

Cruise Report

Belgica 09/14c

Belgica GENESIS, Leg 3

“Galicia”



The shipboard scientific party



Marine Biology Section



Renard Centre of Marine Geology

Ghent University, Belgium
May 30 – June 08 2009

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1. CRUISE REFERENCE

Belgica 09/14c
Vigo (ES) – Zeebrugge (B)
30.05.2009 - 08.06.2009

2. SCIENTIFIC PERSONNEL

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Guillermo DIAZ	USC
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3. FRAMEWORK AND OBJECTIVES

3.1. Framework

The biological/geophysical research programme of the Belgica cruise 09/14c frames into several international and national projects:

- **EC FP7 IP HERMIONE (2009-2012) (Biology and Geophysics)**

HERMIONE (“*Hotspot Ecosystem Research and Man’s Impact on European Seas*”) is the ecological follow-up of the EC FP6 IP HERMES project. Together with its 38 partners, it will focus on ecosystem research along key sites on the European margin. It will try to investigate the dimensions, distribution and interconnection of deep-sea ecosystems, as well as to understand the influence of climate change, anthropogenic impact and large-scale episodic events (hydrologic or geologic). The results of this project will be directly coupled to the EU policy (among others) (<http://www.eu-hermione.net/>). Results of this campaign will contribute to the PhD projects of Julie Réveillaud and Annelies De Groot, which both frame into the HERMIONE project.

- **ESF BIOFUN-EURODEEP (2008-2010) (Biology)**

The European Science Foundation (ESF) - EuroDEEP project BIOFUN “Biodiversity and Ecosystem functioning in contrasting southern European deep-sea environments: from viruses to megafauna” aims at understanding the relationship between biodiversity of different benthic components (micro- to megabenthos and fish fauna) of the marine environment and the functioning of the ecosystems. The main study area of this project is the Mediterranean whereas the Galicia Bank and adjacent basin, offshore the Iberian Margin was chosen as a kind of reference site for comparison with the more oligotrophic Mediterranean. Additionally the influence of Mediterranean Outflow water on the summit of the Galicia bank and its importance in the distribution of species was investigated. The Marine Biology research group is partner in the BIOFUN project.

- **BELCOLOUR-2**

This BELSPO-funded project aims to improve the quality of existing optical remote sensing products for marine, coastal and inland waters based on new scientific knowledge and to develop new products (including partial pressure of CO₂ and primary production) for key applications such as aquaculture and air-sea CO₂ flux quantification. In addition to algorithm work and image processing BELCOLOUR-2 participates in seaborne cruises for the purposes of calibration of algorithms and for validation of the end products.

3.2. Programme Objectives

This cruise focused, as the last one in a series of 3 ROV campaigns, on the region of the "Massif Galicien de l'Ouest" located near the "Cabo Ortegal" in the most southern part of the Gulf of Biscay (Figure 1). In the "Massif Galicien de l'Ouest" suspected deep-water coral hotspots are present, earlier described by Le Danois in 1948. This area was surveyed in the first cruise using multibeam bathymetry and high resolution seismic profiling. Based on this site survey, ROV Genesis was going to deploy a lander experiment at the end of Leg 2 (14b) within the surveyed zone. Furthermore, the location of the sites that were sampled during leg 3 (14c) was dependent of the results gathered in leg 14a. In addition to biological sampling and ROV-born experiments, also seismic surveying (in order to obtain detailed visual maps) was planned in this third leg.

The campaign was executed in cooperation with the Spanish USC (University of Santiago de Compostella) and the Dutch UVA (University of Amsterdam).

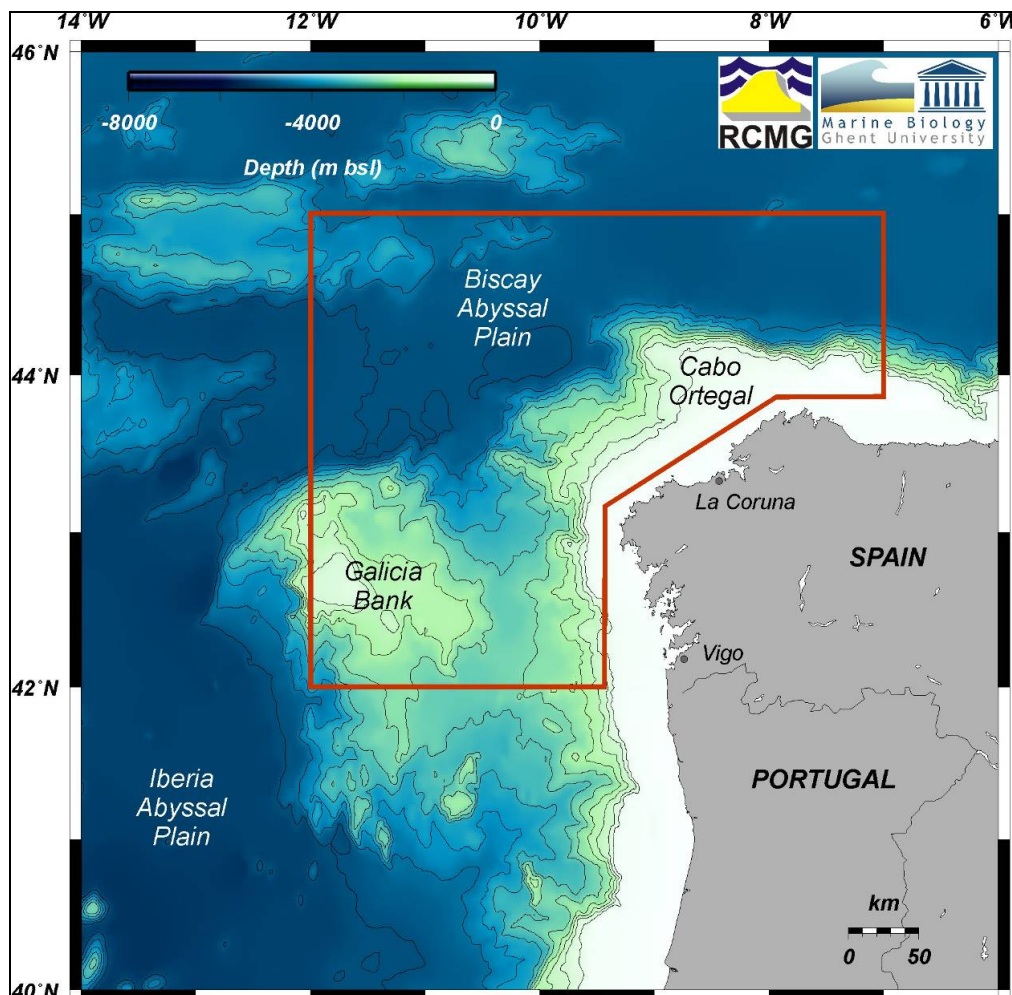


Figure 1: General localization of the study area along the Iberian margin area during Leg 3 (14c) (GEBCO contour lines every 250m).

This campaign focused on the following objectives within the study area:

Ghent University (MARBIOL + RCMG), University of Santiago de Compostella & University of Amsterdam

1. **Sediment sampling:** Sediment cores were taken with the multicorer (MUC) or box corer (BC)(in case sampling with the MUC fails) at 700 m and 1200 m water depth at the Iberian margin in order to analyze
 - The biodiversity of the meiofaunal and nematode community in the framework of the ESF funded BIOFUN project (UGent-MARBIOL).
 - The stable isotope and fatty acid profile of the nematode community in order to get an idea about their diet in the framework of the ESF funded BIOFUN project (UGent-MARBIOL).
 - Environmental variables (pigment concentration, C/N, fatty acids, grain size and organic matter content) which later on can be related to meiofaunal diversity and biomarker signal.

In addition, 10 MUC cores (originating from station 5) were the subject of an *ex situ* experiment onboard R/V Belgica. A syringe filled with defaunated sediment, rabbit pellets or dried macro-algae was placed in every core. In this set-up the possible preferential active (lateral) colonization of the defaunated sediment by the local meiofauna community was investigated. The community structure (genera/species) of the migrated meiofauna will be characterized upon return in the lab.

2. **BC sampling:** box core samples were taken for sponges associated with cold-water corals. In the framework of the HERMIONE project a phylogeny/phylogeography study will be conducted on these sponges from the Mediterranean up to Norway. The aim is to assess the possible connection of coral and associated fauna along the European margin as well as the health of the gene pool of these sponges in different areas.
3. **ROV operations:** ROV Genesis was used in visual and acoustic observation and mapping of seafloor ecosystems. During the ROV dives performed in leg 14b a seabed experiment was going to be deployed (station 2). This was going to be recovered during leg 14c (duration = 4 days). In this experiment several types of azoic oxygen-poor substrates (defaunated sand, rabbit pellets and dried macro-algae) were offered to the local benthic community. It would have been checked if and by which species the substrates are colonized. The ROV was also used for sampling of sponges associated with cold-water corals.
4. **High-resolution seismic profiling:** investigation of the stratigraphic framework and the sedimentary environment. The coordinates of these seismic lines were determined after the multibeam survey during campaign 09/14a.

Management Unit of the North Sea Mathematical Model (MUMM)

- **MUMM: BELCOLOUR-2**

MUMM’s contribution to the BELCOLOUR-2 measurements consisted of reflectance, suspended matter and phytoplankton pigment measurements for use in satellite image validation (if cloud-free) and algorithm calibration and validation.

The primary objectives of this campaign were making *in situ* measurements simultaneous with satellite overpasses of MERIS (Medium Resolution Imaging Spectrometer) and MODIS (Moderate Resolution Imaging Spectrometer).

- **MUMM: MARIN**

The objectives were based on previous experience (see Jan Haelters report, Belgica cruise 2005-13) to identify marine mammals and seabirds species inhabiting shelf waters of the Atlantic margin and in the Channel and to estimate their abundance. Observations were linked to oceanographic parameters (water temperature, chlorophyll,...) collected for the BELCOLOUR-2 project.

4. LOCALIZATION

The study area is located on the Galician continental margin in the Bay of Biscay, in water depths between 500 and 1500 m depth, 50 km Northwest off La Coruna (Figure 1,2).

During 30/05-5/06 BELCOLOUR-2 (MUMM) measurements were made at times specified regardless of location. From 5/06 until 8/06 measurements were made at times specified during transit from La Coruna to Zeebrugge passing through UK and FR waters, and data about bird and marine mammals were gathered.

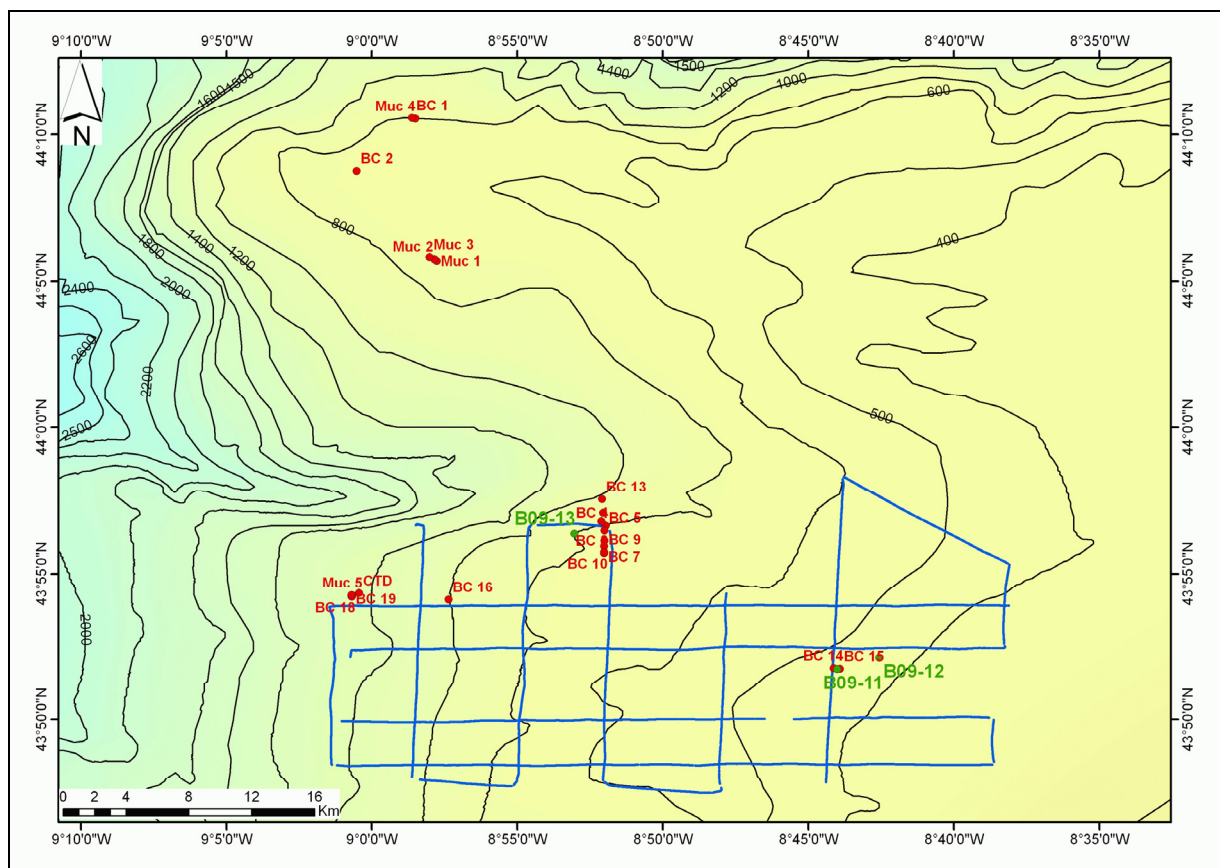


Figure 2: Localization of the Multicorer (MUC) and boxcore (BC) sampling stations together with seismic lines and ROV dives.

5. OPERATIONS

5.1. Biological Sampling and Oceanographical Measurements

5.1.1. Multicorer (OSIL) – box corer

- **Practical problems**

Five attempts were made to retrieve sediment from the deep-sea bottom with the Multicorer (MUC). However, none of them were successful. This can have 2 causes: or the bottom surface is too hard so the cores can't penetrate the sediment, or a technical default prevents the retrieval of sediment. The MUC will be tested this fall at the Belgian coast in order to get a better view of possible technical problems.

During the campaign the box corer (BC) was slightly damaged a few times due to the hard bottom surface covered with rocks.

- **Deployment protocol**

To avoid damage to the MUC the deployment speed was kept to approx. 40 m/min (0.67 m/sec). Fifty meters above the sea bottom a stabilization period of 1 to a few minutes was incorporated. After this period, the corer was lowered at approx. 10 m/min (0.16 m/sec), which seemed optimal. Extra pay out depended on the swell and stability of the ship, but at least 10 m is necessary. A stabilization period of 1 min at the bottom is recommended (if possible). When retrieving the MUC first a speed of 10 m/min (0.16 m/sec) is maintained. When the device is further away from the sea bottom, a speed of 50 m/min (0.83 m/sec) is possible.

When using the BC a faster descent and ascent is possible, due to the more robust construction and the higher weight of the device.

- **Processing of core samples**

In the context of the ESF funded BIOFUN project, samples from 700 and 1200 m depth were required. However, only sediment from a 1200 m depth area was collected. At this location three replicate deployments were performed with the BC. After each successful deployment, sub-sampling with 4 MUC cores (10 cm internal diameter) was done (Figure 3). From every BC deployment each time one core was used for:

- Meiofaunal diversity research
- Meiofaunal (nematode) natural stable isotope profile
- Meiofaunal (nematode) fatty acid profile
- Environmental variables

For meiofaunal characterization, the sediment was extruded and sliced in cm layers to investigate community variability with sediment depth: 0-1, 1-2, 2-3, 3-4, 4-5, 5-10 cm. Also 5 cm of overlying water was collected. The slices were washed down into 500 ml bottles and fixed

with 8 % formalin, buffered with seawater, to obtain a final formalin concentration of about 4 - 5%.

At the lab of the Marine Biology Department of Ghent University, these samples will be rinsed over 1000 and 32 μm mesh-sieves to retain the meiofaunal size-class (32-1000 μm). Following a standard protocol, the samples will be resuspended and centrifuged with the colloidal silica polymer LUDOX to separate the meiofaunal organisms from the surrounding sediment (Heip *et al.*, 1985; Vincx, 1996). After fixation in 4 % formalin and staining with Rose Bengal, all metazoan meiobenthic organisms will be counted and classified at higher taxon level under a stereoscopic microscope using Higgins & Thiel (1988) and reference material. At least 100 nematodes will randomly be picked out and mounted on glass slides in glycerin. A formalin-ethanol-glycerin technique will be used to prevent dehydration of the organisms during the transfer from formalin to glycerin (Seinhorst, 1959; Vinck, 1996). Finally, nematodes will be identified to genus/species level using relevant taxonomic literature and reference drawings of the Department of Marine Biology of Ghent University, gathered in the nematode-library of Ghent University and the NeMys database (Deprez *et al.*, 2005).



Figure 3: Retrieval of the cores. Sub-sampling of the BC with the MUC cores

The cores for natural stable isotope and fatty acid analysis were sliced (0-1, 1-2, 2-3, 3-4, 4-5 cm). The slices were collected in Petri dishes of 140 mm diameter for storage at -20°C .

The cores for environmental variables were again sliced (0-1, 1-2, 2-3, 3-4, 4-5 and 5-10 cm). However, all the slices were sub-sampled in order to investigate different environmental aspects. Here, the following analyses for environmental variables were carried out:

- C/N content: plastic scintillation bottles (1 and 5 cm slices)
- Pigments: Petri dishes of 55 mm (1 cm slices), PE jar of 125 ml (5 cm slices)
- Fatty acid: glass scintillation bottles (1 and 5 cm slices)

This material was frozen at -20°C .

- Organic matter and grain size: Petri dishes of 140 mm (1 cm slices); PE jar of 125 ml (5 cm slices)

These samples were dried in the oven at 60° C.

5.1.2. *In situ* experiment

A seabed experiment was going to be deployed during one of the ROV dives performed in leg 14b, and would have been recovered during leg 14c. In this case the *in situ* experiment was placed on the seafloor for at least 4 days, which is the minimum time needed to obtain good results when processing the different substrates. However, although the experiment was prepared, the weather was not ideal to deploy the ROV, and the deployment of the experiment was delayed to leg 14c.

On 31.06 an attempt was made to deploy the ROV and the experiment. Due to an unfortunate accident, where the cable connected to a video was pulled out during deployment, the dive was cancelled. Because the weather conditions were turned for the worse the next days, the campaign-time left was too short to place the experiment on the seafloor. Another attempt will be made during a following campaign.

5.1.3. *Ex situ* experiment

Sub-samples from BC 8, 9 and 10 were used in an *ex situ* experiment onboard the Belgica. Out of each BC, 4 sub-samples were taken using cores of 10 cm internal diameter (MUC cores). Ten cores (3 of BC 8 and 10, and 4 of BC 9) were placed in 2 water barrels in the cold room of the Belgica (Figure 4A). In every core one syringe, filled with 1 of 3 different treatments (defaunated sand, rabbit pellets or dried macro-algae), was placed. The syringes were distributed in such a way that core samples from every BC were incubated with all the treatments. No treatment was placed in the 4th core of BC 9 in order to follow the evolution of the meiofauna community without treatment. The barrels were filled with water and each core was aerated separately. They stayed into the cold room at *in situ* temperature of 12°C until arrival in Zeebrugge.

The 4th core of BC 8 and 10 was sliced immediately after collection (0-1 + overlying water, 1-2, 2-3, 3-4, 4-5, 5-10 cm). The slices were washed into 500 ml bottles and fixated with 8 % formalin buffered with seawater, to obtain a final formalin concentration of about 4 - 5%.

On 08.06, the 2 water barrels with cores were transported to a climate room (at 6° C) at the University of Ghent. On 10.06, 7 days after the beginning of the experiment, the syringes were removed (Figure 4B). The content was washed into 500 ml bottles and fixated with 4% formalin. Next to this, a sub-sample of the surrounding sediment was taken from every core and fixated with 4 % formalin. These samples will be further processed as explained in 5.1.1.

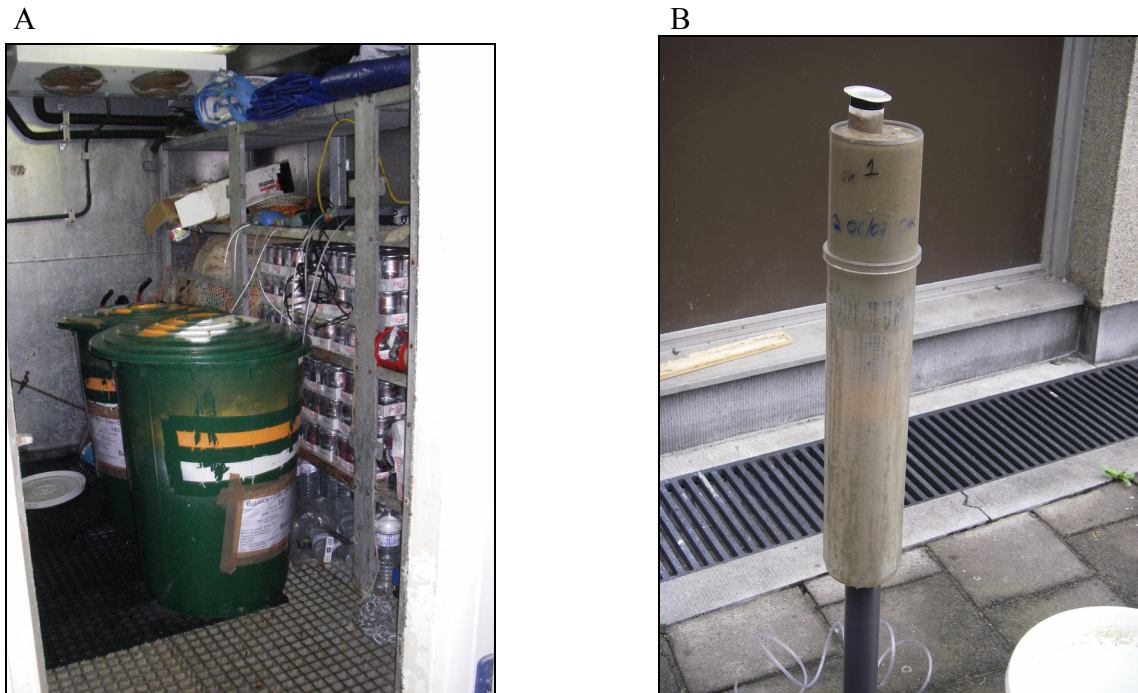


Figure 4: *Ex situ* experiment. A) 2 water barrels in the cold room of R/V Belgica. B) Processing of the experiment: removal of the syringe

5.1.4. CTD

One CTD deployment was performed to provide data on salinity, depth and temperature at the BIOFUN2 station at 1200 m depth. A Niskin bottle was attached to the cable above the CTD to recover an amount of above bottom seawater. In the ship's lab this water was filtered for chl-a measurements.

5.2. Geological activities

5.2.1. Seismic Survey

About 240 kilometers of high-resolution single channel seismic data (Figure 5) were collected (17 2D lines) in the study area with a SIG sparker source (120 electrodes). The sparker was triggered every 3 s reaching 500 J energy. The sampling frequency was set at 8 kHz and a record length of 2900 ms TWT was used. The velocity of the ship during seismic work was about 4 knots. During this work, R/V Belgica operated on electrical engines for noise reduction.

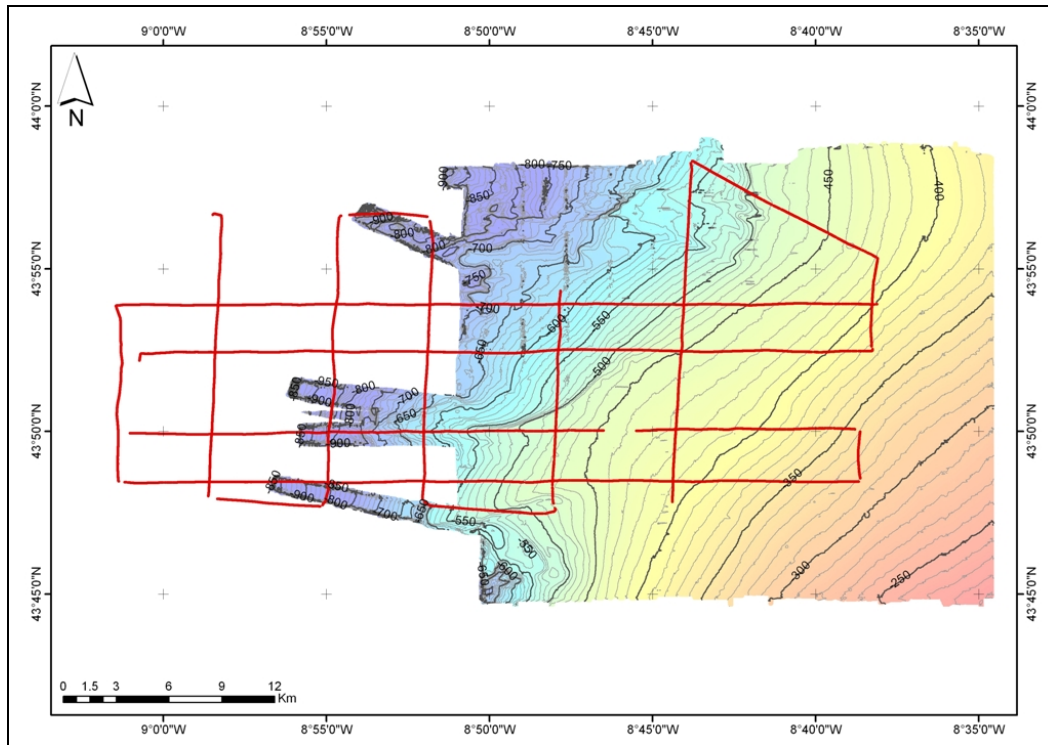


Figure 5: 2D seismic navigation (WGS84) (background: multibeam grid obtained during campaign 09/14a).

5.2.2. Multibeam survey

The multibeam echosounder used during this cruise is the Simrad EM1002 system from the Belgian Ministry of Economical Affairs, installed permanently on the Belgica. Standard procedures were chosen for its application. Before leaving the port of Vigo, the draft of the ship was measured at four locations, resulting in the average value of 5.151 m. Once arrived at the study site, the sound absorption coefficient (Figure 6) in the water was calculated from the temperature and salinity of the surface water, given by the ODAS-II system. No pH measurement was carried out, but an average value of 7.5 was entered in the formulas. An average of 0.75 km was taken for the survey water depth. The calculation of the sound velocity is described above.

INPUT PARAMETERS :		ABSORPTION COEFFICIENT :	
DATE	2009-05-09 07:25	α in dB/km (T > 20°C)	30.51
SOUND SPEED C in m/s =	1502.20	α in dB/km (T ≤ 20°C)	29.78
SEA WATER TEMPERATURE, T in °C =	13.27		31.38
SEA WATER SALINITY, S in ppt =	35.66		
SEA WATER pH, pH =	7.5		
WATER DEPTH in km =	0.75	RATIO (α_1/α_2) x 100	105.38
		α_1 - 98 KHz	31.38
		α_2 - 93 KHz	29.78
FREQUENCY in KHz, f	93		
	98		

Figure 6: Input parameters for the multibeam calibration

At the beginning of the survey during cruise 09/14a a roll calibration was carried out. Therefore 2 tracks were sailed in opposite direction. No adjustments were necessary. It was chosen to record all possible parameters; position, backscatter image...

During the actual survey we aimed at keeping a 10-20% overlap between the consecutive swaths. This resulted in a line spacing ranging of 700-750 m (maximal swath of 2x600) (Figure 7). For most of the time the system was switched to the manual detection of the appropriate working mode (deep). The beam angles were generally chosen at 70°, seen the relatively gentle slope. The beam spacing was chosen as in-between.

During the multibeam survey, it was tried to keep the vessel speed to a minimum of 5 knots (to avoid heavy pitch movement), and a maximum of 7 knots. Overall, the weather conditions were quite good during the survey, and the data quality was fairly good too, until a water depth of ca. 925 m. In such deep waters the system easily lost the bottom.

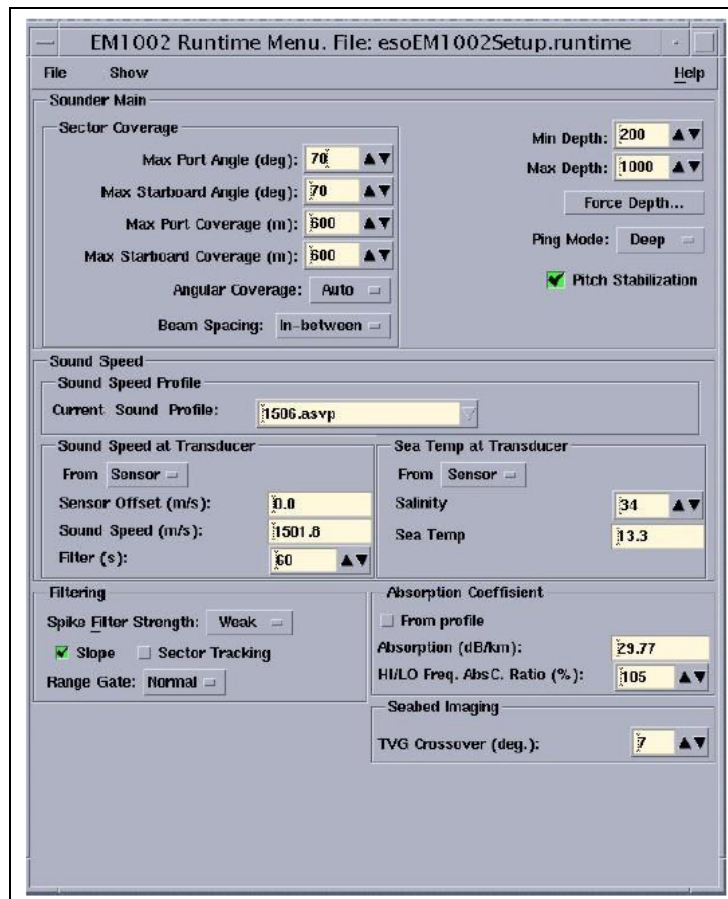


Figure 7: Screenshot of the multibeam input parameters concerning sound velocity and filtering.

5.2.3. ROV Survey

The RCMG acquired a Sub-Atlantic Cherokee-type ROV "Genesis", with TMS and shipboard winch. This winch hosts a reinforced cable of 1600 m which can bring the TMS and ROV to a safe depth prior to ROV launch (with a maximum tether of 120 m). The winch cable is connected to a pilot control interface which was installed in the laboratory container. This encompasses the physical control of the ROV and its instruments, as well as the observation (and navigation cameras). 4 cameras and 1 still camera were active: one on the TMS (ROV launch & re-entry control), a backward looking within the ROV (for TMS re-entry and tether inspection) and the two forward-looking black & white and colour (with overlay) cameras. An overlay on the screen with navigation control information could be put on an arbitrary camera display. The main sampling tool on the ROV is the controlled grab arm and a deployable tray in which samples can be stored. The ROV also contains a depth control, an altimeter and a side-looking sonar for detection of seabed objects.

Positioning of the TMS and ROV was done through the GAPS positioning system (IXSEA). This Global Acoustic Positioning System, GAPS, is a portable Ultra Short Base Line (USBL) with integrated Inertial Navigation System (INS) and Global Positioning System (GPS). The GAPS was deployed at the side and a transponder fixed on the TMS and on the ROV, resulting in the position of the Belgica, TMS and ROV. Navigation from the GAPS software is stored in raw format. During the deployments, the ship's, TMS and ROV navigation was also recorded through the OFOP software (J. Greinert, Royal NIOZ, The Netherlands).

During ROV survey, the control is performed by the pilot and the PI scientist (scientist, co-pilot/navigator), assisted by another shipboard scientist and contact with the bridge is held. Propulsion of the ship remained diesel which enables to handle the ship in a very controlled manner, even though dynamic positioning is not available.

5.3. BELCOLOUR-2

The standard BELCOLOUR-2 sampling at each station consisted of the following set of observations (estimated 20 minutes):

- Orientation of the ship with the sun at 135° according to the bow of the ship
- Above-water light measurements from TriOS-RAMSES spectroradiometers
- Niskin water samples at -0.5 m for: suspended particulate matter, chlorophyll-a and phaeopigments, turbidity, CDOM and particulate absorption
- ODAS printout
- Subjective description of sea/sky state (wave height, foam fraction coverage, cloud fraction, sun visibility, etc.) and sea/sky photos
- SeaCAT profile (SCTD+OBS+PAR)
- Secchi depth
- Vertical profile of the water column with an optics cage for determining the vertical variability of inherent optical properties over the water column (with BB9 and ECO-VSF backscattering meters, fluorescence, CDOM, etc.)

For the above-water light measurements with the RAMSES spectroradiometers viewing direction was at an azimuthal angle of 135° to the sun and the ship was oriented to avoid ship

shadow and reflection on the water being targeted.

5.4. Operational Report

It is worth noting that the time used in this cruise report is the Belgian Summer time (BRAVO TIME = UTC + 2 hours). On the ROV sheets UTC time was used.

Saturday 30.05.2009

10:05 Start of the campaign, departure from Vigo, transit to the study area
12:59 BELCOLOUR-2 measurement (VC01)
14:30 Scientific programme briefing with the scientific crew practical considerations and run over the time schedule
15:20 Exercise abandon ship
15:26 BELCOLOUR-2 measurement (VC02)
00:15 Arrival at the study area.

Sunday 31.05.2009

14:17 BELCOLOUR-2 measurement (VC03)
15:02 Start preparation of the ROV for the dive
16:13 BELCOLOUR-2 measurement (VC04)
17:27 Start deployment of the ROV, technical problem
17:28 ROV placed back on deck, reparation is necessary
18:09 Transit to the coastline of La Coruna
18:32 Changing of the material: ROV is replaced by the MUC
18:59 Transit to multibeam survey site

Monday 01.06.2009

02:06 Start of multibeam line 1.
03:06 Start of multibeam line 2.
03:21 Start of multibeam line 3.
03:21 Start of multibeam line 4.
03:30 Start of multibeam line 5, heading 180°.
04:30 Start of multibeam line 6.
05:15 Start of multibeam line 7, heading 7°.
06:15 Start of multibeam line 8.
07:05 Start of multibeam line 9.
07:37 Start of multibeam line 10.
08:37 Start of multibeam line 11.
09:03 Deployment of MUC 1 at BIOFUN area 1 (780 m)
09:29 MUC at bottom
09:46 MUC on deck
09:55 Repositioning
10:24 Deployment of MUC 2 at BIOFUN area 1 (790 m)
10:38 MUC at bottom

10:57 MUC on deck
11:18 Deployment of MUC 3 at BIOFUN area 1 (790 m)
11:41 MUC at bottom
11:58 MUC on deck
12:33 Repositioning
13:30 BELCOLOUR-2 measurement (VC05)
14:22 Deployment of MUC 4 at BIOFUN area 1 (800 m)
14:46 MUC at bottom
15:02 MUC on deck
15:15 BELCOLOUR-2 measurement (VC06)
15:36 Switching from MUC to BC
15:50 Deployment of BC 1 at BIOFUN area 1 (800 m)
16:10 BC at bottom
16:25 BC on deck
16:27 Repositioning
16:37 Deployment of BC 2 at BIOFUN area 1 (680 m)
16:55 BC at bottom
17:08 BC on deck
17:10 Repositioning
17:21 Deployment of BC 3 at BIOFUN area 1
17:39 BC at bottom
17:52 BC on deck, cease the coring
18:45 Transit to multibeam survey site
20:18 Start of multibeam line 12.
19:52 Start of multibeam line 13.
21:18 Start of multibeam line 13.
19:59 Start of multibeam line 14.
21:54 Start of multibeam line 14.
21:55 Start of multibeam line 15.
22:55 Start of multibeam line 16.
23:17 Start of multibeam line 17, not logging.
23:24 Start of multibeam line 18, not logging.
23:31 Start of multibeam line 19.

Tuesday 02.06.2009

00:31 Start of multibeam line 20.
00:52 Start of multibeam line 21, not logging.
00:56 Start of multibeam line 22.
01:56 Start of multibeam line 23.
02:24 Start of multibeam line 24.
03:24 Start of multibeam line 25.
03:52 Start of multibeam line 26.
03:54 Start of multibeam line 27, not logging.
03:57 Start of multibeam line 28.
04:57 Start of multibeam line 29.
05:22 Start of multibeam line 30, not logging.

05:24 Start of multibeam line 31.
06:24 Start of multibeam line 32.
07:05 End of multibeam operations, transit to next sampling area.
08:07 Deployment of BC 4 at the dredged transect (890 m)
08:29 BC at bottom
08:46 BC on deck
08:49 Deployment of BC 5 at the dredged transect (860 m)
09:10 BC at bottom
09:26 BC on deck
09:33 Deployment of BC 6 at the dredged transect (780 m)
09:52 BC at bottom
10:07 BC on deck
10:10 Deployment of BC 7 at the dredged transect (780 m)
10:30 BC at bottom
10:44 BC on deck
10:47 Deployment of BC 8 at the dredged transect (780 m)
11:04 BC at bottom
11:19 BC on deck, 4 good cores present
11:23 Deployment of BC 9 at the dredged transect (780 m)
11:35 BC at bottom
11:49 BC on deck, 4 good cores present
12:57 BELCOLOUR-2 measurement (VC07)
13:32 Deployment of BC 10 at the dredged transect (780 m)
13:49 BC at bottom
14:03 BC on deck, 4 good cores present
14:04 Repositioning
14:14 Deployment of BC 11 at the dredged transect (780 m)
14:32 BC at bottom
14:46 BC on deck
14:50 Deployment of BC 12 at the dredged transect (980 m)
15:12 BC at bottom
15:29 BC on deck
15:42 Repositioning
15:55 BELCOLOUR-2 measurement (VC08)
16:22 Deployment of BC 13 at the dredged transect (1000 m)
16:47 BC at bottom
17:04 BC on deck
17:12 Transit to Twin Mound
18:01 Deployment of BC 14 at Twin Mound (440 m)
18:12 BC at bottom
18:21 BC on deck
18:28 Deployment of BC 15 at Twin Mound (440 m)
18:30 BC at bottom
18:39 BC on deck, presence of dead corals
18:43 Transit to seismic survey site
19:15 Start of seismic operations.
19:26 Start of line Gm090508, heading 167° (av. Speed 3.8 knots).

23:51 End of line Gm090508.

23:52 Start of line Gm090509, heading 180° (av. Speed 4.0 knots).

Wednesday 03.06.2009

00:00 Continue seismic operations.

01:22 End of line Gm090509.

01:25 Start of line Gm090510, heading 90° (av. Speed 3.5 knots).

06:05 End of line Gm090510.

06:09 Start of line Gm090511, heading 5° (av. Speed 4.0 knots).

06:28 End of line Gm090511.

06:31 Start of line Gm090512, heading 271° (av. Speed 3.8 knots).

07:48 End of line Gm090512.

08:00 End of seismics. Start transit to mini mound area.

08:30 Arrival at Twin mound.

08:55 ROV in the water for dive B09-11.

10:50 Start transit to Singular mound. ROV back into TMS and TMS stays into the water.

11:50 Start of dive B09-12.

13:10 ROV on deck. Start transit to 'Mount structure'.

13:34 BELCOLOUR-2 measurement (VC09)

14:50 ROV in the water for dive B09-13.

16:20 Technical problem with the thrusters and the cable of the ROV.

16:50 ROV on deck.

17:08 BELCOLOUR-2 measurement (VC010)

18:00 Start transit to continue the seismic grid.

18:55 Start of seismic operations.

19:03 Start of line Gm090513, heading 270° (av. Speed 4.0 knots).

21:33 End of line Gm090513.

22:05 Start of line Gm090514, heading 90° (av. Speed 4.4 knots).

Thursday 04.06.2009

00:00 Continue seismic operations.

01:58 End of line Gm090514.

02:02 Start of line Gm090515, heading 0° (av. Speed 3.9 knots).

02:42 End of line Gm090515.

02:44 Start of line Gm090516, heading 310° (av. Speed 3.8 knots).

04:00 End of line Gm090516.

04:03 Start of line Gm090517, heading 180° (av. Speed 3.6 knots).

06:55 End of line Gm090517.

07:01 Transit to next sampling area

08:35 Deployment of BC 16 at BIOFUN area 2 (1050 m)

09:08 BC at bottom

09:27 BC on deck

09:30 Repositioning

09:38 Deployment of BC 17 at BIOFUN area 2 (1200 m)

10:04 BC at bottom

10:25 BC on deck, 4 good cores present
10:28 Deployment of BC 18 at BIOFUN area 2 (1200 m)
10:44 BC at bottom
11:06 BC on deck, 4 good cores present
11:10 Deployment of BC 19 at BIOFUN area 2 (1200 m)
11:23 BC at bottom
11:42 BC on deck, 4 good cores present
13:12 BELCOLOUR-2 measurement (VC011)
13:26 Switching from BC to MUC
13:46 Deployment of MUC 5 at BIOFUN area 2 (1200 m)
14:19 MUC at bottom
14:43 MUC on deck
15:58 CTD measurement, cease the activities
17:10 Start of seismic operations.
17:20 Start of line Gm090518, heading 185° (av. Speed 3.6 knots).
17:30 Reception
19:30 End of line Gm090518.
19:33 Start of line Gm090519, heading 95° (av. Speed 4.0 knots).
20:07 End of line Gm090519.
20:09 Start of line Gm090520, heading 2° (av. Speed 4.4 knots).
22:10 End of line Gm090520.
22:12 Start of line Gm090521, heading 94° (av. Speed 4.6 knots).
22:34 End of line Gm090521.
22:36 Start of line Gm090522, heading 180° (av. Speed 4.0 knots).

Friday 05.06.2009

00:00 Continue seismic operations.
00:35 End of line Gm090522.
00:38 Start of line Gm090523, heading 260° (av. Speed 4.0 knots).
01:21 End of line Gm090523.
01:24 Start of line Gm090524, heading 6° (av. Speed 4.5 knots).
02:50 End of line Gm090524.
03:00 End of seismics,
03:01 End of scientific programme, start of transit to La Coruna
08:56 Arrival at La Coruna.
09:45 Start of transit to Zeebrugge
13:02 BELCOLOUR-2 measurement (VC012)
14:51 BELCOLOUR-2 measurement (VC013)

Saturday 06.06.09

12:31 BELCOLOUR-2 measurement (VC014)

Sunday 07.06.09

12:42 BELCOLOUR-2 measurement (VC015)

14:32 BELCOLOUR-2 measurement (VC016)

5.5. Operational Remarks

During our campaign we encountered, next to the problems with the MUC, some technical problems with the thrusters and the cable of the ROV during dive B09-13. The situation was handled perfectly by the crew of the R/V Belgica.

6. PRELIMINARY RESULTS

6.1. Biology

6.1.1. Core sampling

A total of 4 potential sampling areas were identified prior to the cruise. The locations for biological sampling with MUC and/or BC, and for visual exploration done by ROV in order to find suitable locations to retrieve corals and sponges, were dependent of the results of the multibeam surveys performed in the GENESIS 1 “Cabo Ortegal” cruise (09/14a). Next to this Guillermo Diaz, who was also onboard, gave us interesting information about suitable sample locations, based on his own experience in the area.

BIOFUN1 (780 m, Figure 8) and BIOFUN2 (1200 m, Figure 11) were identified as areas with the correct depth and the presence of soft-sediment ideal for the BIOFUN meiofaunal samples. The sample locations for sponges associated with corals were identified based on the results obtained during the 2008 cruise of the Sarmiente de Gamboa. During that cruise two transects were dredged (780-1000 m, Figure 9, proposed by Guillermo Diaz) and coral fragments/branches were recovered. Based upon these tracks and the obtained CTD and multibeam information different sampling locations for coral rubble were identified. The Twin Mound is a more shallow station (440 m, Figure 10) located in an area of so-called minimounds. These mounds were assumed to be partly composed out of coral rubble.

Due to the low efficiency of MUC sampling, we switched to BC sampling. However, some locations appeared to be covered with hard substrate and rocks, so little to no sediment was recovered during many of the BC deployments.

An overview of the sampling stations is given in Table 1. A more detailed overview of observations and findings is given in Table 2.

Date	Dive/station	Area	Lat (N)	Long (W)	Depth (m)	Use
01.06.09	MUC 1	BIOFUN1	44° 05.6800'	08° 57.7622'	780	Empty
01.06.09	MUC 2	BIOFUN1	44° 05.7430'	08° 57.8404'	790	Empty
01.06.09	MUC 3	BIOFUN1	44° 05.7430'	08° 58.0117'	790	Empty
01.06.09	MUC 4	BIOFUN1	44° 10.5370'	08° 58.4915'	800	Empty
01.06.09	BC 1	BIOFUN1	44° 10.5610'	08° 58.6081'	800	Empty
01.06.09	BC 2	BIOFUN1	44° 08.7640'	09° 00.5149'	680	Empty
02.06.09	BC 4	Dredged transect	43° 56.6520'	08° 51.9510'	890	2 cm sed.

02.06.09	BC 5	Dredged transect	43° 56.4790'	08° 51.9923'	860	5 cm sed.
02.06.09	BC 6	Dredged transect	43° 56.1320'	08° 51.9989'	780	2 cm sed.
02.06.09	BC 7	Dredged transect	43° 55.9420'	08° 52.0104'	780	2 cm sed.
02.06.09	BC 8	Dredged transect	43° 55.7090'	08° 52.0063'	780	> 10 cm sed.
02.06.09	BC 9	Dredged transect	43° 55.7400'	08° 52.0085'	780	> 10 cm sed.
02.06.09	BC 10	Dredged transect	43° 55.7400'	08° 52.0088'	780	> 10 cm sed.
02.06.09	BC 11	Dredged transect	43° 56.7940'	08° 52.0088'	780	Empty
02.06.09	BC 12	Dredged transect	43° 57.0770'	08° 52.0431'	980	Empty
02.06.09	BC 13	Dredged transect	43° 57.5510'	08° 52.0803'	1000	Empty
02.06.09	BC 14	Twin Mound	43° 51.7890'	08° 44.1224'	440	Dry sed.
02.06.09	BC 15	Twin Mound	43° 51.7600'	08° 43.9119'	440	Death corals
02.06.09	BC 16	BIOFUN2	43° 54.1180'	08° 57.3482'	1050	< 2 cm sed.
04.06.09	BC 17	BIOFUN2	43° 54.2580'	09° 00.6561'	1200	> 10 cm sed.
04.06.09	BC 18	BIOFUN2	43° 54.2320'	09° 00.6962'	1200	> 10 cm sed.
04.06.09	BC 19	BIOFUN2	43° 54.2090'	09° 00.6834'	1200	> 10 cm sed.
04.06.09	MUC 5	BIOFUN2	43° 54.2670'	09° 00.6907'	1200	Empty

Table 1: Overview of stations sampled during GENESIS 3 Belgica 09/14c. BC 3 is not included, because the information is not available. MUC= Multicorer, BC=boxcorer, sed.=sediment

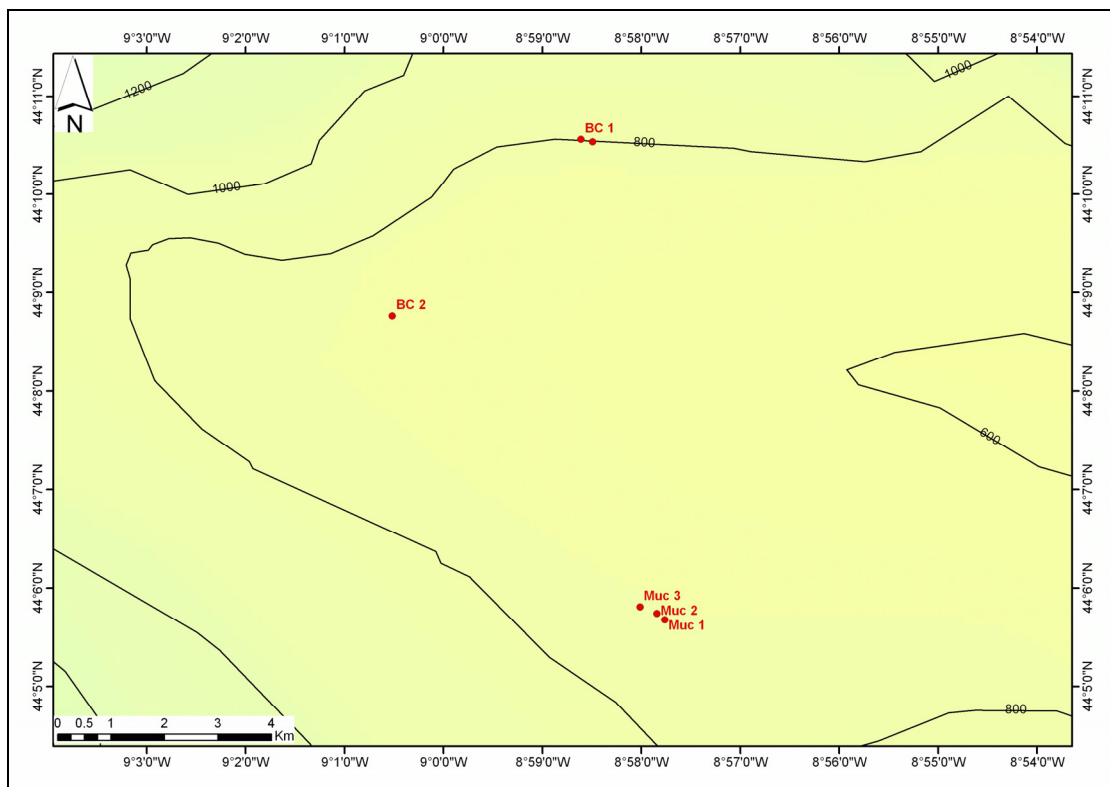


Figure 8: Location of the BIOFUN1 MUC and BC deployments (red dots)

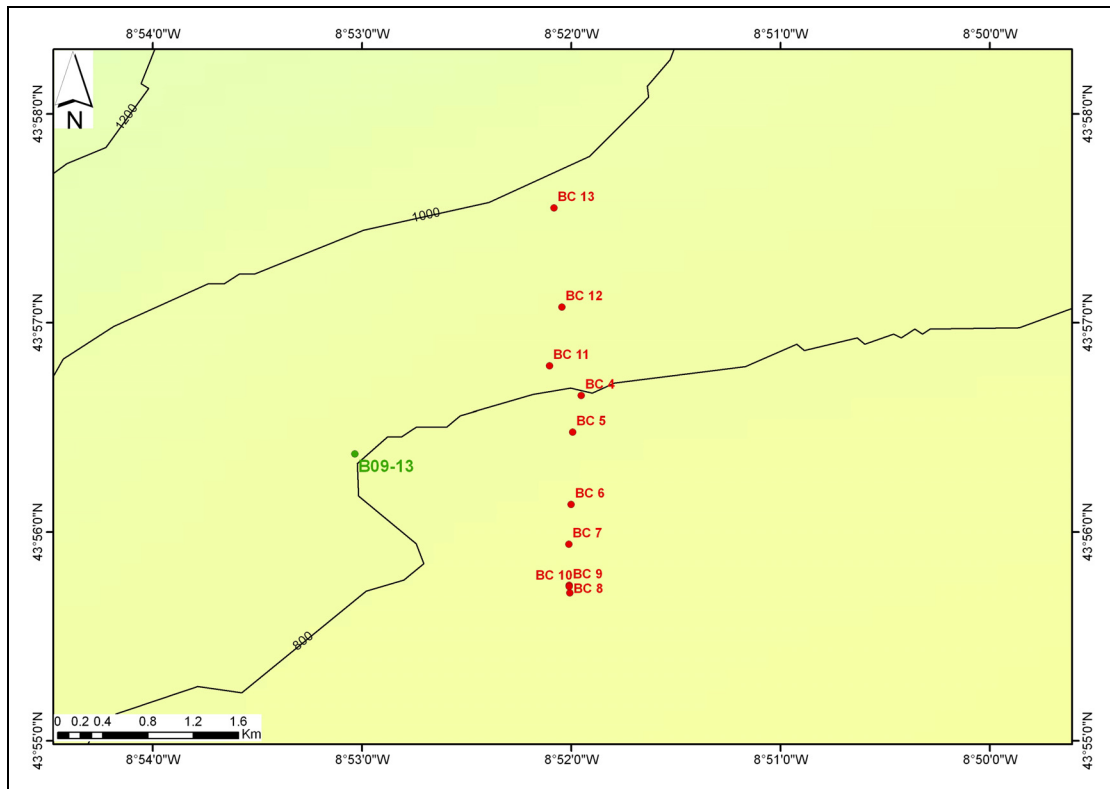


Figure 9: Location of the “dredged transect” BC deployments (red dots) and ROV dive (green dot)

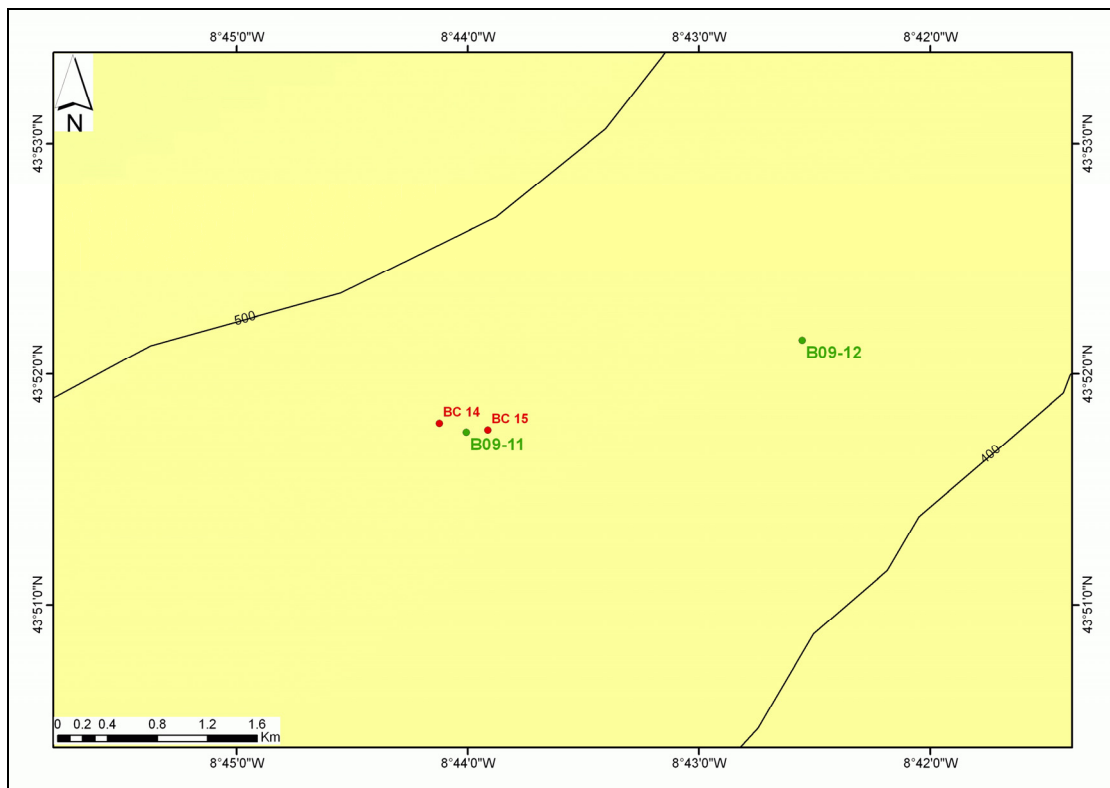


Figure 10: Location of the Twin Mound BC deployments (red dots) and ROV dives (green dots)

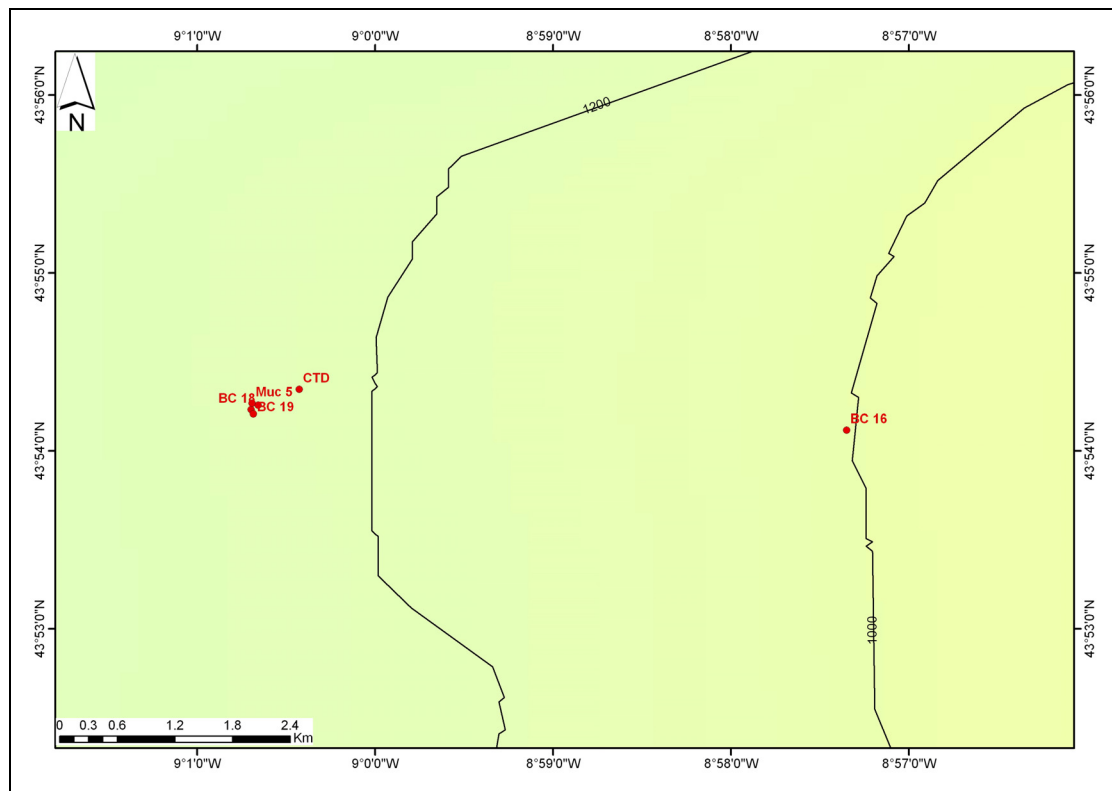


Figure 11: Location of the BIOFUN2 BC and MUC deployments (red dots)

Dive	Station	Depth	Remarks
BC 4	Dedged transect	890	2 cm of sediment present; 1 big rock with a few sponges and fragments of limestone
BC 5	Dedged transect	860	5 cm of silt sediment; several small stones
BC 6	Dedged transect	780	2 cm of silt/clay sediment
BC 7	Dedged transect	780	2 cm of silt/clay sediment; 1 big rock with different sponges, polychaetes and Ophiura present
BC 8	Dedged transect	780	> 10 cm of grey/yellow sandy sediment. 4 cores were sub-sampled and used for the <i>ex situ</i> experiment
BC 9	Dedged transect	780	> 10 cm of grey/yellow sandy sediment. 4 cores were sub-sampled and used for the <i>ex situ</i> experiment
BC 10	Dedged transect	780	> 10 cm of grey/yellow sandy sediment. 4 cores were sub-sampled and used for the <i>ex situ</i> experiment
BC 14	Twin Mound	440	Dry, coarse sediment. 1 core was sub-sampled for sediment analysis for D. Van Rooij (RCMG, UGent)
BC 15	Twin Mound	440	Full of dead corals. Ophiura, 1 large isopod, 1 holothurian with large tentacles, 2 purple holothurians present
BC 16	BIOFUN2	1050	< 2 cm of sediment present
BC 17	BIOFUN2	1200	> 10 cm of grey/yellow sandy sediment present. Cores used for meiofaunal, natural stable isotope, fatty acid and environmental variables analysis (BIOFUN)
BC 18	BIOFUN2	1200	> 10 cm of grey/yellow sandy sediment present. Cores used for meiofaunal, natural stable isotope, fatty acid and environmental variables analysis (BIOFUN)
BC 19	BIOFUN2	1200	> 10 cm of grey/yellow sandy sediment present. Cores used for meiofaunal, natural stable isotope, fatty acid and environmental variables analysis (BIOFUN)

Table 2: Overview of collected samples.

6.1.2. Biological observations during the ROV dives

The locations of the 3 ROV dives are shown on Figure 12. Some preliminary observations about the ROV dives are summarized here. A full analysis of the video data will be done in a later stage. A recapitulative list of the ROV dives is given in Table 3.

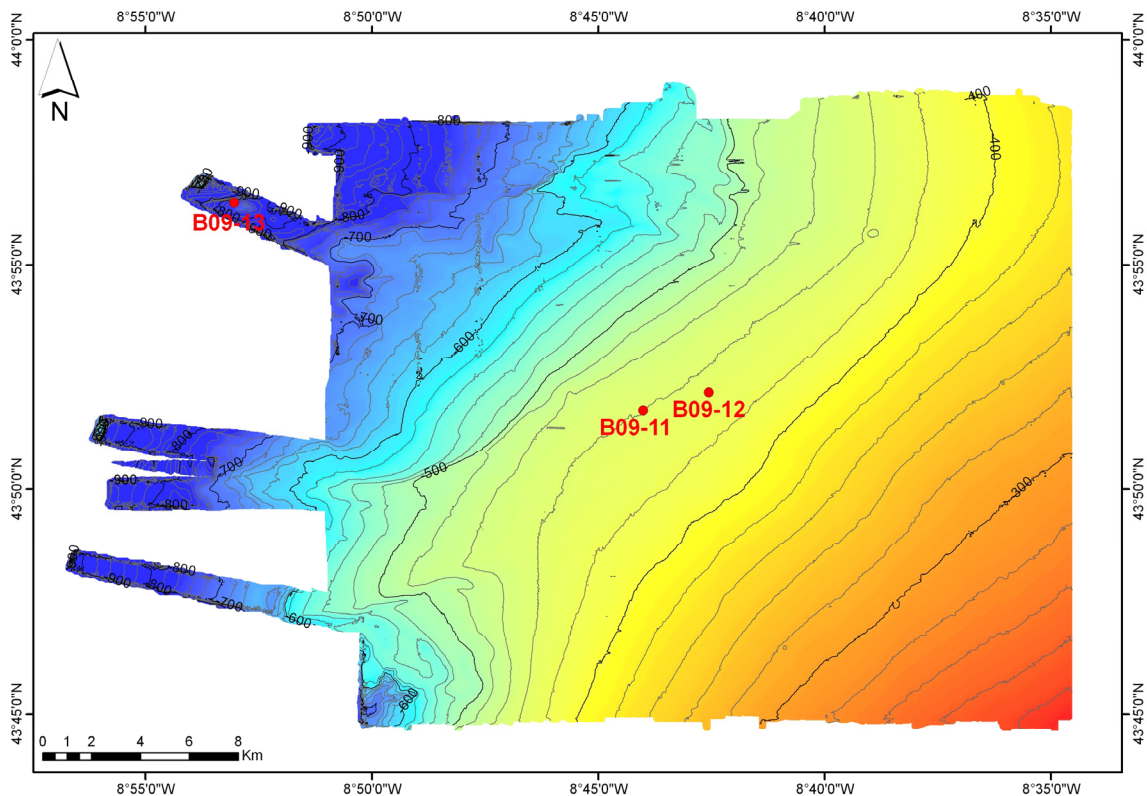


Figure 12: Location of the ROV dives (from RCMG)

<i>Name</i>	<i>Area</i>	<i>Start track</i>		<i>End track</i>	
		<i>Time</i>	<i>Depth</i>	<i>Time</i>	<i>Depth</i>
B09-11	Twin Mound	06:57:04	438 m	08:50:25	428 m
B09-12	Singular Mound	09:51:55	432 m	10:34:37	430 m
B09-13	Mount structure	13:15:06	759 m	14:11:30	755 m

Table 3: Names, locations and operational data of the ROV Genesis dives. Time in UTC.

Dive B09-11 (Figure 13) and B09-12 (Figure 15) were taking place in an area of so-called mini mounds whereas dive B09-13 (Figure 17) took place in an area where coral rubble was recovered by means of dredge samples during the Sarmiente de Gamboa cruise in 2008.

A set of about 30 mini-mounds were encountered on the EM1002 multibeam bathymetry on water depths between 400 and 450 m during the Belgica GENESIS 09/14a. Similar features at similar depths were already observed near the Whittard Canyon (MESH cruise 2006) and the Guilvinec canyon (R/V Belgica 2008).

Dive B09-11:

Twin Mound (NW-SE orientation)

Mound 1: N43°51.728' – W8°43.940'

Mound 2: N43°51.810' – W8°44.032'

Depth: 438-439 m

Dimensions: 170 m wide, 1 à 2 m high

Date: 03.06.2009

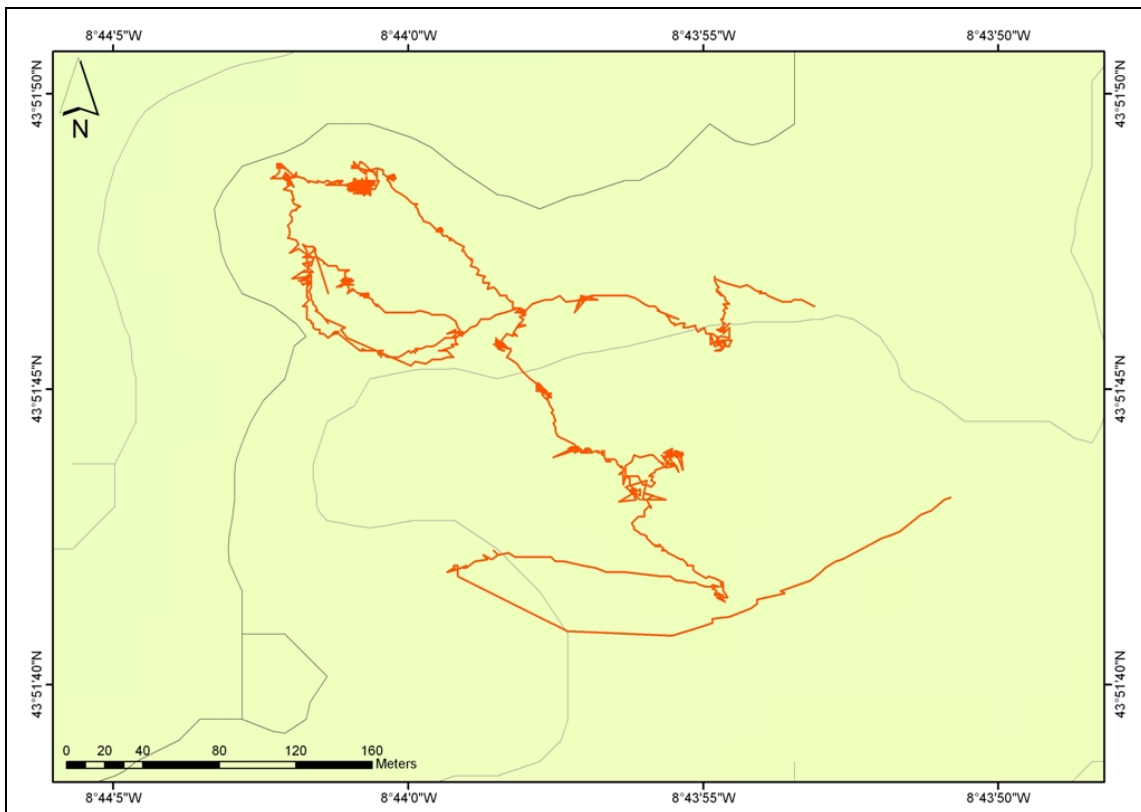


Figure 13: Map ROV dive B09-11.

Start of the dive at 06.50 UTC. ROV leaves TMS. At the seafloor at 06.57. The seafloor consisted of soft sediments that were bioturbated. Several large, dark colored anemones were observed through the dive. On a regular base small to larger pieces of dead coral (*Lophelia*) were observed and three pieces were collected. There is a lot of phytodetritus in the water column resulting in a strong turbidity. Ripple marks are observed on some parts of the seafloor. Furthermore we observed several flatfish (“four spotted megrim”, *Lepidorhombus boscii*) and some gadiidae. We also noticed several large gastropods, two holothurians, a few sea pens (one purple), an octopus, hermit crabs (with and without anemones on shell), crinoids and a few galatheid lobsters. The dive ended at 08.48 UTC. The ROV mounted until the TMS but remained in the water during the transit for the next location. A list with observations and pictures are given (Table 4 – Figures 14).

Dive nr B09-11		Start 6.50 end 8.48	Scientist on watch Ann Vanreusel Joanna Xavier	
UTC time	Technical	Observations		Foto's
6.57	On bottom	Soft sediments		
6.58		Lot of bioturbation		
		Anemone		
7.01		Piece of coral		
7.03		Ripple marks		
7.04		Holothurian		
7.07		Soft sediments with phytodetritus (?)		
		Fish (gadiidae ?)		
7.10		Octopus		
7.12		Anemone		
7.14		Soft sediments		
7.15		Gastropod		
7.18		Dead coral piece		
7.19	In water column			
	Back on bottom			
7.23		Soft sediments		
		Fish		
7.26		Ripple marks		
7.27		Echiuran traces		
		Round structure (?)		
7.29		Anemone		
7.30		Gastropod		
7.33		More bioturbation		
7.36		Sea pen		
		Hermit crab		
7.38		Crinoid		
7.40		Anemone		
7.41		Corals		
7.49	Sample of corals			
7.55		Purple sea pen		
7.57		Galatheid lobster		
8.00		Several galatheids on piece of coral		
8.01		Soft sediments		
8.02		Several anemones		
8.03		Dead coral piece		
8.05		Crinoid		
8.06		Dead coral + galatheid lobsters		
		Soft sediments		
8.13		Gastropod		
8.15		Piece of dead coral		

8.16		Four spotted megrim	
8.19		Crinoid with coral piece	
8.24	Sample of small coral piece		
8.28		Anemone	
8.30		Gadiidae fish	
8.32		Anemone	
8.33	Sample of coral piece		
8.40		Hermit crab carrying anomenies	
8.44		Crinoids	
8.48	Of bottom		

Table 4: List of observations done during B09-11

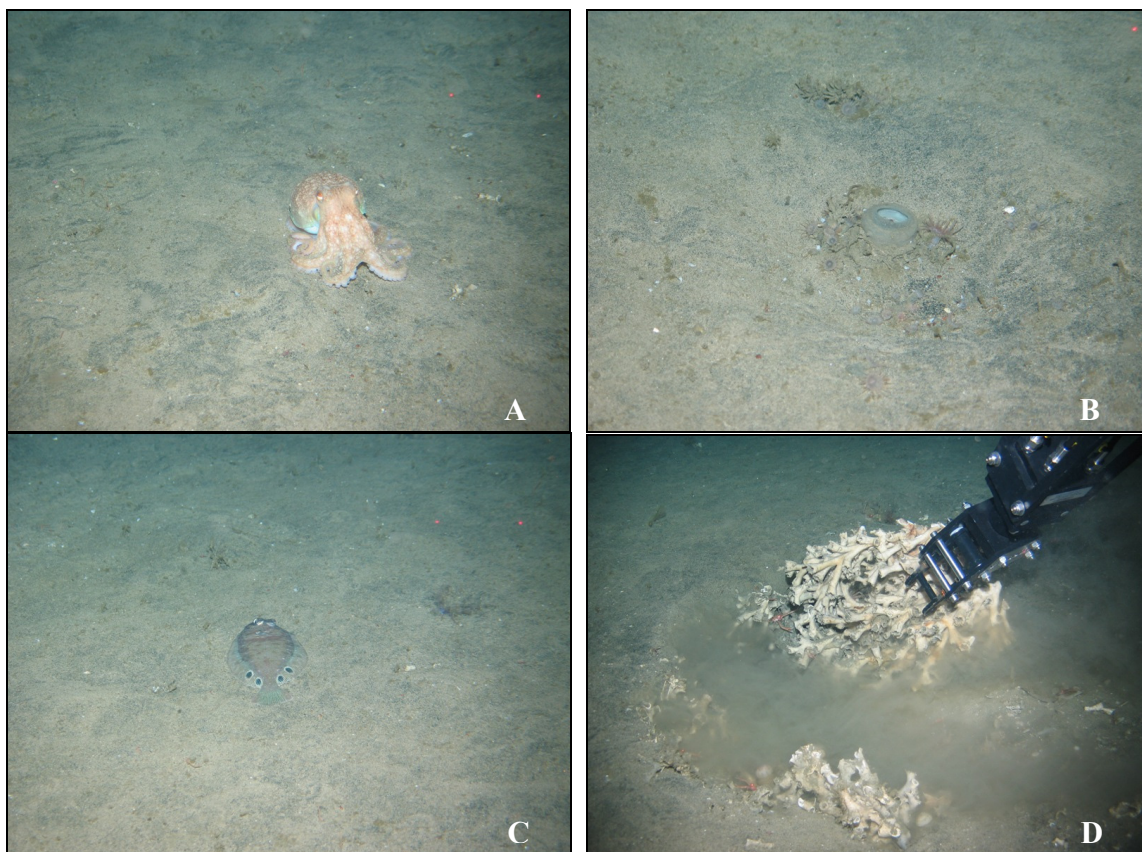


Figure 14: Pictures of ROV dive B09-11

Dive B09-12:

Largest singular mound

N43°52.160' – W8°42.528'

Depth: 431 m

Dimensions: 250 m wide, 3 m high

Date: 03.06.2009

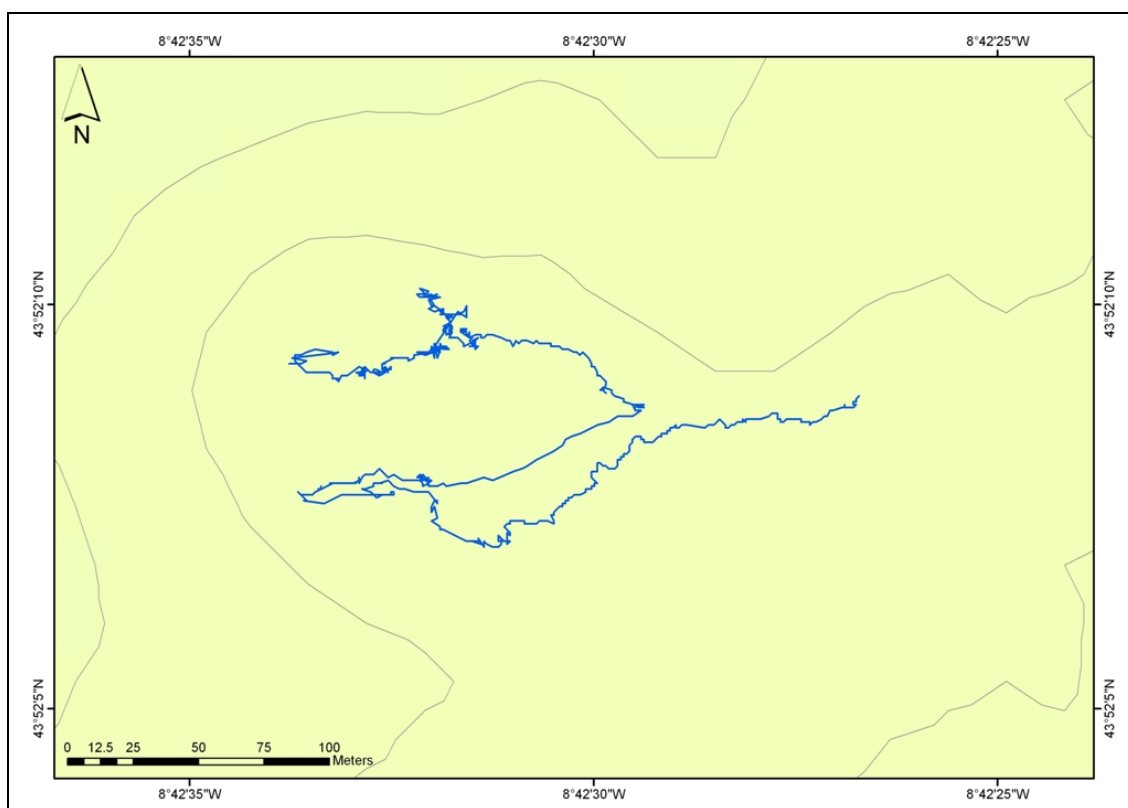


Figure 15: Map ROV dive B09-12.

The ROV was on the seafloor at 09.51 UTC. The seafloor consisted of highly bioturbated soft sediments. Most of the biogenic traces came from galatheid lobsters which burrowed holes, of which the entrance seemed to be protected with small pieces of *Lophelia*. The burrows could attain high densities of more than 5 per m². Burrows were also observed on top of small mounts. These high numbers of galatheid lobsters and their burrows (and mounds) were observed during the whole dive. A spectacular rabbit fish (*Chimaera monstrosa*) was observed at the beginning of dive (with long tail and large pectoral fins with black tips). Several anemones (at least 2 species) were observed through the dive as well as crinoids. Again some hermit crabs, *Lepidorhombus boscii*, some gastropods and holothurids were seen. The dive ended at 10.34 UTC. The observations and some pictures are given below (Table 5 – Figure 16).

Dive nr B09-12		Start 9.50 end 10.34	Scientist on watch Ann Vanreusel Joanna Xavier	
UTC time	Technical	Observations		Foto's
9.51	On bottom	Soft sediments		
		Galatheid lobsters in burrows (about 5/m ²)		
9.55		Crinoids		

		Field of galatheid burrows	
		High bioturbation	
9.59		Fish, fewer burrows	
10.00		Again more burrows of galatheid lobsters	
10.03		Rabbit fish	
10.07		Galatheid lobsters	
10.10		Holothurian	
10.12		2 Anomenies	
		Strong currents	
10.18		Galatheid burrows and lobsters	
10.20		Anomenies	
		Small pieces of coral	
10.23		Anemone (different species than before)	
10.29		Four spotted megrim	
10.31		Gastropod	
10.32		Hermit crab	
10.33		Bioturbation (mounds)	
10.34	Of bottom		

Table 5: Observations made during B09-12

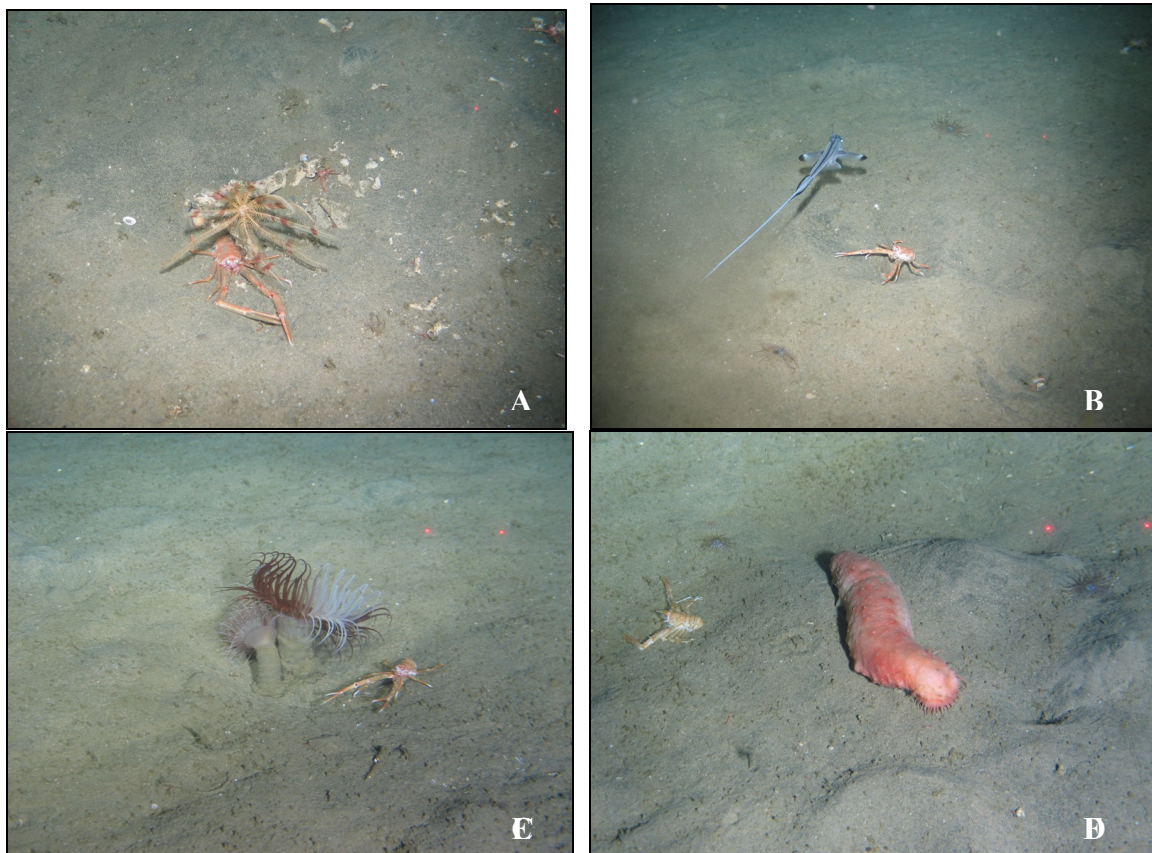


Figure 16: Pictures of ROV dive B09-12

Dive B09-13:

In an area of dredged locations (Sarmiente de Gamboa, 2008) with *Lophelia* remains.

Start transect: N43°56.169' – W8°52.777'

End transect: N43°56.348' – W8°53.055'

Date: 03.06.2009

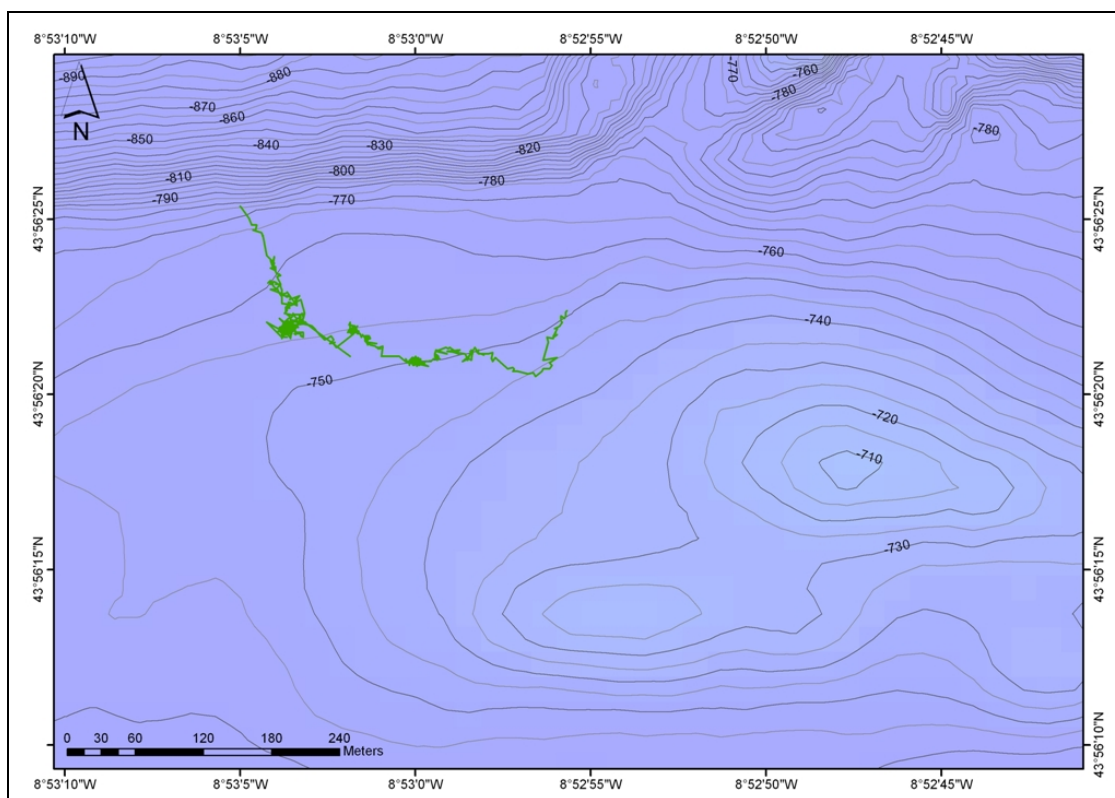


Figure 17: Map ROV dive B09-13.

The ROV was at the bottom at 13.15 UTC. The seafloor showed obvious dark bands. It was a hard stony substrate which was only covered by a thin layer of sediments. There were plenty of soft corals (several species of Gorgonians) and sponges. A stone was collected which was grown over by encrusting sponges and other organisms. Some delicate Hexactinellids (or glass sponges) were observed. A living coral (*Madrepora*) was seen on top of a big rock. At 14.00 there is a problem with the thruster which did not react anymore. The dive is terminated at 14.12. Pictures and a list with observations are given (Table 6 – Figure 18).

Dive nr B09-13		Start 13.12 end 14.12	Scientist on watch Ann Vanreusel Annelies De Groote	
UTC time	Technical	Observations		Foto's
13.15	On seafloor	Shrimp		
		Soft sediment interrupted by dark bands of		

		rock (sediment seems only thin layer)	
13.22		Rocks with encrusted sponges	
13.28		Different species of gorgonians	
		Bioturbation	
13.34	Stone collected		
		Soft coral (yellow)	
13.37		Rough seafloor interrupted with rocks	
13.40	From seafloor		
13.41		Big rock + seafish	
13.42		Soft corals	
	From seafloor		
13.46		White sponge	
13.51		Large white gorgonians	
13.53		Glass sponge (hexactinellids)	
		Sea urchin	
14.02		Living <i>Madrepora</i> on big rock	
14.00	Truster stops		
14.12	Of seafloor		

Table 6: Observations made during B09-13.

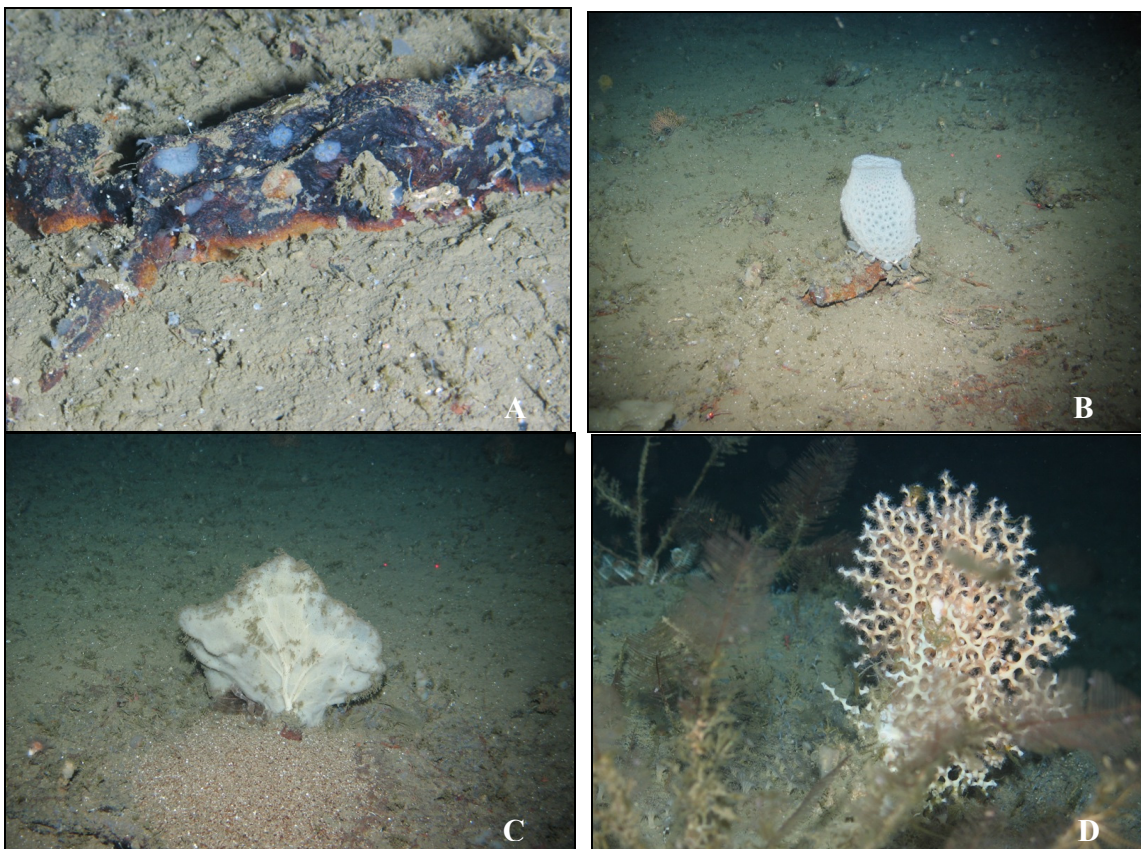


Figure 18: Pictures of ROV dive B09-13

6.1.3. Porifera observations

On the course of the GENESIS 14c campaign we aimed at collecting sponges associated to the deep-water corals in order to: i) assess the diversity of the sponge fauna associated to different reefs and ii) assess the extent of genetic connectivity among the reefs of the European margin (genera *Hexadella* and *Plocamionida* – PhD project of Julie Réveillaud). Because we could not find live coral nor coral rubble during the cruise these goals weren't truly achieved. Nevertheless 22 sponge specimens were collected. These were mostly small crusts growing over rocks (2 specimens in BC 4, 10 in BC 7 and 10 samples from ROV dive B09-13). This material will be identified at the Zoological Museum of Amsterdam by Joana Xavier (who participated in the cruise) along with Rob van Soest (head curator for invertebrates and sponge expert). Molecular analysis of the material will be performed by Julie Réveillaud at University of Ghent.

Despite the meagre results, some interesting specimens were observed and photographed during the ROV dive B09-13. Unfortunately this dive had to be interrupted due to technical problems and therefore the specimens were not collected. The mixed substrate and observation of one living colony of *Madrepora oculata* in this location showed great promise for finding the corals and therefore this area should be further investigated in future explorations.

6.1.4. CTD

One CTD and Niskin bottle deployment was performed in order to obtain oceanographic background data of the water column and chl-a concentrations of the bottom water (Table 7).

Date	Area	Gear	Station & drop	Lat (N)	Long (W)	Depth (m)	Remarks
02.06.2009	Cabo Ortegal	CTD + Niskin	BIOFUN2- CTD	43° 54.3470'	09° 00.4241'	300	data ok

Table 7: CTD measurement

6.1.5. *Ex situ* observations

In the coral debris recovered from the Twin Mound during BC dive 15, some larger organisms were encountered (Figure 19).

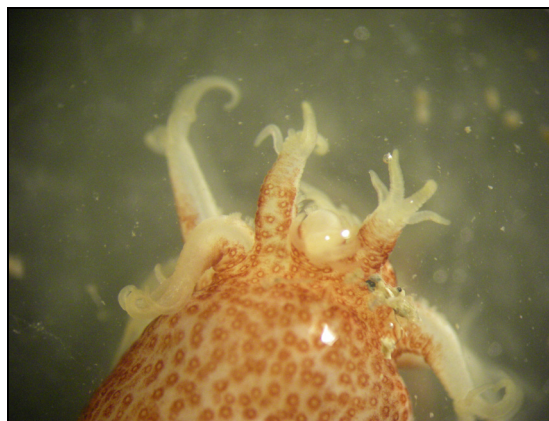


Figure 19: Holothuroidea found during BC 15

On the stone recovered during ROV dive B09-13 several organisms were present (Figure 20).

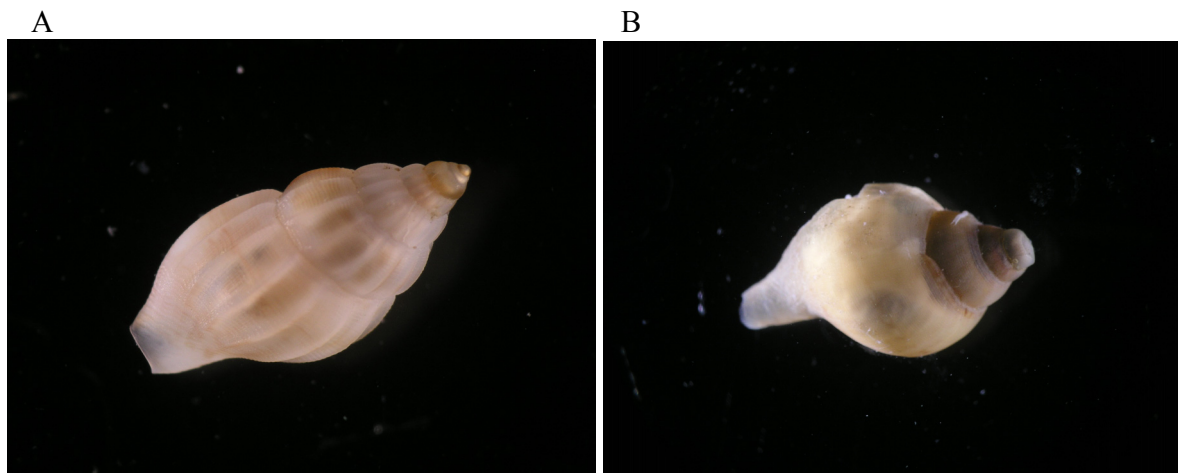


Figure 20: Brachiopoda present on the rock recovered during ROV dive B09-13

On the same rock several Gastropoda were encountered (Figure 21). They are all quite common in this area.

Gastropods	Bivalves
<i>Trophonopsis</i> sp.	<i>Palliolum pudicum</i> (juvenile)
<i>Colus sarsi</i>	
<i>Bellaspira grimaldii</i>	

Table 8: Gastropoda found on the stone recovered during ROV dive B09-13.



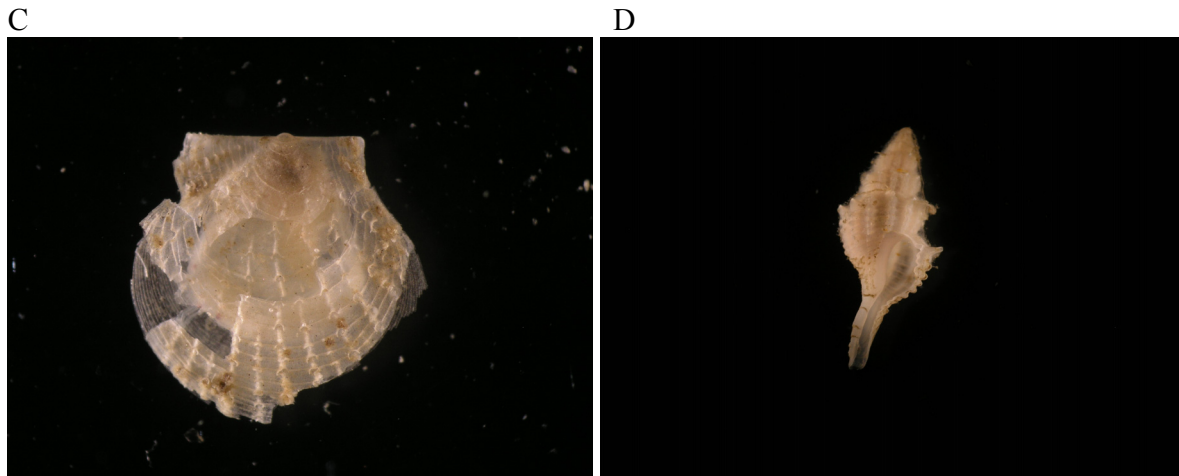
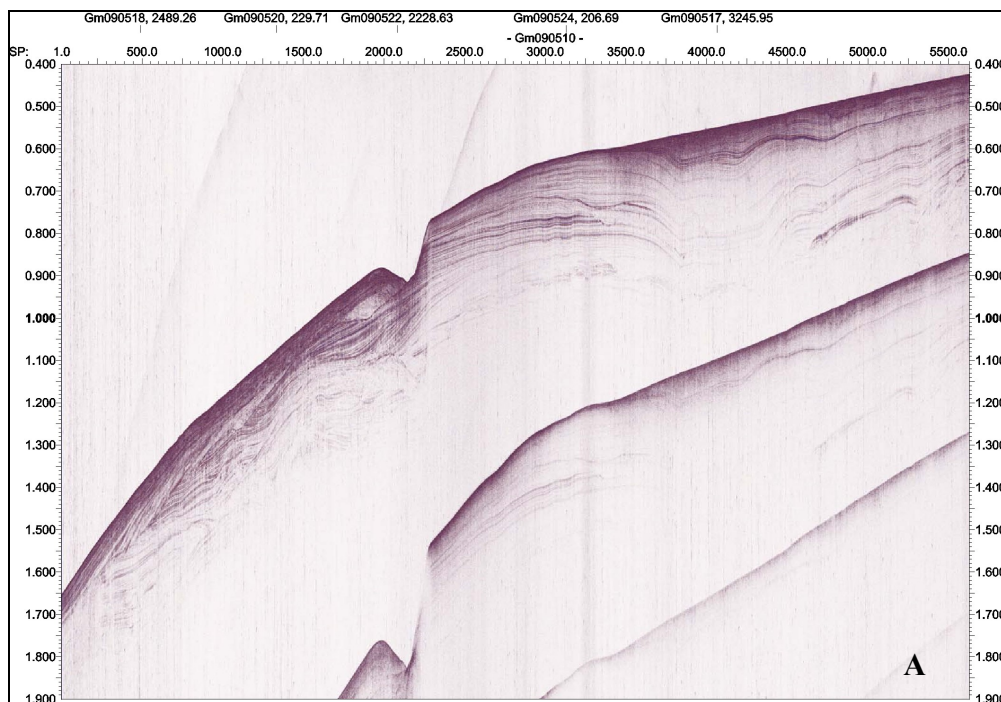


Figure 21: Overview of the recovered Gastropoda. A) *Bellaspira grimaldii* B) *Colus sarsi* C) *Palliolium pudicum* D) *Trophonopsis* sp.

6.2. Geology

6.2.1. High-resolution 2D seismics



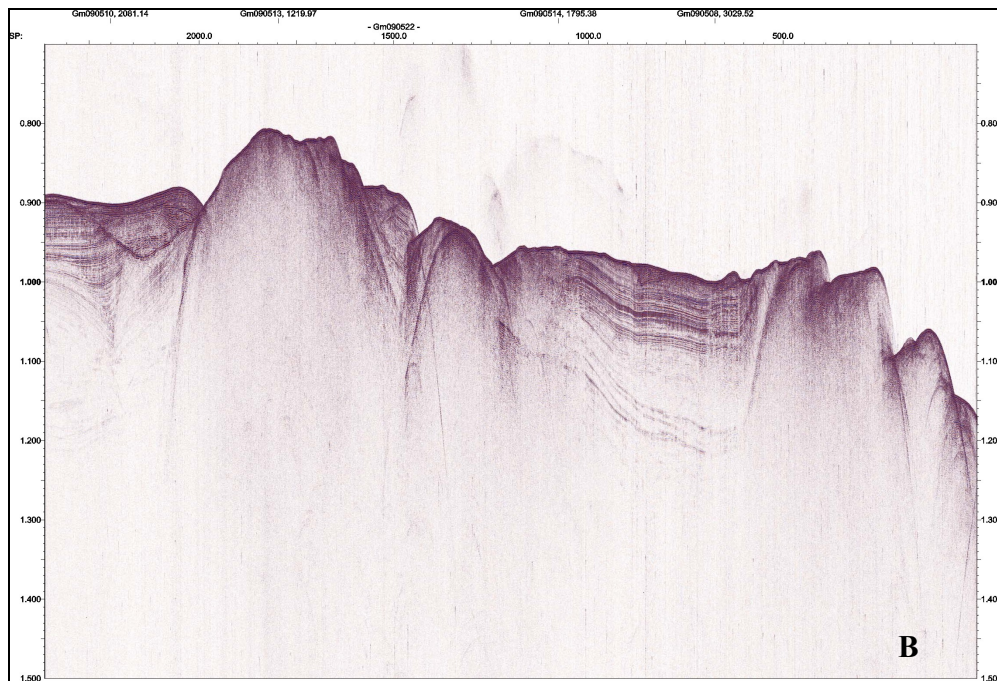


Figure 22: Example of two seismic profiles: A) Gm090510 is an E-W profile, B) Gm090522 is a N-S profile (SP = shotpoints, vertical scale in seconds TWT).

6.2.2. Data storage

During the Belgica 09/14c campaign, 17 seismic lines were acquired over approximately 240 km. All lines were recorded in ELICS format and were converted in a SegY-Motorola format with associated navigation files (these are text files containing shot point, longitude, latitude, date and time).

A total of 3 ROV dives were performed. The ROV imagery (forward looking colour camera with/without overlay, black/white camera and rear camera) was recorded on DV tapes through Professional-DV recorders.

All data are stored at the RCMG. For more information about the seismic, multibeam and video data, please contact

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6.3. BELCOLOUR-2

Campaign 09/14c has been successful: we have made in-situ measurements of Total Suspended Matter (TSM), chlorophyll, turbidity, CDOM and particulate absorption and vertical profiles of inherent optical properties of the water column (examples given in Figure 23) simultaneous with satellite overpasses of MODIS and MERIS. Sampling locations are shown in Figure 24. Nine out of 16 observations were match-ups (simultaneous satellite/in-situ measurements in cloud free conditions): four with MERIS, four with MODIS Aqua and one with MODIS Terra, as shown in Table 9.

A ship rotation experiment was conducted on 31st of May to investigate the effect of ship-sun relative azimuth angle on the above-water reflectance measurements.

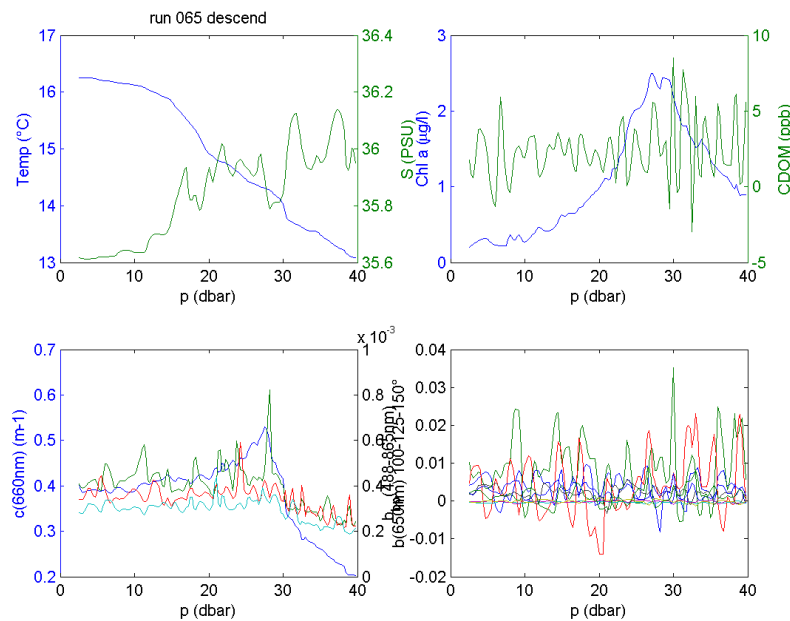


Figure 23: Vertical profile of temperature, salinity, chlorophyll a, CDOM, attenuation at 660 nm, backscattering at 650 nm at 100, 125 and 150° scattering angle and backscattering at 9 wavelengths between 488 and 865 nm at Station VC14.

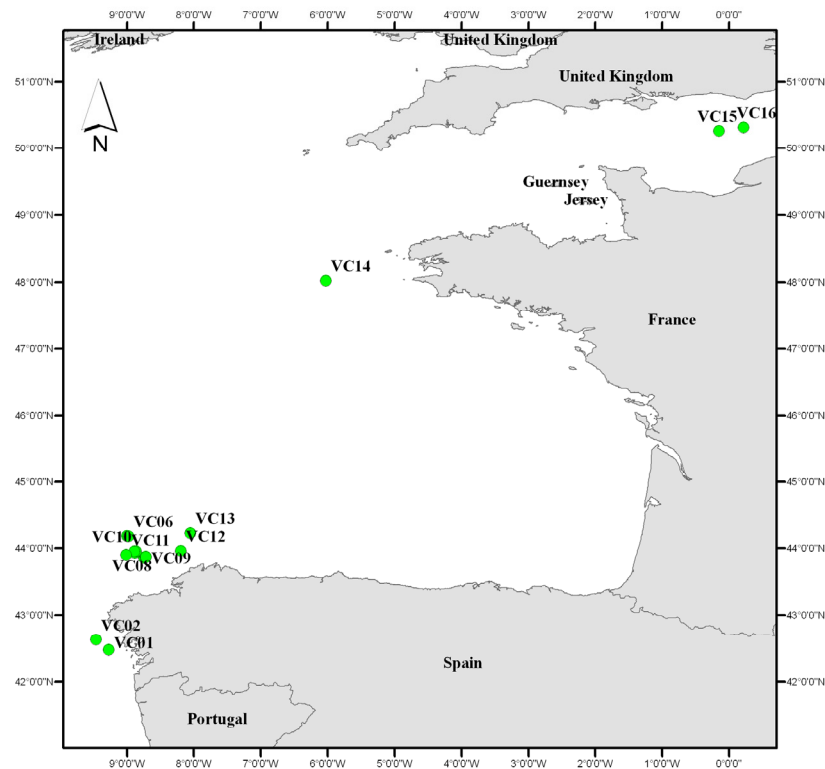


Figure 24: Sampling locations VC01-VC16 during campaign 09/14c.

Station	Date	Time (UTC)	Latitude (dec deg)	Longitude (dec deg)	Depth (m)	Wind (m/s)	Waves (m)	Clouds (/8)	Satellite overpass	Match-up
VC01	30-May-2009	10:59	42.472	-9.269	146.0	3.5	0.50	0	MERIS	x
VC02	30-May-2009	13:26	42.628	-9.463	197.0	3.9	1.00	0	MODIS Aqua	x
VC03	31-May-2009	12:17	43.862	-8.743	445.0	9.9	1.00	0		
VC04	31-May-2009	14:13	43.872	-8.718	440.3	12.4	1.50	0	MODIS Aqua	x
VC05	1-Jun-2009	11:30	44.188	-9.001	1116.0	4.6	1.50	0	MERIS	x
VC06	1-Jun-2009	13:15	44.178	-8.976	787.0	8.9	1.00	0	MODIS Aqua	x
VC07	2-Jun-2009	10:57	43.932	-8.879	822.6	7.0	2.00	1	MERIS	x
VC08	2-Jun-2009	13:55	43.956	-8.864	964.0	12.5	1.50	4	MODIS Aqua	x
VC09	3-Jun-2009	11:34	43.871	-8.712	438.5	2.0	0.20	8	MODIS Terra	
VC10	3-Jun-2009	15:08	43.954	-8.883	1038.4	5.0	0.30	8		
VC11	4-Jun-2009	11:12	43.905	-9.011	1223.0	1.2	0.50	8		
VC12	5-Jun-2009	11:02	43.960	-8.195	215.6	6.2	0.30	3	MERIS	x
VC13	5-Jun-2009	12:51	44.230	-8.052	398.7	7.3	0.20	3	MODIS Aqua	
VC14	6-Jun-2009	10:31	48.023	-6.026	133.0	13.3	0.20	8	MERIS	
VC15	7-Jun-2009	10:42	50.263	-0.146	55.0	6.0	0.30	4	MODIS Terra	x
VC16	7-Jun-2009	12:32	50.319	0.222	44.3	3.2	0.50	7	MODIS Aqua	

Table 9: Measurements done at various stations on campaign 09/14c. Match-ups are indicated.

7. ACKNOWLEDGEMENTS & CREDITS

The scientific crew wishes to thank the Commander and crew for their fantastic assistance and the fine cooperation during the campaign. Their experience and professionalism contributed greatly to the results of the campaign.

