				03:30	Glacial moranic deposits, well rounded, settled by sponges
				04:18	Branched sponge (Fig._15), again at 05:07, 06:07, 06:35, 07:01
09:23		59°05.595'	10°47.827'	09:04	First ascidians on boulders
09:28	120	59°05.633'	10°47.818'	11:40	
				14:40	Change of sediment facies: no glacial deposits, soft bottom
				15:30	First dead coral fragments
09:35	112	59°05.642'	10°47.838'	17:03	First living *Lophelia* and dense dead coral framework
				18:10	Compact morphotype of living *Lophelia*
				21:30	Living satellite corals on up to 1 m thick dead coral framework
09:41	91	59°05.648'	10°47.818'		
				29:00	Near reef top? Dense and compact coral -sponge cover, build-ups up to 2 m high
				30:30	Backward and downslope movement
	92			33:00	Sampling of live *Lophelia* (at 35:00 Fig._16)
09:58		59°05.65'	10°47.936'		
				38:15	Next samples of *Lophelia*
10:06		59°05.643'	10°47.92'	38:51	Next position, big *Lophelia* patch, close-up of polyps (Fig._18)
10:28	102	59°05.645'	10°47.939'	40:33	Next position, further downslope flight (E of ridge)
				42:00	Next *Lophelia* sample trial
10:49		59°05.66'	10°47.935'	51:15	*Lophelia* sample (Fig._19)
				54:10	LIS (Low-Impact-Sampling) (Fig._20)
				56:24	Niskin bottles released for water sample
10:54		59°05.66'	10°47.947'		Start ascending
11:20	0				Surfaced

JAGO Dive 925 (4) = **AL275-423** J. Schauer, K. Hissmann
East of Søster Island (Pos.2) MiniDV Tape 4

Time (LT)	**Depth (m)**	**Latitude (N)**	**Longitude (E)**	**Tape Time (start at 0:00)**	**Comments**
14:20	0	59°05.62	10°47.82		Submerged
14:30	118	59°05.66	10°47.77	00:09	At bottom south of coral mound, on gravel field with lots of ascidians; Big boulder, 1.5 m high, densely settled by ascidians (*Metridium senile*), sponges and tube worms
	120			04:30	Next position, several rounded boulder settled by different species of *Actiniidae* (Fig._21 and Fig._22) and sponges
				09:07	Next position, still boulder facies with sponges, *Actinidae*
	114			11:24	First *Lophelia* colony, further upslope flight
				13:00	Slope angle increases, coral rubble facies
14:58	109	59°05.64	10°47.88	15:20	Coral rubble increases, single live *Lophelia* colonies
	105			16:40	Larger reef patches (> 1m)
				18:10	Flight 2 m above ground over reef structure
				19:26	Close-up of *Lophelia* colony (Fig._23)
15:25	100	59°05.63	10°47.88	20:33	Experiment with coloured water
				26:00	Sampling
				29:45	Release of Niskin bottles for water sample
	98			30:11	Next position, overview of reef complex
				33:23	Coral samples removed from basket on deck
	152			34:19	Strong currents, no positioning possible

Wednesday, 29.03.2006

JAGO Dive 928 (7) = **AL275-429** J. Schauer, C. Oettmeier
East of Søster Island (Pos.2) MiniDV Tape 4

Time (LT)	Depth (m)	Latitude (N)	Longitude (E)	Tape Time (start at 0:00)	Comments
08:42	0	59°05.62	10°47.85		Submerged, strong surface currents from S to N below 40 m
8:53	140	59°05.537	10°47.81		At bottom, very strong bottom currents towards S
09:09	152	59°05.53	10°47.82	34:19	Strong currents, no positioning possible, stabilized on sea-floor, pebble pavement
10:20	153	59°05.53	10°47.807	37:16	Collecting plankton with net
10:28	150	59°05.41	10°47.74		Still strong currents, start ascent
10:45	0				Surfaced

JAGO Dive 929 (8) = **AL275-430** J. Schauer, M. Gruber
Western Trough of Oslo Fjord MiniDV Tape 4

Time (LT)	Depth (m)	Latitude (N)	Longitude (E)	Tape Time (start at 0:00)	Comments
13:43	0	59°04.51	10°44.088		Submerged
13:55	120	59°04.558	10°44.126		At bottom
14:01	110	59°04.54	10°44.13		Strong bottom currents, nice coral reefs
				39:10	Water current measurement with coloured water
				43:44	Close-up of *Lophelia* with *Munida*
				44:20	*Munida* on sea-floor
15:09	110	59°04.54	10°44.12	46:27	Collecting corals
				48:52	Yellow gorgonian (Fig._26)
				49:41	Next position, sampling
				54:37	Close-up of *Lophelia* with fish
	108			54:50	Flight obove reef complex (Fig._27)
15:17	100	59°04.54	10°44.165		Start ascending
15:43	0				Surfaced

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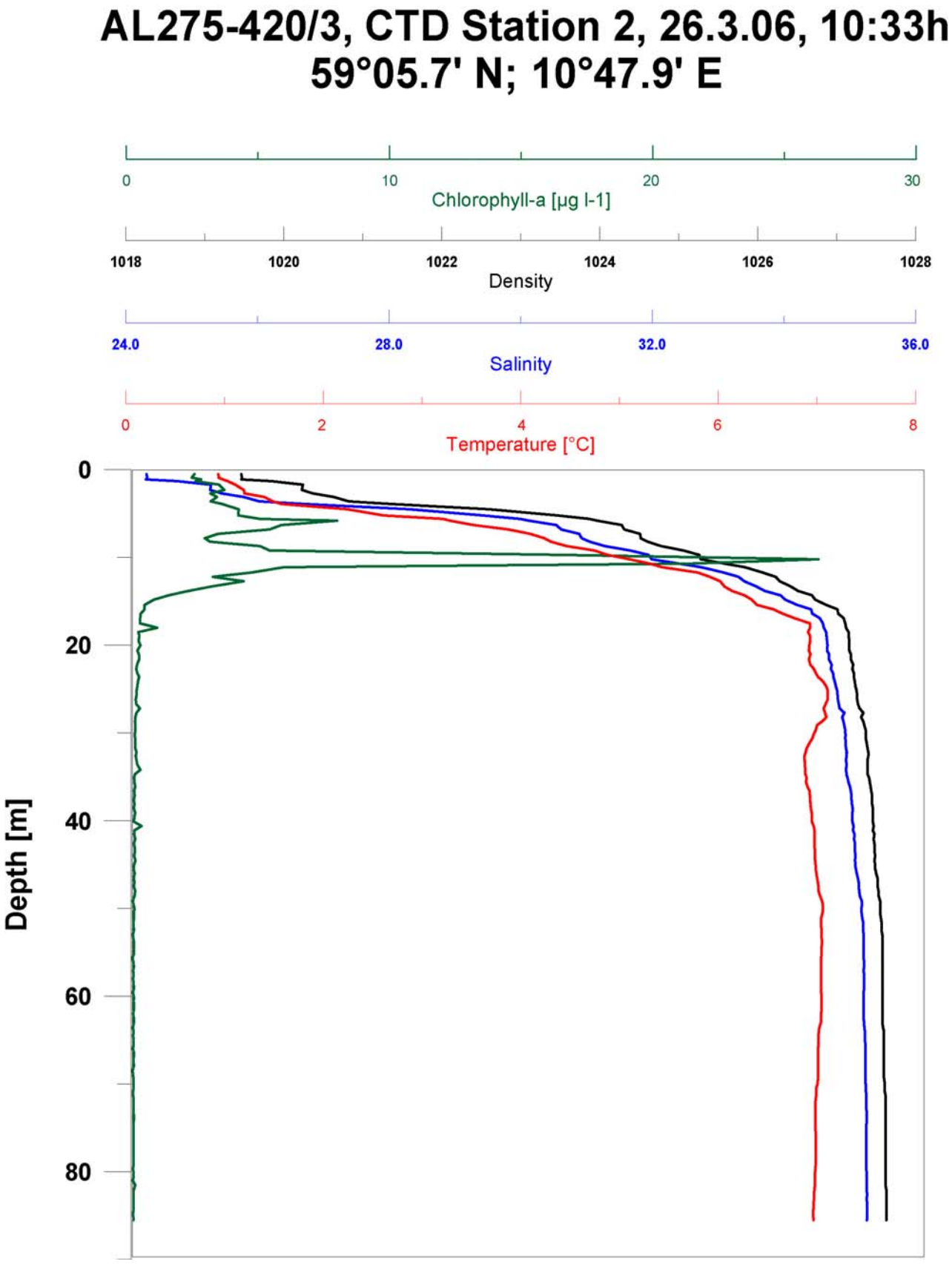
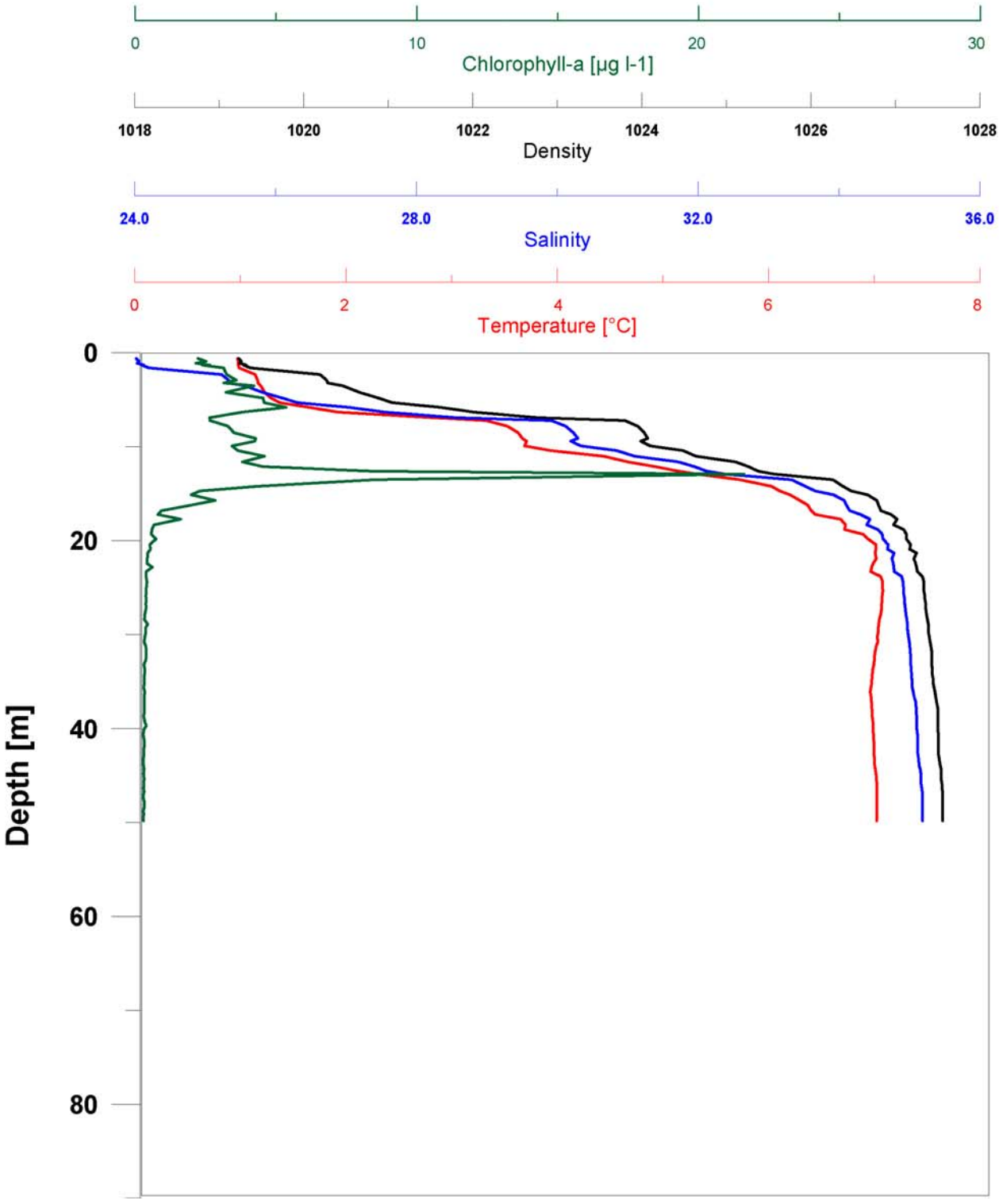
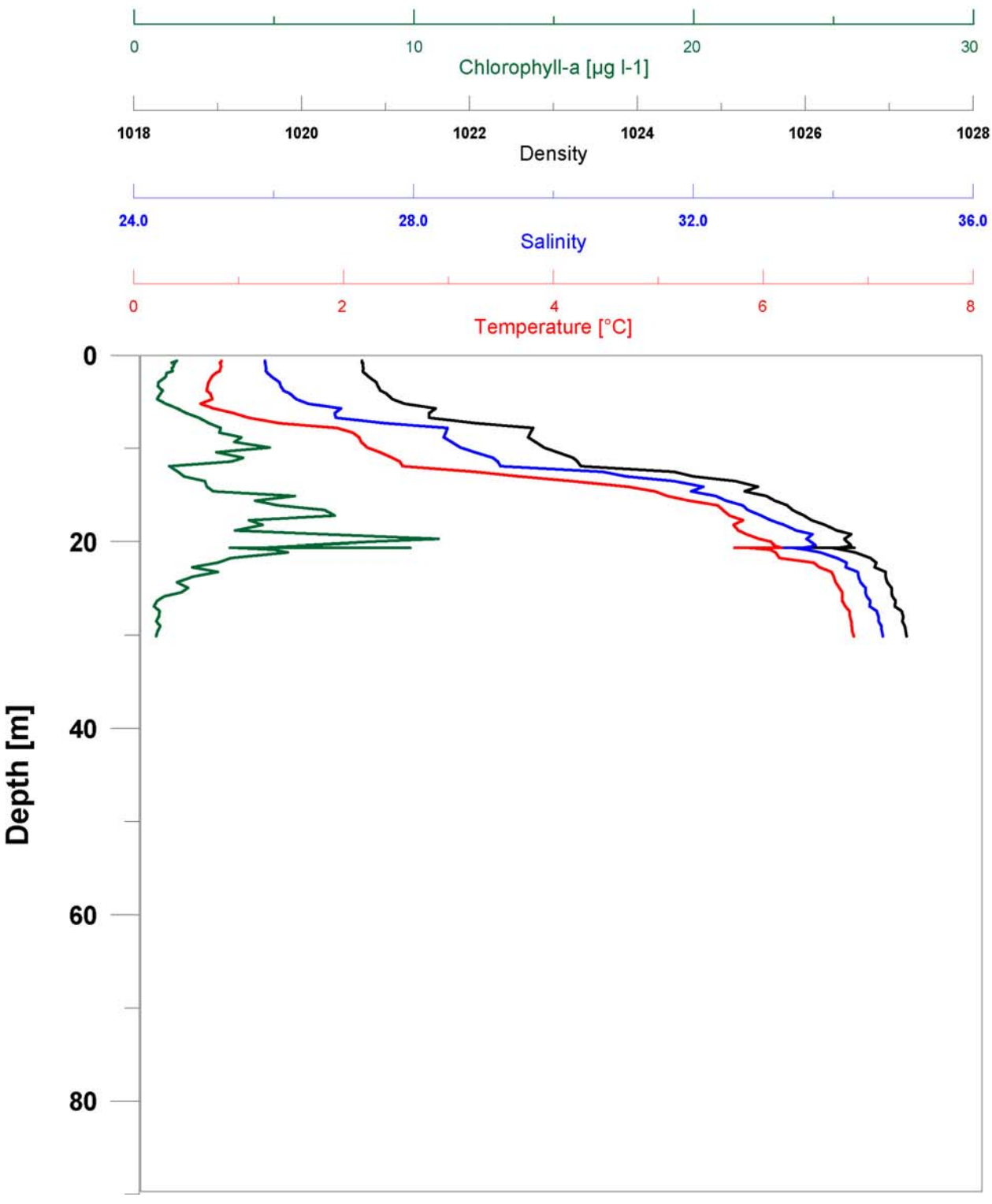
Appendix 4: CTD-Profiles



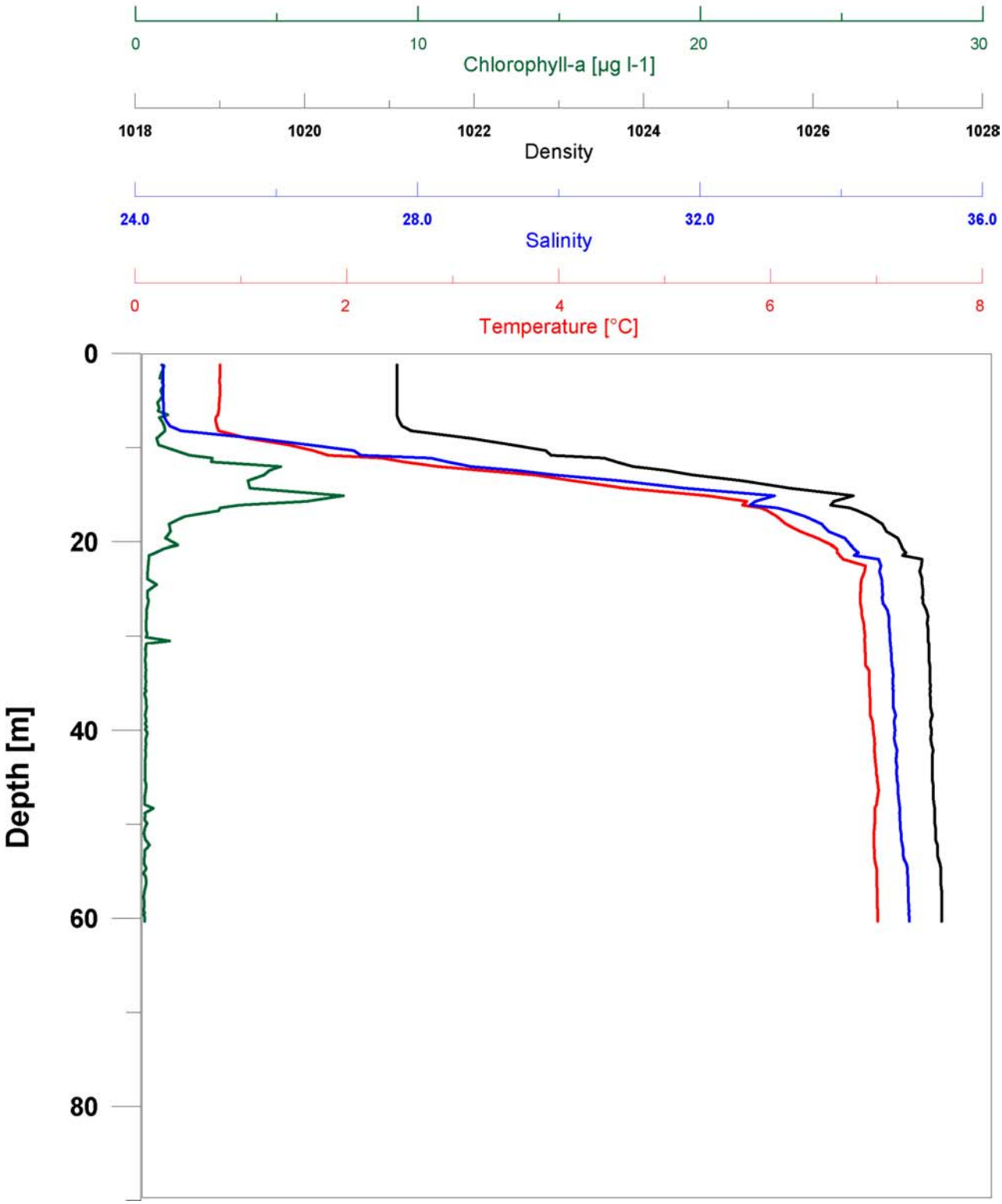
AL275-421/2, CTD Station 3, 26.3.06, 18:00h
59°05.7' N; 10°47.9' E



AL275-425/3, CTD Station 5, 28.3.06, 10:30h
59°05.7' N; 10°47.9' E



AL275-427, CTD Station 6, 28.3.06, 18:30h
59°04.6' N; 10°44.0' E



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No.	Title
1	RV Sonne Fahrtbericht / Cruise Report SO 176 & 179 MERAMEX I & II (Merapi Amphibious Experiment) 18.05.-01.06.04 & 16.09.-07.10.04. Ed. by Heidrun Kopp & Ernst R. Flueh, 2004, 206 pp. In English
2	RV Sonne Fahrtbericht / Cruise Report SO 181 TIPTEQ (from The Incoming Plate to mega Thrust EarthQuakes) 06.12.2004.-26.02.2005. Ed. by Ernst R. Flueh & Ingo Grevemeyer, 2005, 533 pp. In English
3	RV Poseidon Fahrtbericht / Cruise Report POS 316 Carbonate Mounds and Aphotic Corals in the NE-Atlantic 03.08.–17.08.2004. Ed. by Olaf Pfannkuche & Christine Utecht, 2005, 64 pp. In English
4	RV Sonne Fahrtbericht / Cruise Report SO 177 - (Sino-German Cooperative Project, South China Sea: Distribution, Formation and Effect of Methane & Gas Hydrate on the Environment) 02.06.-20.07.2004. Ed. by Erwin Suess, Yongyang Huang, Nengyou Wu, Xiqiu Han & Xin Su, 2005, to be published summer 2006. In English and Chinese
5	RV Sonne Fahrtbericht / Cruise Report SO 186 – GITEWS (German Indonesian Tsunami Early Warning System 28.10.-13.1.2005 & 15.11.-28.11.2005 & 07.01.-20.01.2006. Ed. by Ernst R. Flueh, Tilo Schoene & Wilhelm Weinrebe, 2006, 169 pp. In English
6	RV Sonne Fahrtbericht / Cruise Report SO 186 -3 – SeaCause II, 26.02.-16.03.2006. Ed. by Heidrun Kopp & Ernst R. Flueh, 2006, 174 pp. In English
7	RV Meteor, Fahrtbericht / Cruise Report M67/1 CHILE-MARGIN-SURVEY 20.02.-13.03.2006. Ed. by Wilhelm Weinrebe und Silke Schenk, 2006, 112 pp. In English
8	RV Sonne Fahrtbericht / Cruise Report SO 190 - SINDBAD (Seismic and Geoacoustic Investigations Along The Sunda-Banda Arc Transition) 10.11.2006 - 24.12.2006. Ed. by Heidrun Kopp & Ernst R. Flueh, 2006, xx pp. In English
9	RV Sonne Fahrtbericht / Cruise Report SO 191 - New Vents "Puaretanga Hou" 11.01. - 23.03.2007. Ed. by Jörg Bialas, Jens Greinert, Peter Linke, Olaf Pfannkuche, 2007, xx pp. In English

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