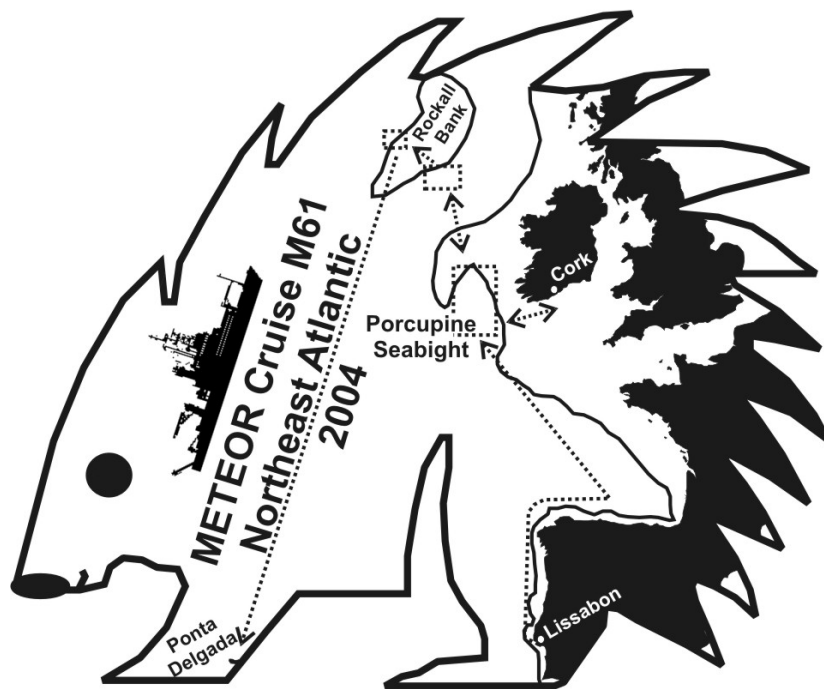


METEOR-Berichte 06-2

Northeast Atlantic 2004

Cruise No. 61, Leg 3

June 4 to June 21, 2004, Cork – Ponta Delgada



Development of Carbonate Mounds on the Celtic Continental Margin

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3.1 Participants

Tab. 3.1 List of Participants on Leg M61-3.

Name	Discipline	Institute
Beck, Tim, Dipl. Biol.	Benthic Ecology	IPAL
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Grehan, Anthony, Dr.	Benthic Biology	NIUG
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Kahl, Gerhard, Dipl.Met.	Meteorology	DWD
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Klar, Steffen, TA	Marine Technology (ROV)	MARUM/RCOM
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Ratmeyer, Volker, Dr., Chief Scientist	Marine Geology	MARUM/RCOM
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Wienberg, Claudia, Dr.	Marine Geology	MARUM/RCOM

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MARUM	Zentrum für Marine Umweltwissenschaften Universität Bremen Klagenfurterstraße D-28359 Bremen / Germany	SAMS	Scottish Ass. for Marine Sciences Dunstaffnage Marine Laboratory Oban, Argyll, PA37 1QA / UK
NDR-TV	Norddeutscher Rundfunk Fernsehen Oldenburg / Germany	UCC	University College Cork Donovans Road Cork / Ireland

3.2 Research Program

3.2.1 Development of Carbonate Mounds Along the Celtic Continental Margin

In the past years, the EU-projects ECOMOUND (*Environmental Controls on Mound Formation along the European Margin*), GEOMOUND (*The Mound Factory - Internal Controls*) and ACES (*Atlantic Coral Ecosystem Study*) have generated many new results concerning the large carbonate mound provinces at the NW-European continental margin. These made clear that particular external environmental factors have a significant influence on the development of the mounds and on the cold water corals living on them. However, the investigation of the mound surfaces and their uppermost layers is still in its early days. There are many open questions, that are dealt with in the scope of the ESF-Euromargins project MOUNDFORCE (*Forcing of Carbonate Mounds and Deep Water Coral Reefs along the NW European Continental Margin*), and which were addressed during leg M61-3:

Which factors control the development of the carbonate mounds?

Possible limiting environmental factors, which have to be considered, are related to specific characteristics of the different water masses, as e.g. temperature, salinity and oxygen concentration, the structure of the water column (e.g. the development of a pycnocline), water-mass movements (currents, internal tides), and the food sources available for the corals. An important aspect here is the distribution of living corals on the carbonate mounds in relation to these parameters.

How do associated faunas develop on the carbonate mounds under changing environmental conditions?

Video footage from carbonate mounds reports highly diverse faunas consisting of corals, sponges, crinoids and numerous other organism groups. Among these organisms the framework building coral *Lophelia pertusa* takes a dominant role with regard to mound development. Long-term changes of these benthic ecosystems (e.g. the last glacial / interglacial change) are indicated by first data from glacial sediment sequences from the Celtic continental margin which e.g. do not contain any *L. pertusa*. On the base of sediment cores from Propeller Mound investigated in Bremen, a model for mound development has been established to describe mound evolution from interstadial to glacial to interglacial stages. To what extent this model, developed for one particular mound, can be extrapolated to other structures in the Porcupine Seabight (e.g. Galway Mound) or to other areas along the Celtic Continental margin (e.g. Western Rockall Bank) is unknown at the moment.

What are the dominant stabilisation and lithification processes at the carbonate mounds?

The steep slopes of the carbonate mounds, often exceeding inclinations of 10%, raise the question if solely the incorporation of corals in the sediments is sufficient to stabilise the mostly fine-grained hemipelagic mud. Another hypothesis claims that bacteria at the sediment surface contribute to the stability of the sediments by e.g. the production of biofilms. Detailed sampling of very steep slope areas is envisaged to solve this question.

In addition there is a great interest to investigate carbonate crusts and hardgrounds, as those are probably also closely related to the growth history of the carbonate mounds. Furthermore, the lithification of the mound sediments will be assessed by the analysis of diagenetic changes in the sediments.

3.2.2 Working Program

The working program during M61-3 focused on the application of the remotely operated vehicle (ROV) QUEST, based at MARUM / Uni Bremen, and the sampling of sediments by box corer and gravity corer, accomplished by CTD casts and hydroacoustic surveys.

The variable appearance of carbonate mounds in the individual mound provinces is an indication of varying cause-and-effect relationships. In order to study these various relationships, carbonate mounds from four different provinces were examined during the M61-3 cruise (Fig. 3.1).

The first location observed was Galway Mound in the Belgica Mound Province (eastern Porcupine Seabight). In summer 2003, seven autonomous sensor units measuring current speed and direction and containing a CTD were placed on this mound. As a major goal of the work program during M61-3, these were successfully located and recovered by Bremen's QUEST ROV after one year of deployment.

The second working area covers Propeller Mound in the Hovland Mound Province (northern Porcupine Seabight). Numerous data already exist from this 'housegarden' of the Bremen, Kiel and Erlangen teams, making Propeller Mound an ideal place for a sampling campaign to take a number of CTD casts and boxcores with the latter aiming to cover some facies that have so far not been sampled representatively.

The relatively unknown West Rockall Bank was chosen as the third working area. As a fourth working area, the so-called Connaught Mound and an associated terrace structure on the Northern Porcupine Bank were selected after exploring TOBI sidescan images obtained by the Geological Survey of Ireland.

For all of the four working areas (Galway Mound, Propeller Mound, West Rockall Bank, North Porcupine Bank, Fig. 3.1) the working program was based on a similar sampling strategy including (1) an initial hydroacoustic characterisation of the selected structures (Hydrosweep, Parasound), (2) dives with the ROV QUEST, (3) supplemental CTD casts, (4) sampling of sediments with gravity and box corer. Appropriate sediment sampling sites were selected based on site-survey and visual information resulting from the ROV dives. Using QUEST was also essential for a targeted sampling of carbonate crusts, hardgrounds and very steep slopes. Spatial distributions of the faunas on these mounds were video taped during ROV transects over different mound areas (e.g. mound crest, luff and lee flanks, moats).

Although the time budget available for different sampling campaigns at Galway Mound and the West Rockall Bank was limited, information already available from the earlier leg M61-1 allowed an effective planning of sampling campaigns and ROV dives.

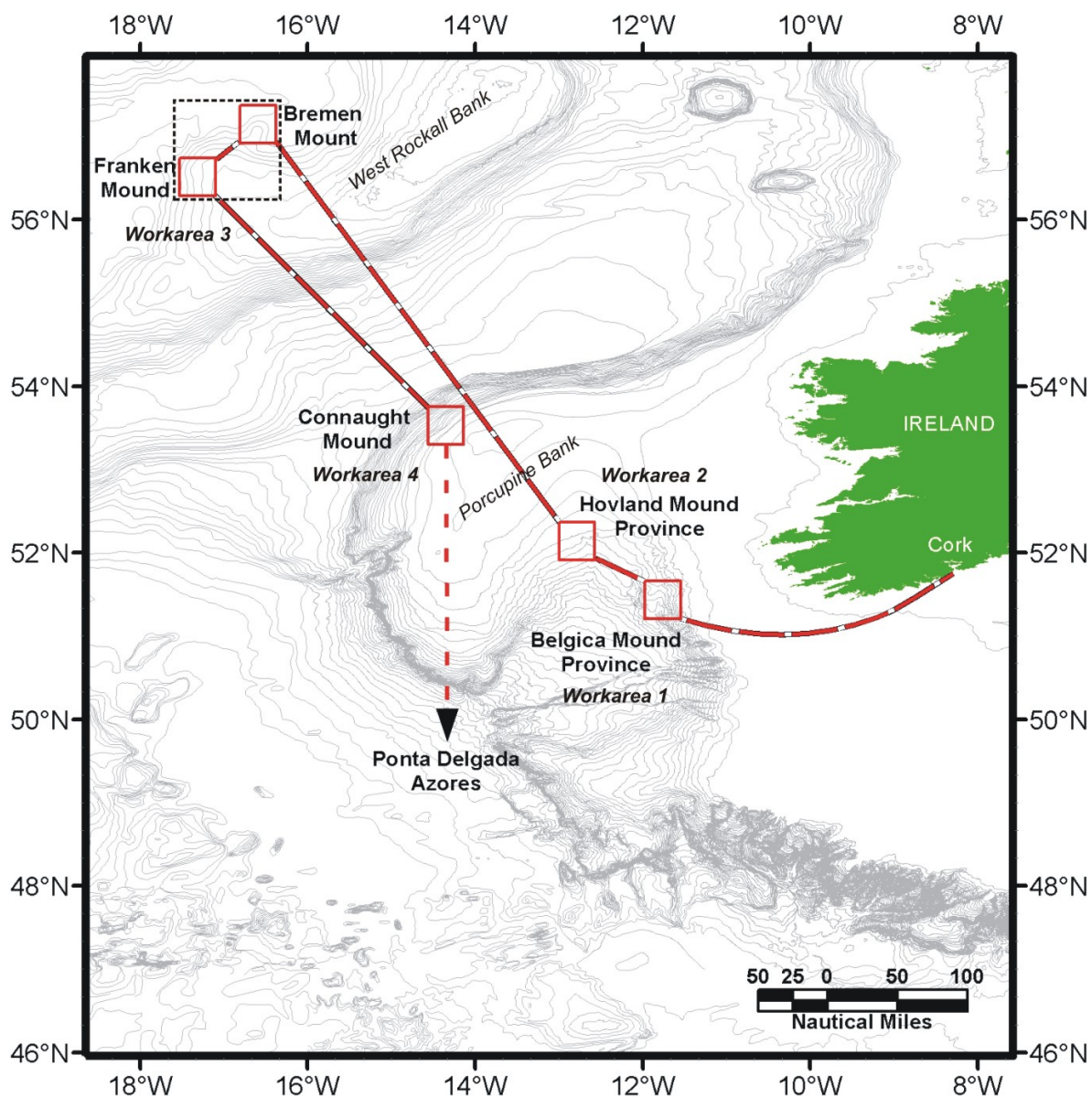


Fig. 3.1 Map of the Celtic continental slope and the four working areas during leg M61-3. Workarea 1 includes Galway and Poseidon Mound, whereas workarea 2 includes Propeller Mound.

3.3 Narrative of the Cruise, Leg M61-3

The third leg of the M 61 cruise lasted 18 days. It started in Cork, Ireland, on June 4th, and ended in Ponta Delgada, Azores Islands, Portugal, on June 21st. After the scientific equipment was loaded aboard RV METEOR, mobilisation of the 4000 m deep diving remotely operated vehicle ROV QUEST of the University of Bremen took place. Beside the vehicle and its scientific payload, a new deployment frame and a new underwater positioning system were installed aboard the vessel. Mobilisation was finished with a successful QUEST dive test at the pier in Cork harbour. RV METEOR departed from Cork in the early afternoon of June 4th, towards the Porcupine Seabight west of Ireland. Sailing down the river Lee provided a scenic background for the first TV-film work of the participating NDR TV-team.

The first working area around Galway Mound (Belgica Mound Province) on the north western edge of the Porcupine Seabight at 51°26.70' N, 11°45.03' W was reached on June 5th, and the scientific program started during night with two CTD profiles and water sampling. Station work continued with the deployment of an elevator-mooring designed for the ROV-based recovery of seven combined CTD/current meter devices. Recovery of these probes, which were set during 2003 with the help of the French ROV VICTOR, was the major goal of two dives with QUEST at Galway Mound. The sensor units, consisting of inductive current meters and CTDs, were deployed on north-south and east-west transects over the structure to collect data on the small scale flow field around Galway Mound. With sampling intervals of 10 minutes, the recorded data are sufficient to provide information on possible tidal influences on the mound. Being installed in the frame of the ESF-project MOUNDFORCE, the main task was to create a data base for the correlation of the current regime at Galway Mound with different biological and geological facies. After successful recovery of these probes, work was followed by a series of boxcorer stations and gravity cores across Galway Mound.

During June 7th, the slightly easterly located Poseidon Mound at 51°26.60' N, 11°41.80' W was sampled with three additional boxcores. A time-series of eight CTD profiles with one-hour interval between each cast indicated the influence of tidal waves at 600–700 m water depth. The detection of such processes is important for the understanding of the deep-water coral ecosystem as the corals take advantage of the strong currents and the pumping dynamics associated to internal waves which both may result in a high nutrient availability for the corals.

After finishing station work in the Belgica Mound Province on June 9th, RV METEOR moved towards West Rockall Bank. On the way, a short stopover at Propeller Mound in the Hovland Mound Province was used to complete previous sampling of surface sediments with the box corer and to take CTD casts across the mound.

First target area in the West Rockall Bank area was an interesting sea floor elevation, discovered previously during RV POSEIDON expedition POS 292. After detailed hydroacoustic mapping the 5th dive with QUEST was scheduled for the evening of June 10th. Since video-observation suggested that the structure was an old volcanic seamount with only very sporadic coral growth, the dive was terminated and RV METEOR moved west towards Franken Mound, a promising structure discovered during M61-1, at 56°29.93' N, 17°18.21' W. A major work program covering nearly the complete mound surface could be performed at this site between June 11th and 13th, including extensive sediment surface and gravity core sampling, CTD casts and four complementary ROV dives. Result of this station work is a complimentary dataset of oceanography, detailed in-situ observations, mapped surface structure extensions and a large variety of sediment and surface samples. Due to changing weather conditions, we decided to spend the remaining time not in the West Rockall Bank area as originally planned, but to move further south towards the Northern Porcupine Bank.

After inspection of TOBI sidescan images provided by the Geol. Survey of Ireland (GSI), a prominent edge structure with a small mound was chosen as next dive and sampling target. At the so-called Connaught Mound at 53°30.92' N, 14°21.16' W, station work lasted from the evening of June 14th through June 16th, providing spectacular video footage (two dives), a variety of lithified carbonate crust samples and coral specimen as well as extensive boxcore, gravity core and water samples. As an important result of the opportunity to sample carbonate crusts with QUEST at different sites, hardground samples recovered from Franken Mound and Connaught Mound can be

divided into two major facies: a) poorly to moderately lithified pelagic foraminiferal-nannoplankton oozes, and b) highly lithified fossil coral reef framework.

Station work was finished in the morning of June 16th. In total, 95 stations with 117 deployments were carried out during M61-3. The ROV QUEST could be deployed for nine dives. RV METEOR returned to Ponta Delgada, Azores, in the morning of June 21st, where scientific equipment was unloaded and the scientific crew left the ship.

3.4. Methods

3.4.1 CTD Measurements

(A. Rüggeberg, L. Dodds)

A total of 41 CTD casts were carried out during RV METEOR cruise M61-3. The purpose of these measurements was to perform transects across carbonate mound structures of the Belgica Mound Province at the eastern slope of the Porcupine Seabight, the Propeller Mound within the Hovland Mound Province (northern Porcupine Seabight, the Franken Mound at the western slope of Rockall Bank, discovered during RV METEOR cruise M61-1, and the new Connaught Mound along the Porcupine Bank Margin. Some profiles were measured at the same positions as during cruise M61-1 to determine differences in small-scale variability close to the mounds. Another objective was to investigate the temporal variability of the influence of tidal waves and internal waves at the water mass boundary close to the carbonate mound structures. Therefore, CTD profiles were performed at three stations (west–top–east of a mound) with each measurement being repeated three times.

The CTD system used is a SeaBird Electronics, model 911 plus type, referred to as IFM-GEOMAR serial number 2. The underwater unit was built into a rosette housing capable of holding 24 water sampler bottles. Pre-cruise laboratory calibrations of the temperature and pressure sensors were performed. Both yielded coefficients for a linear fit. The oxygen sensor must be considered unreliable because no in-situ measurements were carried out during the cruise. However, the general downcast trend of dissolved oxygen seems to follow previous studies (e.g. WOCE Global Data, World Ocean Database 2001; Conkright et al., 2002), but due to unrealistic decreasing values during several downcasts (between 0.5-1 ml/l) the absolute values are unreliable.

The overall impression of CTD performance was very positive. The downcast profiles showed virtually no spikes in the data and the recording computer worked without problems. Further processing of the data was performed using software SBE Data Processing, Version 5.30a (<ftp://ftp.halcyon.com/pub/seabird/out>) and Ocean Data View mp-Version 2.0 (<http://www.awi-bremerhaven.de/GEO/ODV>) for visualisation. Water samples were taken at stations 10 m above the seafloor (bottom alarm) and within the water column for stable isotope analyses (IFM-GEOMAR, Kiel), as well as at selected stations at water depths corresponding to 500 db and 100 db for DIC analyses (SAMS, Oban).

3.4.2 Deployment of the QUEST Remotely Operated Vehicle (ROV) for Video Observation and Sampling

(V. Ratmeyer, M. Bergenthal, G. Engemann, S. Klar, G. Ruhland, C. Seiter, W. Schmidt, M. Schroeder)

The remotely operated deep diving robot QUEST is an electric 4000 m-rated, commercial work-class ROV, operated by MARUM, University of Bremen, since May 2003 (Fig. 3.2). The robot was designed and manufactured by Schilling Robotics, Davis, USA. The whole QUEST system weighs 45 tons (including the vehicle, control van, workshop van, electric winch, 5000-m umbilical, and transportation vans) and can be transported in four 20-foot vans. Using a MacArtney Cormac electric driven storage winch to manage the 5000 m of the 17.6 mm NSW umbilical, no hydraulic connections had to be installed during mobilisation.

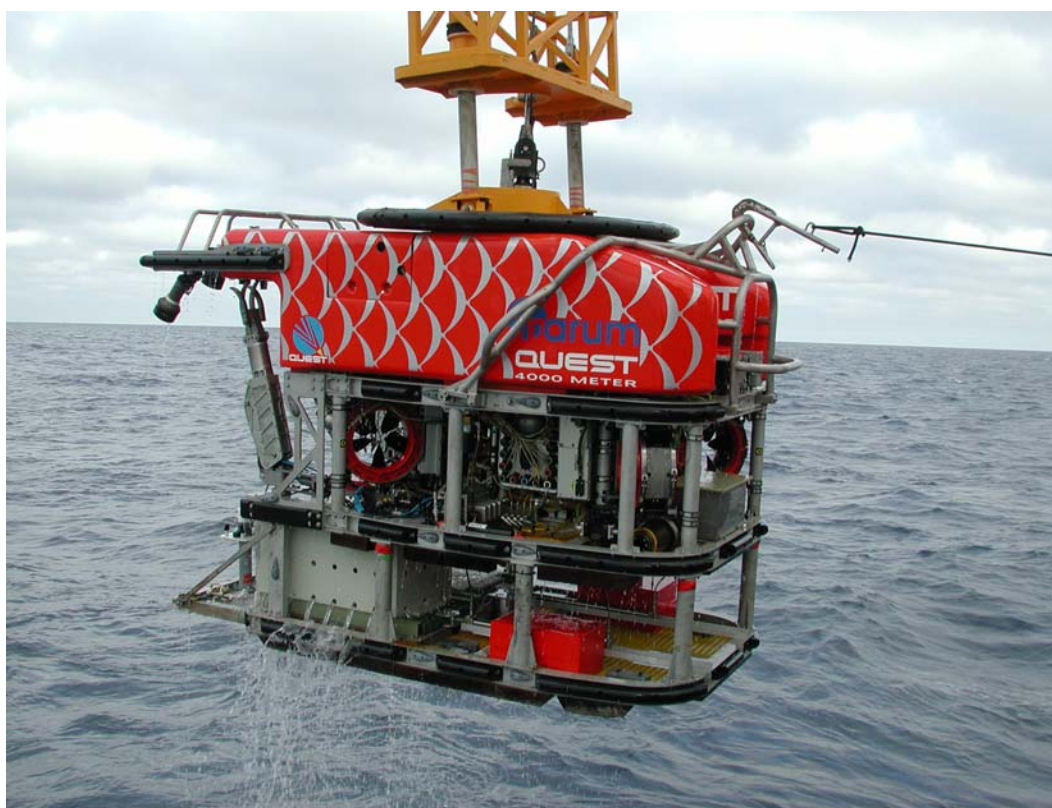


Fig. 3.2 Deployment of the remotely operated vehicle QUEST from RV METEOR during M61-3.

During this cruise, QUEST's technical innovations played a key role to gain operational success aboard RV METEOR and provide a flexible and highly adaptable platform for scientific sampling and observation tasks. A key feature is the reliable and precise positioning capability of the system. QUEST uses a Doppler velocity log (DVL) to perform Station Keep Displacement, automatically controlled 3D positioning, and other auto control functions. Designed and operated as a free-flying vehicle, QUEST system exerts such precise control over the 60-kW electric propulsion system allowing the vehicle to maintain a positioning accuracy within centimetre to decimetre ranges. During M61-3, these functions provided the base for detailed close-up photography and video, as well as for sampling of carbonate hardgrounds with two different robotic arms. In addition to QUEST's standard control features, the vehicle provides lift capacity

of up to 250 kg with the RIGMASTER manipulator, as well as a set of different scientific tools and adaptations for biological and geological sampling. A major installation is the advanced camera and lighting suite, consisting of 2.4 kW light power and six different video and still cameras.

The QUEST control system provides transparent access to all RS-232 data and video channels. The scientific data system used at MARUM feeds all ROV- and ship-based science and logging channels into a commercial, adapted real-time database system (DAVIS-ROV). During operation, data and video can be easily distributed over the ship to allow maximum data and video online access by minimizing crowding in the control van. Using the existing ship's communications network, all sensor data can be distributed in real-time via TCP/IP from the control van into various client laboratories, regardless of the original raw-data format and hardware interface. This allows topside processing equipment to perform data interpretation and sensor control from any location on the host ship.

Additionally, the pilot's eight-channel video display can be distributed to up to 16 client stations on the ship via CAT5 cable. This allows the simple setup of detailed, direct communication between the bridge and the ROV control van. Similarly, information from the pilot's display can be distributed to a large number of scientists. During scientific dives where observed phenomena are often unpredictable, having scientists witness a "virtual dive" from a laboratory rather than from a "crowded" control van allows an efficient combination of scientific observation and vehicle control.

During operation, the data distribution setup allows easy access and distribution of data during all stages of the expedition, including the compilation of customized data products for post processing applications after the cruise. Additionally, "dive summaries" containing all data of interest including video and digital still photographs have been compiled. Using the database's export capabilities in combination with the French software product "ADELIE" developed at IFREMER, GIS based plots, data graphs and dive track maps containing time and position-referenced scientific data, video and images are available shortly after or even during the dives.

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

During leg M61-3 QUEST has been successfully deployed for 9 dives (Tab. 3.2) encountering sea states up to 4, and winds of up to 6 bft., using the ships stern A-frame in combination with a customized deployment frame. During operation, both ship's and ROV crew were in close contact and could provide a successful handling and navigation to fulfil the scientific tasks required, including instrument search and recovery, digital imagery, video mapping and observation, close up high resolution imaging, specimen sampling and carbonate crust sampling at a variety of locations.

Tab. 3.2 QUEST dives during M61-3. BMP: Belgica Mound Province; WRB: West Rockall Bank; NPB: Northern Porcupine Bank.

Dive No.	Station No.		Area	Date (dd/mm/yy)	Time (UTC)		Position at bottom contact		Depth max (m)
	GeoB	METEOR			Begin	End	Lat. °N	Long. °W	
16	9203	550	BMP; Galway Mound	05/06/2004	09:48	20:50	51°26.70'	11°45.03'	892
17	9211-2	558-2	BMP; Galway Mound	06/06/2004	09:38	14:48	51°27.10'	11°45.20'	795
18	9239-1	586-1	BMP; Galway Mound	08/06/2004	07:25	16:30	51°27.10'	11°45.20'	781
19	9240	587	BMP; Poseidon Mound	08/06/2004	17:50	20:54	51°24.30'	11°41.20'	700
20	9249	596	WRB; Bremen Mount	10/06/2004	18:42	00:08	57°06.40'	16°35.30'	803
21	9255-1	602-1	WRB; Franken Mound	11/06/2004	09:46	19:09	56°30.16'	17°18.16'	607
22	9267	614	WRB; Franken Mound	12/06/2004	08:25	18:52	56°30.30'	17°17.30'	685
23	9281-1	628-1	WRB; Franken Mound	13/06/2004	07:59	15:17	56°29.90'	17°18.20'	651
24	9285-1	632-1	NPB; Connaught Mound	15/06/2004	08:10	19:08	53°30.99'	14°22.00'	876

3.4.3 Sediment Surface Sampling with Giant Box Corer

(S. Noé, T. Beck, A. Foubert, A. Grehan)

The main tool used for sediment sampling was the giant box corer, with a sampling area of 50x50 cm and a maximal penetration depth of 50 cm. The giant box corer was deployed at 38 stations during M61-3.

Penetration was highly variable due to the specific types of sediment. At sites dominated by sediments, recovery was on average 20-40 cm with reasonably well preserved surfaces. Areas with a dense coral cover did not allow a penetration depth beyond 20 cm. In total, ten box-corer failed to collect any sediments. Extremely inclined mound flanks as well as exposed hardgrounds prevented any penetration with the giant box corer; instead, these were successfully sampled by the ROV.

The sediment-dominated surfaces mostly comprised light brownish-grey muddy/silty sands, well-sorted sands or poorly sorted muddy silts to coarse sands. In some off-mound areas polymict dropstones of up to 10 cm in diameter were present. Coral-dominated on-mound samples contained mostly coarse-grained sediments underneath the exposed coral framework with high contents of skeletal grains. As these samples have been partly washed out during recovery, however, their composition might be altered.

The sediment column in boxes with a recovery of >20 cm often revealed a significant change in composition and colour in about 5-15 cm depth: at a relatively sharp boundary representing the reduction horizon, colour changed from brownish-grey to olive-grey, while grain sizes decreased to a finer-grained composition and more cohesive properties. Hence, a coarsening-upward succession was observed in many sections. At other stations, however, even bedding and sharp horizons were sometimes blurred by intense bioturbation and burrowing.

In summary, 12 stations of a total of 19 deployments in working area 1 (Belgica Mound Province), 2 stations of 5 in working area 2 (Propeller Mound), 9 stations of 11 in working area 3 (West Rockall Bank), and 3 stations of 3 deployments in working area 4 (Northern Porcupine Bank) yielded good results.

The sampling scheme of the boxcorer samples included high-resolution sampling of the sediment surface and column. Various kinds of samples taken from the individual box corer

stations are listed in the detailed box corer protocols, available in form of the internal compilation of the cruise data in digital version.

Surface sampling included two 100 cm³ sub-samples - one stained with a solution of 1g of rose Bengal in 1 litre ethanol for foraminiferal studies and one unstained for organic matter (TOC) analyses - taken by GeoB as well as sub-samples of varying quantities collected by IFM-GEOMAR, IPAL, RCMG and UCC. The living invertebrate fauna was collected by IPAL for taxonomic investigations. In addition, sub-samples of living *Lophelia* and/or *Madrepora* skeletons were taken by IFM-GEOMAR and SAMS for stable isotope analyses. Temperature measurements were taken immediately after arrival on deck.

The sediment column was sampled by archive liners taken by GeoB and IPAL (10 cm Ø in each case) and by RCMG (5 cm Ø at every station and, in addition, 10 cm Ø at some selected locations). Bulk core sediment at defined horizons was sampled by UCC at every station, while analogous sampling by RCMG focused on working areas 3 and 4. At stations which provided a recovery of more than 30 cm, GeoB sampled the sediment column by two sets of syringes (10 cm³) at 3 cm levels. In addition, archive boxes were taken by IPAL and RCMG from a few boxes with excellent recovery.

The remaining sediment column was sieved stratigraphically in 10 cm-thick slices (or other, following the sedimentary units) over a series of sieves with > 5,0 mm, 2,0-5,0 mm, 0,5-2,0 mm, 0,2-0,5 mm and < 0,2 mm mesh size. All sieved fractions were kept under seawater. After at least 4 hours in the ships cold room (4°C) all samples were looked through under the microscope. Thereby all animals (or at least a representative number of specimens) have been sorted out. Samples containing a large number of remaining living animals were then preserved in 70% ethanol. Samples from underlying sediments or without any apparent animal life were rinsed and air dried. All living animals were kept alive in the cold room for further documentation. Therefore the IPAL documentation system consisting of a computer-guided digital camera system mounted on a binocular was used. The ANALYSIS software package provided a multitude of different photographic features. Specimens larger than 3 cm have been documented using an ordinary digital camera. After its documentation each specimen was preserved separately in 70% ethanol to allow verification of the preliminary identifications made on board.

3.4.4 Sediment Sampling with Gravity Corer

(C. Hayn, A. Jurkiw, J. Kaiser, M. Lutz, F. Schewe, C. Wienberg)

Sediments were sampled with a gravity corer (SL 6 and SL 12) at 11 stations along the Celtic Continental Margin (Galway Mound, Franken Mound, Northern Porcupine Bank) after detailed surveys with the shipboard PARASOUND system. All details on the core stations are given in Table 3.3 and in the station list (Tab. 3.5). At Galway Mound, seven gravity cores were retrieved. At Franken Mound, we recovered two gravity cores from the top of the mound and off-mound. Additionally, at the Northern Porcupine Bank two gravity cores were retrieved, with the off-mound core not containing any sediments.

To recover longer sediment sequences, a gravity corer with a pipe length of 6 m and a weight of 1.5 tons was used at 9 stations (GeoB 9212, 9213, 9214, 9222-1, 9223, 9282, 9283, 9294-1, 9295) as well as a gravity corer with a pipe length of 12 m and weight of 1.5 tons was used at 2

stations (GeoB 9225, 9226-1). Before using the coring tools, the liners had been marked lengthwise with a straight line in order to retain the orientation of the core. Once on board, the sediment core was cut into 1 m sections, closed with caps on both ends and labeled according to a standard scheme.

Ten cores were retrieved with recoveries between 1.69 and 5.15 m resulting in a total core recovery of 37.80 m. Due to the supposed high content of coral fragments 7 of 10 sediment cores were frozen for 24 hours before opening (Tab. 3.3). All gravity cores were opened on board and 9 of 10 sediment cores were sampled. All cores were cut into an archive and work half. The archive half was used for core description, smear slide sampling, core photography, and color scanning. The work half was sampled with two series of syringes (10 ml) at 5 cm intervals for geochemical, sedimentological and faunal studies. Further analysis of the sediment cores will be done after the cruise at the Department of Geosciences, University of Bremen.

Tab. 3.3 Gravity Corer (SL) stations during M61-3 cruise. BMP: Belgica Mound Province; WRB: West Rockall Bank; NPB: Northern Porcupine Bank.

Stat. No.	Area	Coordinates		Depth (m)	Recovery		Analysis onboard			
		Lat. °N	Long. °W		(cm)	corals	description	photo	color-scanning	sampling
9212	BMP; Top Galway Mound	51°27.13'	11°44.99'	847	193	X	X	X	X	X
9213	BMP; Top Galway Mound	51°27.09'	11°45.16'	793	515	X	X	X	X	X
9214	BMP; Galway Mound	51°27.06'	11°45.28'	857	489	X	X	X	X	X
9222-1	BMP; Galway Mound	51°27.48'	11°45.39'	900	376	X	X	X	X	X
9223	BMP; Galway Mound	51°26.90'	11°45.10'	839	465		X	X	X	X
9225	BMP; Galway Mound, off-mound	51°26.76'	11°48.55'	1072	358		X	X	X	X
9226-1	BMP; Galway Mound, off-mound	51°27.75'	11°43.03'	887	251	X	X	X	X	X
9282	WRB; Top Franken Mound	56°30.20'	17°18.31'	642	169		X	X	X	X
9283	WRB; Franken Mound, off-mound	56°29.98'	17°18.65'	683	489		X	X	no data	
9294-1	NPB; Connaught Mound, off-mound	53°31.06'	14°21.80'	871	no recovery					
9295	NPB; Top Connaught Mound	53°30.90'	14°21.10'	723	475	X	X	X	no data	X

The core descriptions shown in the respective regional results sections summarize the most important results of the analysis of each sediment core following ODP convention. The lithological data, indicated in the "Lithology" column, are based on visual analysis and smear slide analysis of the core. In the structure column the intensity of bioturbation together with special features (coral bioclasts, shell fragments, lamination etc.) is shown. The hue and chroma attributes of color were determined by comparison with the Munsell soil color charts and are given in the color column in the Munsell notation.

A Minolta CM-2002TM hand-held spectrophotometer was used to measure percent reflectance values of sediment color at 31 wavelength channels over the visible light range (400-

700 nm). The digital reflectance data of the spectrophotometer readings were routinely obtained from the surface (measured in 2 cm steps) of the split cores (archive half). The color measurements (red-green ratio, blue-yellow ratio and lightness) of each core are shown together with the visual core description for each core.

3.4.5 Plankton Net

(L. Dodds)

Plankton was sampled using a 120 μm plankton net for on-board feeding trials with *Lophelia pertusa* and *Madrepora oculata*. Vertical tows were performed on two occasions during the cruise, at the Rockall Bank and at the Porcupine Bank. Along the transect from the Porcupine Bank to the Azores, plankton was collected for 24 hours from the centrifugal-pumped seawater in the laboratory. Initial analysis suggested high numbers of copepods within the plankton samples, with large numbers of salps (Class: Thaliacea) being collected with each plankton tow. The plankton were used in feeding trials and then preserved in 10% formaldehyde for subsequent analysis.

3.5. General Results

3.5.1 ROV-Based Recovery of Current Meters

(B. Dorschel)

A major task during this cruise was the recovery of seven sensor units (Fig. 3.3) deployed at Galway Mound (Fig. 3.7) in the Belgica Mound Province in June 2003 with the French ROV VICTOR 6000. The sensor units, consisting of inductive current meters and CTDs, had been deployed on north-south and east-west transects over the structure to collect data on the small scale flow field on and around Galway Mound. With sampling intervals of 10 minutes, the recorded data are sufficient to provide information on possible tidal influences on the mound.

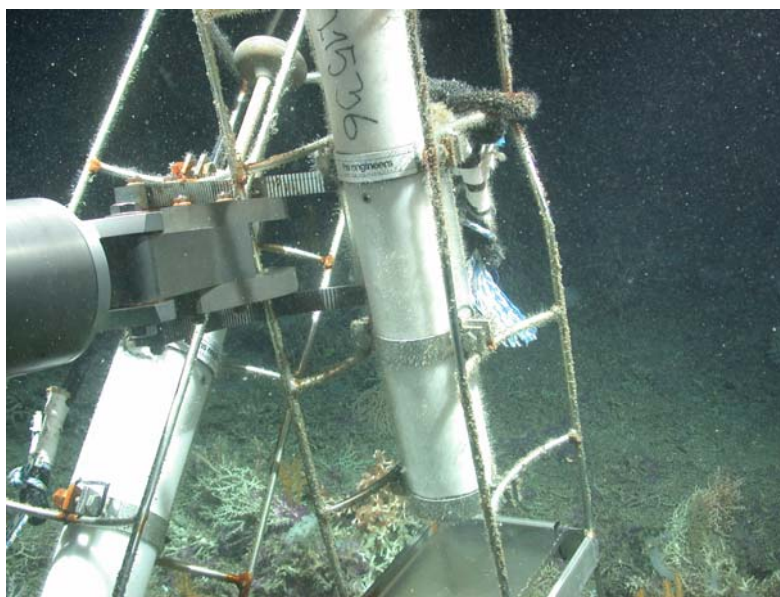


Fig. 3.3 ROV recovery of current meters at Galway Mound.

The sensor units were installed in the frame of the ESF-project MOUNDFORCE and the main task was to analyse the current regime at Galway Mound and to compare these data with different biological and geological facies found on and around this carbonate mound. Earlier work on carbonate mounds in the Porcupine Seabight revealed a close connection between oceanography, the occurrence of coral thickets, the sedimentation and thus the development of carbonate mounds. Therefore, for the first time a carbonate mound had been covered with a grid of sensor units analysing up- and down-stream currents (north-south transect). Two additional sensors were placed in the east and in the west of the top of the mound to obtain a 3D-coverage. First onboard instrument checks indicated that six of seven sensor units were still operating after recovery.

3.5.2 Carbonate Hardgrounds

(S. Noé)

A main objective of RV METEOR cruise M61-3 to the Porcupine-Rockall area was to evaluate which processes are involved in the stabilization and lithification of the steeply inclined flanks of carbonate mounds growing on the continental margins of the Porcupine Bank and Rockall Bank at 600-1000 m water depth. Carbonate samples were collected during ROV dives GeoB 9255-1 and 9267-1 on the western Rockall Bank (Franken Mound) and GeoB 9267-1 on the newly discovered Connaught Mound (Fig. 3.4).

ROV dives along the western flank of Franken Mound (West Rockall Bank) and at the crest of Connaught Mound and a nearby scarp on the Northern Porcupine Bank provided videos of exposed carbonate beds with uneven surfaces that are covered by living and dead coral colonies in certain areas. Cliffs consisting of well-bedded carbonate lithologies of different weathering resistance, which closely resemble alternations of pelagic and hemipelagic sediments, are locally exposed with individual layers measuring several decimetres in thickness. Samples recovered from the rather resistant layers on Franken Mound and Connaught Mound show two major facies: (1) poorly to moderately lithified pelagic foraminiferal-nannoplankton oozes; (2) highly lithified fossil coral reef framework.

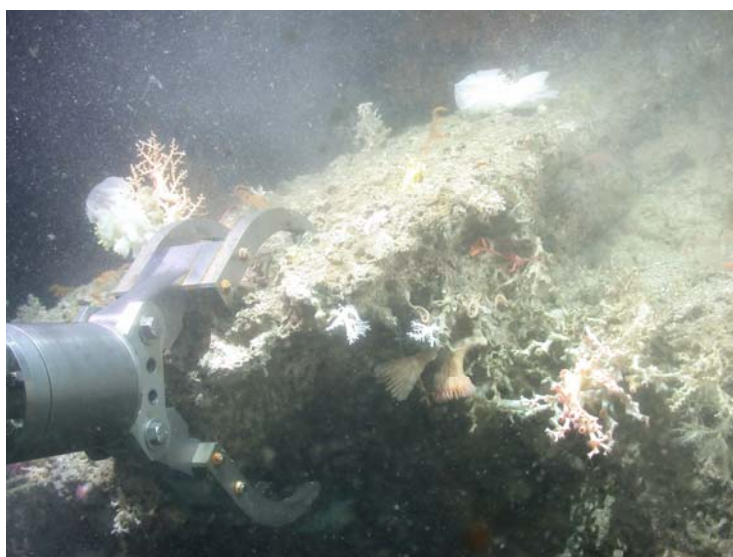


Fig. 3.4 Sampling of carbonate crusts with QUEST's heavy duty Rigmaster manipulator.

Fossil pelagic carbonates

Samples of the well-bedded lithified pelagic oozes show two sub-lithologies: (1) a micritic facies comprising hard, moderately lithified foraminiferal-nannoplankton oozes with very uneven surfaces that are heavily bored, encrusted by sessile invertebrates and Fe/Mn-stained or covered by thin manganese crusts; (2) a chalky facies consisting of soft, poorly lithified nannoplankton-foraminiferal oozes which in the same way shows bioeroded and Fe/Mn-stained surfaces. Both facies are white except for the stained surfaces. Planktic and some admixed benthic foraminifera compose the silt-size fraction, while the clay-size matrix is made up of nannoplankton. The fine-grained pelagites may be admixed with varying amounts of pelagic pteropods, benthic bivalves, and coral fragments which were eroded from coral thickets further upslope.

Fossil coral reef framework

Fossil reef rock consists of scleractinian skeletons (mainly *Lophelia*, *Madrepora* and some solitary corals) and shells of reef dwellers (bivalves, brachiopods, gastropods etc.). Most part of the framework is clogged by fine-grained calcareous sediments. By analogy to the lithified pelagic oozes, the rock surfaces are strongly bioeroded, encrusted by diverse invertebrates, and Fe/Mn impregnated. The reef rock differs from the pelagic carbonates by having a high portion of autochthonous to parautochthonous sessile invertebrates and a high degree of lithification. Exposed cliffs show multiple stages of vertical coral growth which are separated by thin layers of fine-grained pelagic sediments.

Distribution of carbonate facies

ROV dives and the recovery of carbonate samples revealed that the resistant carbonate lithologies - moderately lithified pelagic oozes and fossil coral framework - construct the steep western flank of Franken Mound on West Rockall Bank and the Connaught Mound on the Northern Porcupine Bank, forming bedded cliffs of up to several meters height. Pelagic micrites form major part of the western flank of Franken Mound, while fossil reef framework shows a patchy distribution on the flank and crest of this mound, documenting long-term coral growth in these areas. On the other hand, poorly lithified chalky beds are restricted to the smoothly inclined eastern flank of Franken Mound, where they are eroded from surrounding current-rippled sandy sediments. This facies distribution clearly reflects the asymmetric shape of Franken Mound.

Genesis of hardgrounds on Rockall and Porcupine banks

Lithification of the pelagic (and hemipelagic?) sediments derives predominantly from physical compaction linked with pore fluid escape in the course of sediment burial, although a possible microbial support by precipitation of automicrites in the tiny pores cannot be ruled out. Duration of burial and depth-related overburden pressure controlled the formation of chalky or micritic carbonates respectively. Major lithification of the fossil reef carbonates took place by reduction of primary growth framework porosity via infill of fine-grained pelagic calcareous oozes and – possibly - microbial automicrite precipitation.

After burial, the lithified carbonate beds were exhumed by currents, forming escarpments or steep cliffs on the sea floor. Subsequently their surfaces were affected by (1) bioerosion as indicated by burrows, and (2) abrasion, documented by furrowed surfaces and Fe/Mn impregnation. These characteristic features of non-deposition/erosion and submarine exposure

prove the exposed fossil carbonates to be real hardgrounds which form the steeply inclined flanks of the carbonate mound. Fe/Mn-staining and some manganese crusts argue for a Pleistocene age or older.

Coral colonization of hardgrounds

Hardgrounds exposed in loose sediments of the Rockall/Porcupine continental slope settings are colonized by colonial scleractinians, whereas the dense mesh of coral skeletons surrounded by the sticky coenenchym is a preferential site of fixation of fine-grained pelagic rain. By protecting sediment particles from current transport, the coral framework supports sediment stabilization at the sites of coral growth. After a first stage of patchy colonization, coral colonies gradually amalgamated to coral gardens covering the flanks and ridges of topographic highs, thus forming carbonate mounds with steeply inclined flanks. Internal stratification of the fossil coral framework documents individual stages of coral growth interrupted by periods of pelagic sedimentation. The latter intervals indicate a deterioration of environmental conditions for the corals.

Conclusions

Fossil lithified pelagites and coral reef framework exposed on the flanks and tops of the investigated carbonate mounds represent hardgrounds which are responsible for stabilization of the steep mound flanks and provide a solid substratum for colonization of mound-forming invertebrates in areas of otherwise loose sediment accumulation. A possible microbial control on stabilization and lithification of the investigated carbonate mounds may be based on the formation of biofilms on coral skeletons and hard substrates via sediment binding. In addition, bacterially induced precipitation of automicrite and carbonate cements which are known to occlude major primary porosity in tropical shallow-water reefs may have contributed to porosity reduction and lithification of the deep-water coral reef framework.

Reefal and pelagic hardground facies are strikingly different from bacterially-induced authigenic carbonate precipitates typical of cold seep, mud volcano and gas hydrate settings, such as thin-bedded micritic carbonate crusts and collapse breccias. Their origin is clearly related to local oceanographic conditions, lacking any endogenic control.

3.5.3 Environmental Impacts in Areas of Deep-Water Coral Occurrences

(A. Grehan)

Serious damage to deep-water corals has been observed during ROV investigations of reef areas in Norway. It is estimated that between 30-50% of known reefs have been impacted by the use of deliberate destructive trawling techniques (Fosså et al., 2002). Documentation of this destruction has led the Norwegian Authorities to ban trawling from areas where corals are known to occur. Deep-water corals off the west coast of Ireland are located much deeper than their Norwegian analogues and it was thought that this gave them a degree of protection. Sadly, allegations of Norwegian style damage in Irish waters (Grehan et al., 2003) were substantiated during the R/V ATALANTE CARACOLE cruise in 2001 (Grehan et al., in press) and the subsequent R/V POLARSTERN ARK 3A cruise in 2003 (Grehan et al., 2004).

During M61-3, the QUEST ROV dives offered an opportunity to expand our knowledge of the types and intensity of environmental impacts (particularly from fishing) in Irish waters. This

information will help provide the scientific base for decision makers charged with selecting appropriate management measures to ensure that ecological quality objectives established during designation of conservation areas can be effectively met. Ireland is currently at the beginning of the designation process to establish a network of conservation areas (Special Areas of Conservation under the EU Habitat’s Directive) to protect deep-water coral reefs.

Environmental impacts observed during the dives can be broadly assigned to two categories: (1) small man-made objects lost/thrown overboard (Tab. 3.4, Fig 3.5A), and (2) gears lost during routine fishing activity (Tab 3.4, Figs. 3.5B-D). In the first category, of interest was the utilization of a piece of man made material in place of the usual antipatharian/gorgonian branch, characteristically carried by a *Paramola* sp. crab, as a defence over it’s carapace. In the second category, all of the lost fishing gear was observed on Franken Mound. The images in Fig. 3.5B-D clearly show gill/tangle nets complete with head and ground lines. In Fig. 3.5B, the ground or headline has been colonized by settling epifauna which suggests the gear was not lost recently. In Fig. 3.5C-D, the net is full of coral, and has clearly been dragged in a failed attempt to free it from snags. While some coral may survive in these nets, it is almost certain that many corals died due to the enforced change of location.

The Franken Mound and surrounds, is still an area favoured by fishermen as was evident during the first dive when a longliner (Fig. 3.5A) approached within one nautical mile of R/V METEOR while retrieving previously set gillnets. The skipper confirmed that he was mainly interested in monkfish, blue ling, red crab (Figs. 3.6B-D) and sikki shark.

Deep-water coral areas are fished in Irish waters using both static gears (gill/tangle net and sometimes crab pots) and heavy trawl gear (principally for orange roughy; *Hoplostethus atlanticus*). During M61-3 we saw no evidence of the latter, but once again, we observed the impact that attempted recovery of snagged static gears can have on deep-water corals. It is likely, that in addition to banning trawling, the use of static gears will have to be managed in areas designated for the conservation of deep-water corals. This will require the implementation of appropriate technical conservations measures under the Common Fisheries Policy (Long and Grehan, 2002).

Tab 3.4 Location and description of environmental impacts observed during the M61-3 QUEST dive series.

Event	Station No.	Date	Coordinates		Depth (m)	Dive No.	Time (UTC)	Tape No.	Observation	Digital Still
	GeoB		Lat. °N	Long. °W		QUEST				
1	9203	05/06/04	51°26.71'	11°45.03'	887	16	11:56	2	Metallic box	
2	9203	05/06/04	51°26.71'	11°45.03'	891	16	12:00	2	Metallic rubbish	
3	9255-1	11/06/04	56°30.01'	17°18.42'	666	21	11:40	2	Lost tangle net, <i>Roxania</i> sp.	
4	9267	12/06/04	56°29.92'	17°17.84'	669	22	11:57	4	<i>Paramola</i> sp. with manmade object as cover	
5	9281-1	13/06/04	56°30.30'	17°18.60'	648	23	12:27	5	Lost fishing net (rope) in btw. dead coral and hardground	Fig. 3.5B
6	9281-1	13/06/04	56°30.38'	17°18.63'	651	23	13:27	6	Lost tangle net full of coral, <i>Roxania</i> sp. On rope.	Fig. 3.5C, 3.5D
7	9285-2	15/06/04	53°30.92'	14°21.01'	704	24	12:05	5	White plastic rubbish bag	Fig. 3.5A
8	9285-2	15/06/04	53°30.88'	14°20.94'	758	24	12:22	5	Plastic bag	

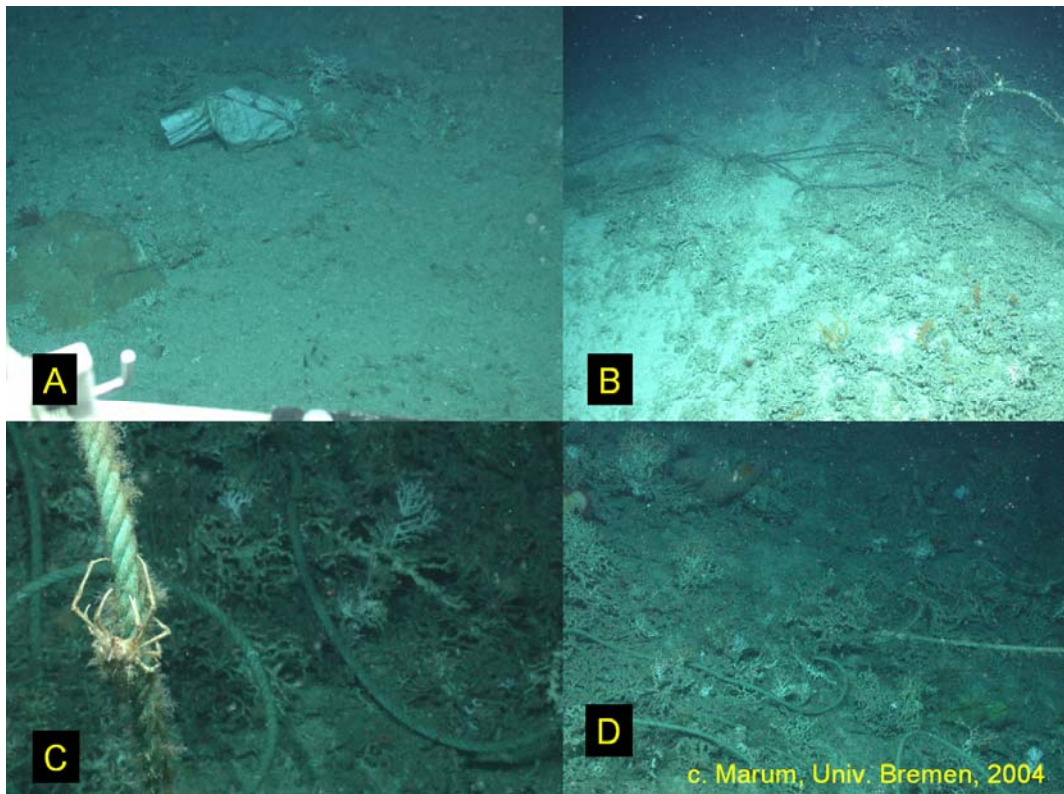


Fig. 3.5 (A) Plastic bag imaged on the Connaught Mound. (B-D) Lost gillnets/tangle-nets on Franken Mound.

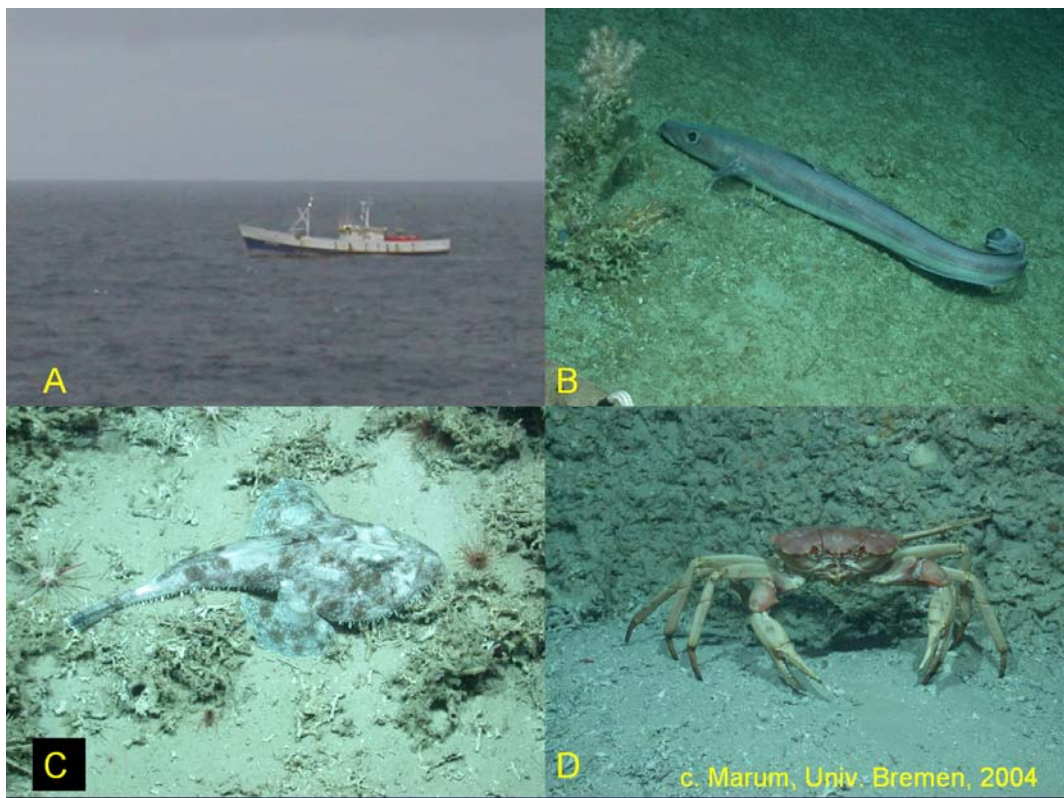


Fig 3.6 (A) Longliner recovering gillnet/tangle net sets from the Franken Mound area. (B) Commercial target species: *Molva dypterygia* (blue ling), (C) *Lophius piscatorius* (monkfish), (D) *Chaceon affinis* (red crab).

3.6 Regional Results

3.6.1 Working Area 1: Belgica Mound Province

3.6.1.1 Bathymetry and Sampling Stations

(A. Foubert, L. Beuck, J. Gault)

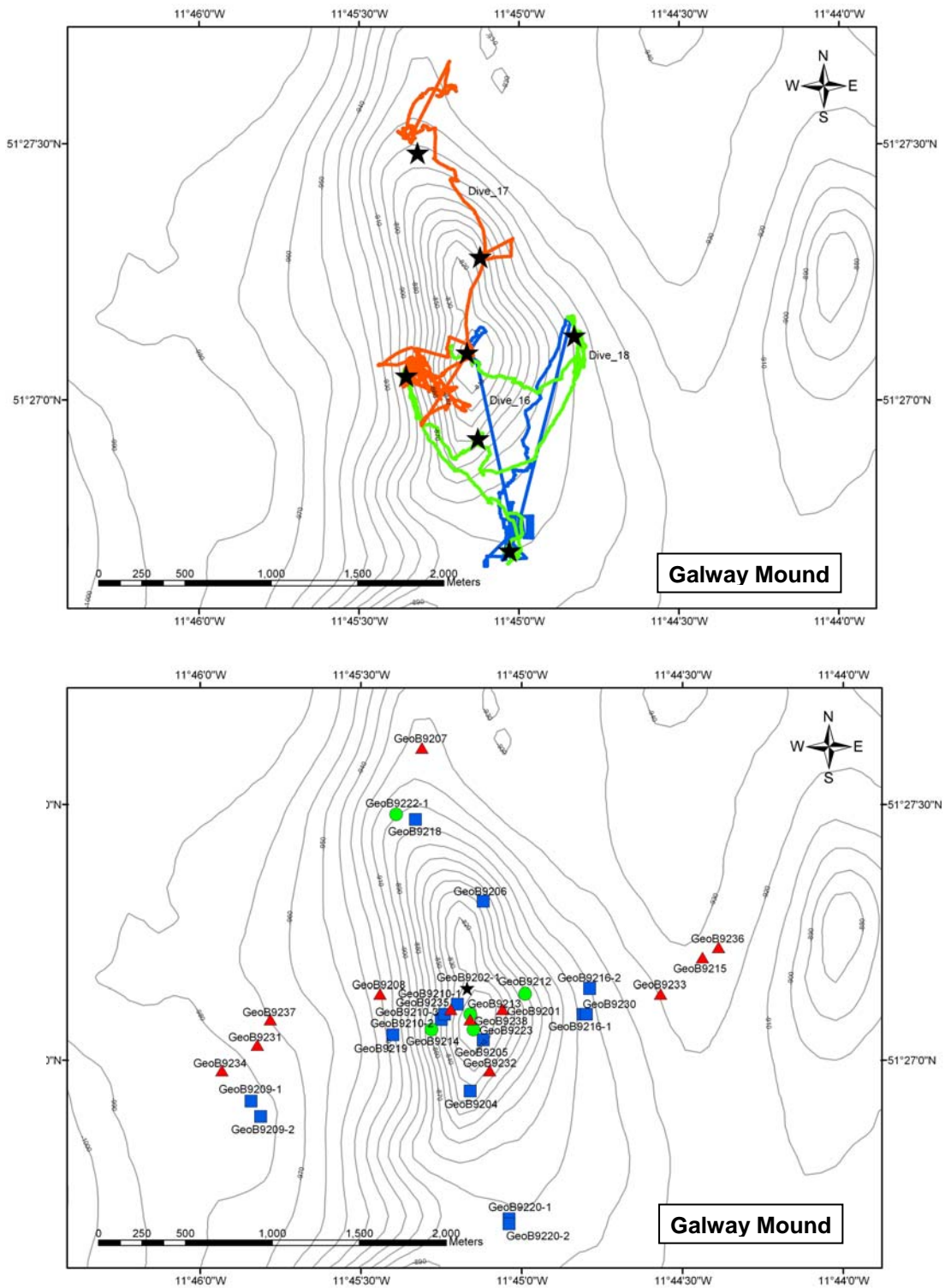


Fig. 3.7 Maps of bathymetry, QUEST dives (top) and sampling stations (bottom) in the Belgica Mound Province. Stars: current meters; circles: gravity corer; squares: box corer; triangles: CTD.

3.6.1.2 Hydrography in the Belgica Mound Province

(A. Rüggeberg, L. Dodds)

Within the Belgica Mound Province 13 CTD profiles were performed, of which 5 profiles covered positions in a NS- and EW-direction across Galway Mound, to compare with measurements taken on cruise M61/1. The distribution of water masses at Galway Mound was typical for the eastern margin of the Porcupine Seabight with a warm surface water mass layer of 40 to 50 m, overlying the Eastern North Atlantic Water, where temperature and salinity decrease to a minimum at ~600 m water depth (Fig. 3.8). Increasing salinity values indicate the occurrence of Mediterranean Outflow Water below ~ 700 m with a coherent decreasing oxygen content.

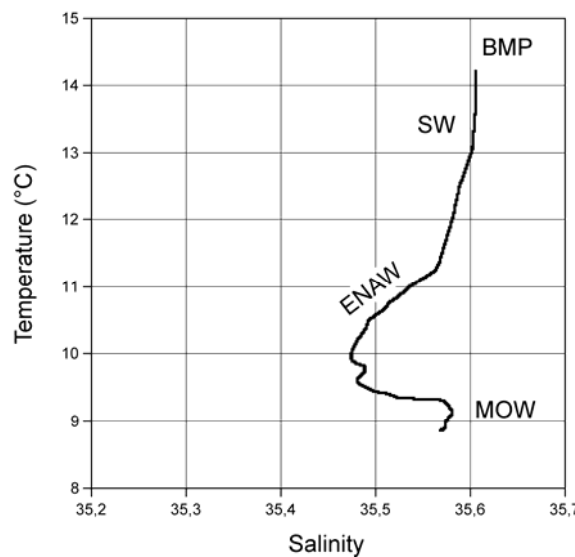


Fig. 3.8 TS-plot of a typical CTD profile in the Belgica Mound Province (BMP; station GeoB 9234-1). SW: Surface Water; ENAW: Eastern North Atlantic Water; MOW: Mediterranean Outflow Water.

To analyse the temporal variation of water mass dynamics in the vicinity of Galway Mound, we established a series of CTD profiles at three positions, west, top and east of Galway Mound and repeated the measurements three times except for the eastern location. The result was a time-series of eight CTD profiles with one-hour interval between each cast, which visually indicates the influence of tidal waves at 600–700 m water depth (Fig. 3.9) as reported by Rice et al. (1990) along the European continental margin and by White (2003) along the eastern slope of the Porcupine Seabight. The salinity minimum appearing from the east may be the result of internal wave reflection at the slope. Additional strong Ekman downwelling induced by the northward flow of the slope current delivers re-suspended organic material into the depth of the carbonate mounds (White, in press). These processes are important for the deep-water coral ecosystem as the corals take advantage of the high nutrient availability, the strong currents and the pumping dynamics of internal waves.

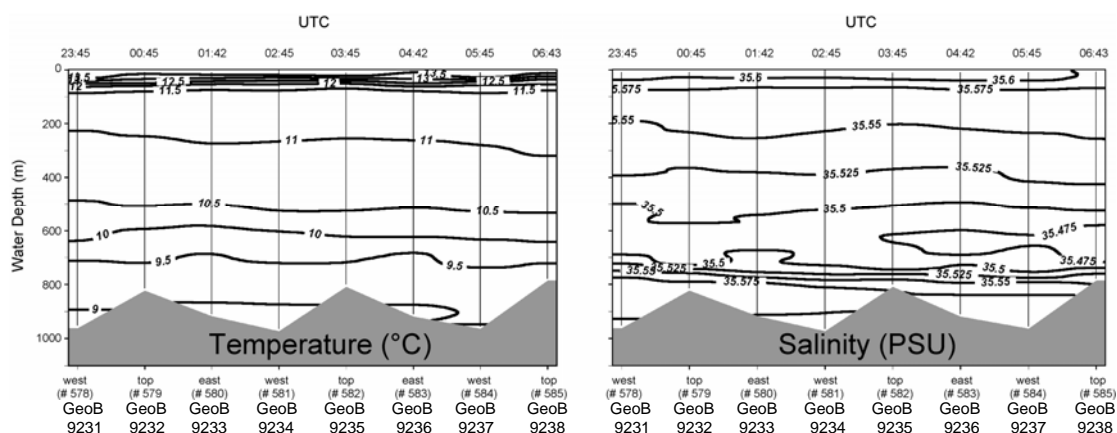


Fig. 3.9 CTD time-series across Galway Mound, Belgica Mound Province. Temperature and salinity indicate the influence of tidal waves at the water mass boundary between Eastern North Atlantic Water (ENAW) and Mediterranean Outflow Water (MOW; 600–700 m) with increasing time (UTC on top, station and GeoB# and position relative to mound on bottom).

3.6.1.3 ROV Video Observations

(B. Dorschel, T. Beck, A. Foubert, J. Gault, A. Grehan, V. Ratmeyer, G. Ruhland)

In total, 4 dives (GeoB 9203-1, 9211-2, 9239-1, 9240-1) were performed in the Belgica Mound province in the Eastern Porcupine Seabight with ~18 hours of video footage recorded (Fig. 3.7, top). Three dives (GeoB 9203-1, 9211-2, 9239-1) were carried out at Galway Mound devoted to the recovery of 7 sensor-packages (current meter, CTD) which have been deployed in June 2003. An additional dive (GeoB 9240-1) targeted an unnamed mound in the Eastern Belgica Mound Province to sample hardgrounds that have been discovered during a ROV survey with the French ROV VICTOR 6000 in June 2003.

The dive tracks for the recovery of the sensor units were chosen to complement existing ROV surveys. Therefore south-north as well as east-west transects over the mounds were selected thus crossing and completing the existing video coverage. During all dives continuous video observations were recorded providing high quality video footage on facies distribution, ecosystems, faunal assemblages and human impacts. In addition sedimentological and biological samples were taken in areas, where standard sampling techniques failed to succeed due to steep slopes and hard substrate.

Description of ROV-dives

Dive GeoB 9203-1 lasted 10h with 9h of ground sight. It started south of Galway Mound, followed a grid at the southern and western base of the mound and then ran over the top to the north. Dive GeoB 9239-1 lasted 9h with 7:20h of ground sight and crossed the mound from east to west further continuing to the south (Fig. 3.7).

The off-mound area south of Galway Mound is characterised by sand waves with several meters wave length. The crest of the sediment waves had often been overgrown by sponges and corals while the troughs contained coarse sands. At the base of the mound the abundance of living corals increased with also the troughs being covered with corals. At the mound flank the wavy structure was still recognisable but being fully overgrown by corals only intercepted by small sand patches. Upslope, increasingly higher abundances of living corals occurred with the

largest colonies in the summit area. North of the summit, following the rim of the mound, the amount of living corals decreased and sand patches became more common. The most northerly extension of the survey reached again the ‘overgrown sand wave’ facies at the lower flank of Galway Mound. Also towards the east of the mound, the living coral facies faded out into the ‘overgrown sand wave facies’ and further into the ‘sand wave facies’. The sand waves showed the characteristic of current induced mega-ripples.

A major task of the ROV-dives at Galway Mound was the recovery of seven sensor packages, which has been performed successfully. The recovery of the sensor packages proofed the capacity of the ROV navigation system to retrieve small objects without the support of acoustic beacons or similar devices. It was possible to locate all seven sensor packages at ~800 m water depth after a one year deployment based on only the deployment coordinates. The sensor packages were picked with a manipulator to remove the stabilising weight with the specially designed ‘Krueger Knife’ and stored on the porch of the vehicle or kept with the ROV manipulator. Different to earlier plans, all sensor packages were brought on board with the ROV and were not recovered with the elevator mooring. During dive GeoB 9203 three sensor packages and during dive GeoB 9239-1 the additional four sensor packages have been collected and brought to surface by the ROV. Against accidental loss during transport, the sensor units were additionally secured with snap hooks to the ROV.

A surface sediment sample was collected by the ROV (GeoB 9239-1) with a sample bag at the location of the current meter west of Galway Mound. The steep slope of this area cannot be sampled with standard tools (e.g. box corer) thus leaving the ROV as the only tool for collecting sediment samples.

The last dive in the Belgica Mound Province, performed at an unnamed mound structure from the mound chain expanding south of Poseidon Mound, was devoted to the collection of hardgrounds. Unfortunately, the attempt to approach the rim of the mound, where the hardground cropped out, failed due to strong currents. The eastern flank of this mound is covered by a dropstone pavement interfering with sediments consisting purely of barnacle plates.

3.6.1.4 Surface Samples

(S. Noé, T. Beck, A. Foubert, A. Grehan)

Galway Mound

Galway Mound represents one of the largest mound structure of the “deeper line of mounds” of the Belgica Mound Province. This prominent elongated seabed structure with more than 160 m positive relief arising from 920 m to 780 m water depth is characterized by living coral framework covering its flat top and steep flanks, contrasting the fine-grained sediments of the surrounding off-mound areas which contain dead coral framework and rubble derived from the flanks. The density of coral cover increases from the base upslope the flanks, culminating with highest abundance and coral size in the summit area (ROV dive observations).

Facies distribution

Living coral/sponge framework, mostly attached to underlying dead framework, was recovered by the giant box corer on a south-to-north transect across the mound crest (GeoB 9204, GeoB 9205 and GeoB 9206), furthermore on the steeply dipping western mound flank down to a depth of 920 m (GeoB 9219), and on the somewhat less steeply inclined east face down to 890 m depth (GeoB

9216-1; Fig. 3.10). Off-mound areas are characterized by a mega-rippled “sand wave facies” composed of mixed siliciclastic-calcareous sediments containing dead coral framework and rubble with a few living *Madrepora* colonies on top. This facies extends from the southern flank of the mound (GeoB 9220-1/9220-2) around the eastern flank to its northern margin (GeoB9218-1), while in the western off-mound area at 981 m depth (GeoB 9209-2) sand waves are covered by dead coral framework preserved *in situ*, forming an “overgrown sand wave facies” as deduced from ROV observations (Fig. 3.10).

Sediment column

At the coral sites, fine-grained muddy to sandy sediment trapped within the dead framework beneath the living surface was partly washed out during recovery. The thickness of the sediment column rarely exceeded 20 cm, while two box corer deployments did not provide any sediment. The sediment columns of the on-mound and off-mound sites showed even to slightly uneven bedding with a reduction horizon being located 5-10 cm beneath the surface of some box core columns, while other stations did not show any distinct differences in redox conditions throughout the section. Bedding was commonly overprinted by irregular bioturbation and/or distinct worm burrowing.

Composition of coral/sponge framework

Living reef framework collected from the crest and flanks of Galway Mound consists predominantly of *Madrepora oculata* thickets. The healthy living framework is generally devoid of any fine-grained sediment. Dead or subfossil coral framework underneath the living reef-building community is made up of (several morphotypes of) *Lophelia pertusa* that provide the colonization substratum for the corals. Dead framework is generally clogged by mixed fine-grained calcareous-siliciclastic sediments. *Lophelia* skeletons show varying taphonomy from *in situ* arrangement to total disintegration of framework with small fragments being embedded in the sediment. In this case a vertical succession from coral rubble to a zone of dead but well preserved *Lophelia* skeletons to living reef communities may be observed (e.g. at site GeoB 9219; Fig. 3.10).

Aphrocallistes, the dominating hexactinellid sponge of the Belgica Mound Province, was found at all on-mound and flank sites where live specimens are actively involved in framework building. Abundant dead specimens buried beneath living coral framework were found at a site on the western mound flank (GeoB 9219), while at the western off-mound site (GeoB 9209-2) a “sponge mass grave” of dead *Aphrocallistes* specimens appeared beneath dead coral framework.

Biological features

Attached to the skeletons of the colonial scleractinians there are some solitary corals (predominantly *Desmophyllum cristagalli*), abundant hexactinellid sponges (*Aphrocallistes bocagei*), as well as gorgonians (*Acanthogorgia armata*). In some areas on Galway Mound these species are extremely abundant and characterise the living coral habitat on this mound structure. Dead and subfossil specimens of *Aphrocallistes* often served as substrate for other animals like a yellow encrusting sponge (not to confuse with living *Aphrocallistes* which is whitish) and species of Zoantharian which is also very characteristic due to its bright yellow colour. The pink-coloured octocorals *Anthothela grandiflora*, hydroids and encrusting bryozoans of different species are commonly encrusting the dead parts of coral framework. The probably closest associate to the colonial scleractinians, the polychaet *Eunice norvegicus*, was present in or on almost each piece of coral larger than 5 cm. Its characteristic tubes, built up of a thin parchment-

like layer, are normally overgrown by the scleractinians and though contribute to the complexity of the coral framework.

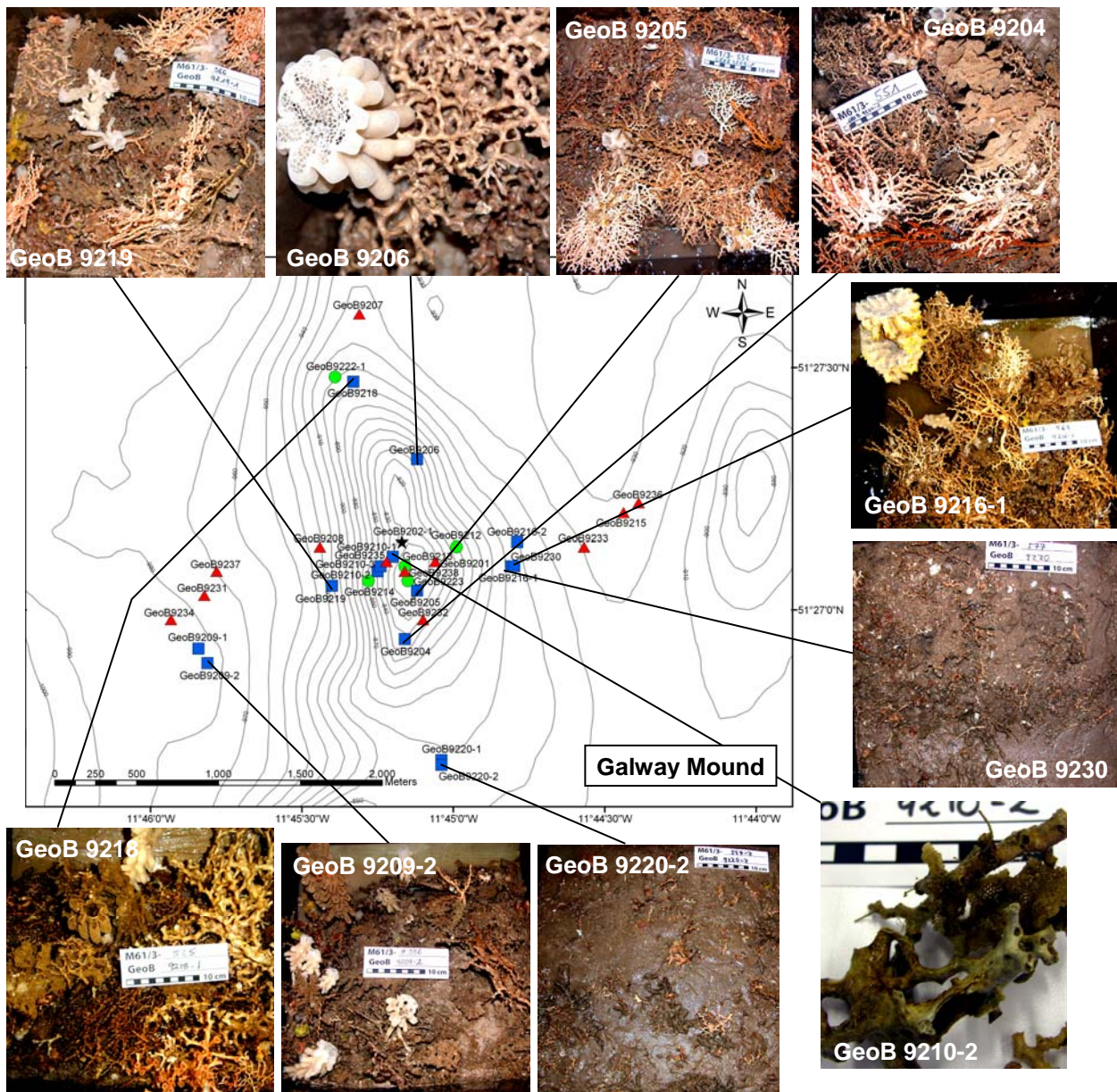


Fig. 3.10 Box core sampling stations and surface sediments in the Galway Mound area. Circles: gravity corer; squares: box corer; triangles: CTD.

A multitude of vagile fauna including ophiuroids, bivalves, gastropods, polychaetes and shrimps (*Palaemon* sp.) has also been sampled. The bivalves are mostly represented by bysally attached species like *Asperarca nodulosa*. A bright red polychaet of the family Hecionidae was almost as abundant as *Eunice norvegicus*. The solitary worm-shaped coral *Stenocyathus vermiformis* was found to be very abundant in a sample from the coral habitat close to the top of Galway Mound (GeoB 9219). Beside the very abundant species *Aphrocallistes* another hexactinellid sponge, *Mellonympha velata*, was found in sample GeoB 9204 from the southern slope of Galway Mound. This was the only record for this species during the entire M61-3 cruise. It remains to be investigated if there is a relation to the very low temperature of the

sediment at this site. The sediment of sample GeoB 9204 was with 7°C about 3°C colder than all other sediment samples collected during M61-3.

Conclusion

Facies distribution revealed by box coring confirms Galway Mound to represent a still growing mound with a deep-water coral/sponge ecosystem densely covering the flat top and steep flanks down to the seabed. By analogy to the adjacent Therese Mound, Galway Mound therefore clearly represents the catch-up to keep-up stage in the evolution of mound growth in the Porcupine Seabight (ECOMOUND model: Rüggeberg et al., in press).

Poseidon Mound

Poseidon Mound, the most prominent carbonate mound of the “shallower line of mounds” of the Belgica Mound Province, elevates from 850 m (western slope) to 670 m (summit) water depth. Since this mound has been sampled by several gears including giant box corer during RV POSEIDON cruise POS 292, only three box-corer stations were carried out during this cruise.

Facies distribution

One site located at the eastern mound flank (GeoB 9227) revealed a dropstone pavement with barnacle hash, stylasterids and echinoid (*Cidaris*) spines. A similar dropstone facies is exposed in the off-mound area further to the south (GeoB 9229). On the other hand, a box corer deployed on the northeastern flank (GeoB 9228) provided *Madrepora* rubble sticking in well-sorted sands (Fig. 3.11). Penetration depth of the dropstone facies amounting up to 41 cm is conspicuously higher than that of the coral sites.

Box core recovery from POS 292 cruise revealed that the crest and western flank of Poseidon Mound are covered by *Madrepora* rubble with encrusting invertebrates largely embedded in fine-grained sediments, while the eastern flank and off-mound areas are covered by sandy sediments with extended dropstone pavements on top. Hence, the box core sampling of M61-3 cruise fits well to the previously discovered sedimentary pattern of Poseidon Mound.

Biological features

The two samples (GeoB 9227 and 9229) from the dropstone habitat surrounding Poseidon Mound revealed a fauna well adapted to high current velocities. As characteristic features the holothurian *Psolus* sp. and the stylasterid *Pliobothrus symmetricus* were found attached to a dropstone. The barnacle *Bathyplasma* sp. was the only one found alive, although the shell plates of dead *Bathyplasma* sp. are an important feature in the surface sediments.

From a biogeographical point of view sample GeoB 9229 is noteworthy as it contained several species of molluscs which normally occur in more northern and shallower areas like the bivalves *Yoldiella pernula* and *Cuspidaria cuspidata*. As these species were only found as empty shells it is possible that they represent elements of a “cold fauna” representing past, colder conditions. In clear contrast, GeoB 9228 contained several possibly subfossil species with clear Mediterranean affinities (*Putzeysia wiseri*, *Spondylus gussoni* and *Lima marioni*). With *Coralliophila* sp. only one species was found which possibly feeds on scleractinia. This species is so far not yet reported from the Belgica Mound area.

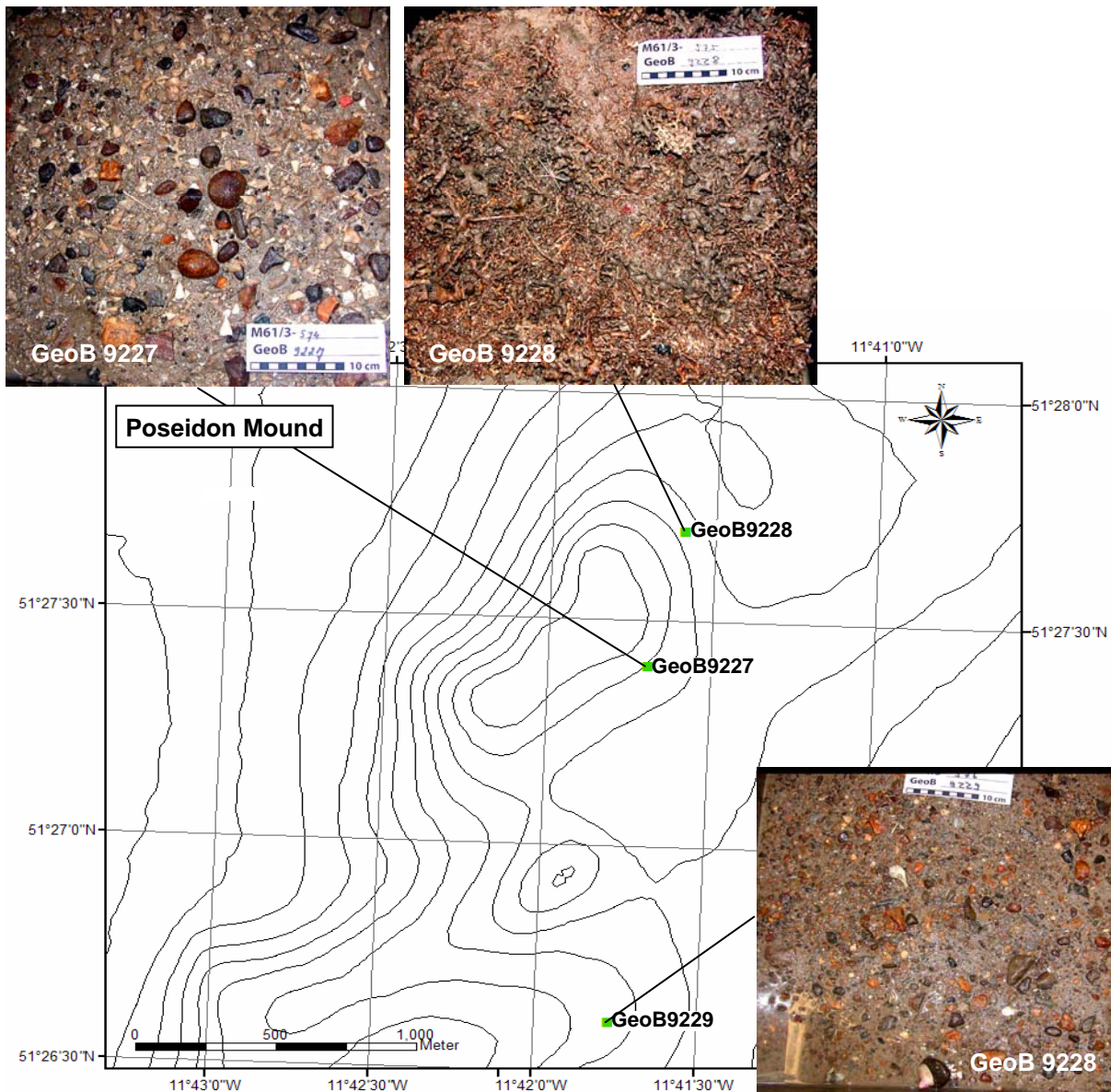


Fig. 3.11 Box core sampling stations and surface sediments in the Poseidon Mound area.

3.6.1.5 Sediment Cores

(C. Hayn, A. Jurkiw, J. Kaiser, M. Lutz, F. Schewe, C. Wienberg)

In the Belgica Mound Province, seven gravity cores were retrieved from Galway Mound. Five cores were retrieved from the top and the flanks of the mound structure (GeoB 9212, 9213, 9214, 9222-1, 9223; Tab. 3.3). These cores are dominated by a silty to fine sandy mud matrix containing abundant bioclasts which are mainly composed of fragments of the coral *Lophelia pertusa* and secondary made up of the coral *Madrepora oculata*, molluscs, echinoid spines, brachiopods as well as benthic and planktic foraminifers. Two cores were retrieved from the off-mound area close to Galway Mound (GeoB 9225, GeoB 9226-1; Tab. 3.3). These cores look completely different compared to the five cores from the top and the flanks. They contain very few fragments of organisms. The sediment is again mainly made up of silty to fine sandy mud and in addition sandy layers occur.

3.6.2 Working Area 2: Hovland Mound Province

3.6.2.1 Bathymetry and Sampling Stations

(A. Foubert, L. Beuck, J. Gault)

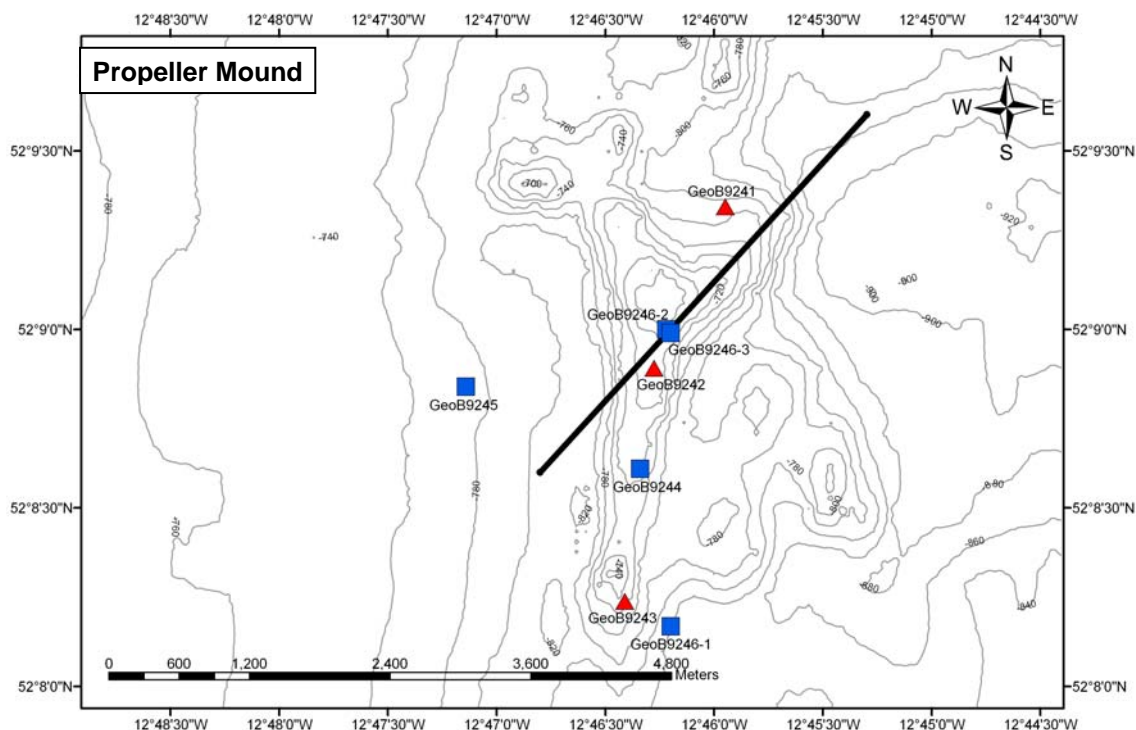


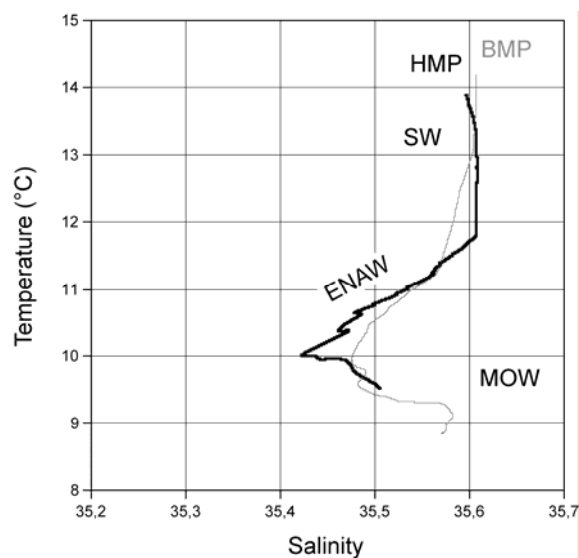
Fig. 3.12 Map of bathymetry and sampling stations around Propeller Mound in the Hovland Mound Province. Squares: box corer; triangles: CTD.

3.6.2.2 Hydrography in the Hovland Mound Province

(A. Rüggeberg, L. Dodds)

In the Hovland Mound Province, northern Porcupine Seabight, three CTD profiles were achieved arranged in a N-S transect across Propeller Mound. The water mass distribution was similar to the Belgica Mound Province with ENAW underlying the surface waters (Fig. 3.13).

Fig. 3.13 TS-plot of atypical CTD profile in the Hovland Mound Province (HMP; station GeoB 9241). SW: Surface Water; ENAW: Eastern North Atlantic Water; MOW: Mediterranean Outflow Water.



However, the signature of MOW seemed to be little shallower compared to the Belgica Mound Province, which is the result of the northward and up-slope flow of water masses. Previous studies and cruises have shown that the current intensity weakens in the northern Porcupine Seabight and the general flow becomes south-westerly (e.g. Freiwald et al., 2000; White, 2003).

3.6.2.3 ROV Video Observations

No QUEST dives were carried out in the Hovland Mound Province.

3.6.2.4 Surface Samples

(S. Noé, T. Beck, A. Foubert, A. Grehan)

Propeller Mound has been intensively investigated during several previous cruises. Hence, box coring was conducted at only four stations, with two of them showing recovery. One box core taken from a site near the summit (GeoB 9246-3; Fig. 3.14) devoid of living coral framework reveals a poorly sorted, strongly burrow-mottled sediment with some *Madrepora* rubble and a few dropstones.

The dead coral framework was typically colonized by hydrozoans, bryozoans and agglutinating foraminifera and inhabited by a remarkable number of very juvenile *Rochinia carpenteria*. These findings support the previous results that the summit of this mound is locally covered by sediment and shows a reduced density of living corals, hence representing a keep-up stage in mound evolution (ECOMOUND model: Rüggeberg et al., in press).

Another station carried out in the distal western off-mound area (GeoB 9245; Fig. 3.14) provided burrowed siliciclastic silty mud lacking any reef-building skeletons. The sample brought up some characteristic soft-bottom dwellers like ophiuroids, polychaetes and some komokiaceans.

3.6.2.5 Sediment Cores

No gravity cores were collected in working area 2.

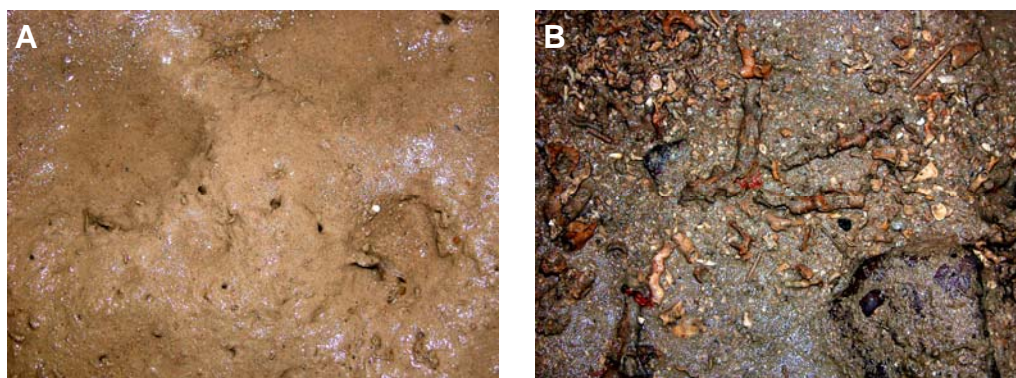


Fig. 3.14 Surface sediments in the Propeller Mound area. (A) Box core surface of GeoB 9245, western off-mound area and (B) GeoB 9246-3, southern margin of summit.

3.6.3 Working Area 3: West Rockall Bank

3.6.3.1 Bathymetry and Sampling Stations

(A. Foubert, L. Beuck, J. Gault)

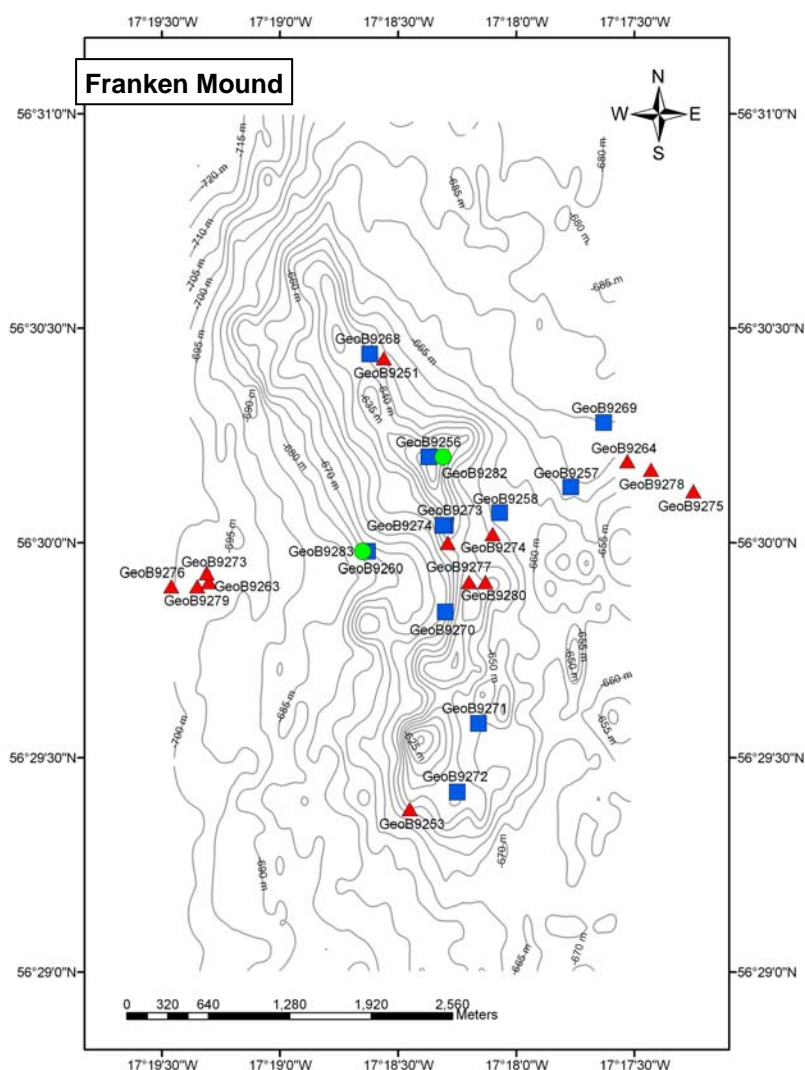


Fig. 3.15 Map of bathymetry and sampling stations at Franken Mound, West Rockall Bank. Circles: gravity corer; squares: box corer; triangles: CTD.

3.6.3.2 Hydrography of the West Rockall Bank Area

(A. Rüggeberg, L. Dodds)

Along the western slope of the Rockall Bank 19 CTD casts were performed at Franken Mound, discovered during cruise M61/1. Eleven profiles were arranged in NS- and EW-transects across Franken Mound in water depths between 640 and 760 m and showed a similar water mass distribution as profiles already performed during cruise M61-1. In comparison to the Porcupine Seabight a typical TS-plot for the West Rockall Bank (Fig. 3.16) showed colder and less saline surface waters. Below the surface waters a continuous and linear TS-relation indicates the occurrence of a colder and less saline water mass, described here as North Atlantic Central Water (NACW) with a different production area compared to the ENAW. Below 600 m a slight

increase in salinity may indicate a contribution of MOW or another high saline water mass of southern origin, as the general direction of circulation around Rockall Bank follows a clockwise flow.

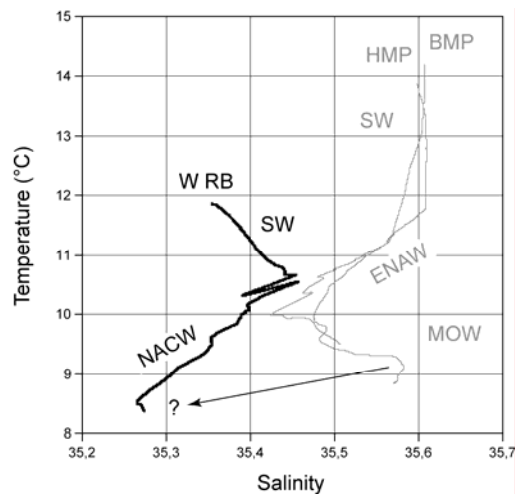


Fig. 3.16 TS-plot of typical CTD profile in the West Rockall Bank area (WRB; station GeoB 9250). SW: Surface Water; NACW: North Atlantic Central Water.

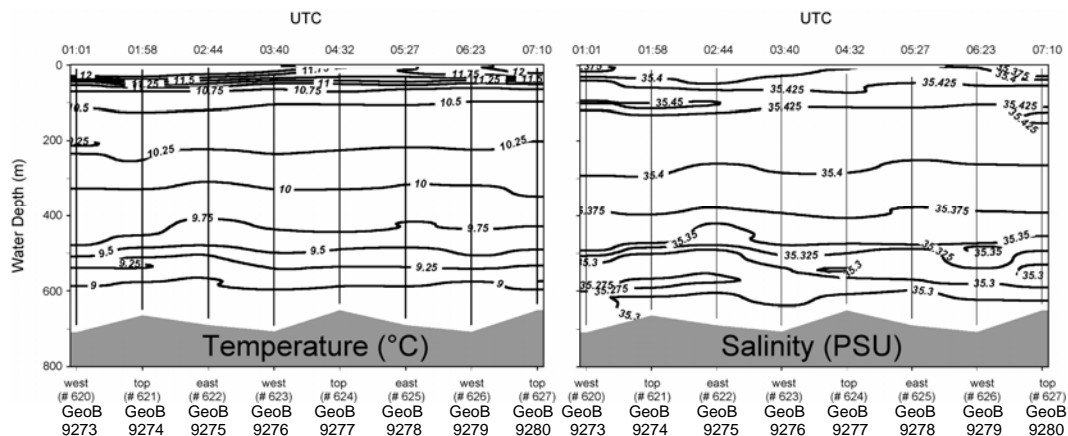


Fig. 3.17 CTD time-series across Franken Mound, West Rockall Bank. Temperature and salinity indicate the influence of tidal waves at the surface and the water mass boundary between NACW and the underlying water mass (~500–600 m) with increasing time (UTC on top, station and GeoB # and position relative to mound on bottom).

A time-series with eight CTD profiles across Franken Mound was achieved in a similar way as in the Belgica Mound Province with three positions (west–top–east), three measurements at each position (except for the eastern one with only two) and approximately 55 minutes interval in between each cast (Fig. 3.17).

The variability of temperature and salinity was similar to the observed variation of the eastern Porcupine Seabight. Salinity showed a minimum at ~580 m water depth at the beginning of the time-series, which vanished at around 4 h UTC and seemed to re-appear at the last station GeoB 9280). The influences of tidal waves, internal wave reflection and Ekman downwelling probably also play an important role as primary processes responsible for coral nourishment at the western Rockall Bank.

3.6.3.3 ROV Video Observations

(B. Dorschel, T. Beck, A. Foubert, J. Gault, A. Grehan, V. Ratmeyer, G. Ruhland)

At the West Rockall Bank, in total 4 dives (GeoB 9249, 9255-1, 9267, 9281-1) were performed. Two mound structures were investigated. The first dive targeted an unexplored structure named Bremen Mount. Three further dives were performed at Franken Mound (Fig. 3.27).

Bremen Mount is a newly discovered circular structure with ca. 3.5 km in diameter at the West Rockall Bank. It was investigated by a ROV transect running up its southern flank (GeoB 9249). The survey revealed that Bremen Mount is rather a seamount than a carbonate mound, with what is supposed to be basalts exposed at its lower flank. Towards the top, the basalt outcrops became covered by hemipelagic sediments. The flat summit area was characterised by hemipelagic sediments with drop stones being common. The occurrence of drop stones on the seafloor indicated that on Bremen Mount Holocene sequences had either not been deposited or were eroded later.

The second target area at the West Rockall Bank was the Franken Mound. Three dives (Fig 3.28) were carried out to explore the curved structure that measured 5.2 km in north-south direction and <1.5 km from east to west. The mound summit is at about 640 m water depth and its base at approximately 680 m water depth.

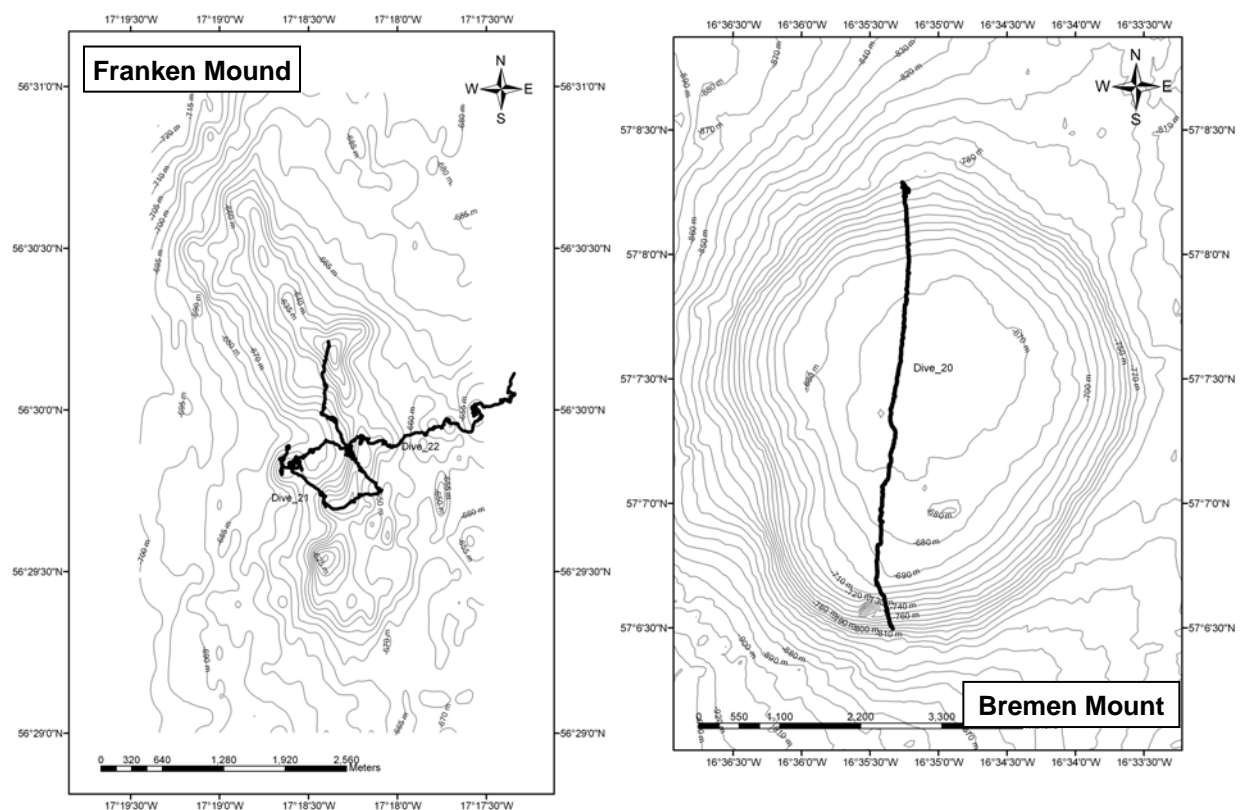


Fig. 3.18 Tracklines of QUEST dives 20 and 21 in the West Rockall Bank area (Franken Mound left, Bremen Mount right).

On Franken Mound ROV-dives of in total 27.25h were performed with dive GeoB 9255-1 lasting 9.5h. It started at the top of Franken Mound crossing its western flank in SW di-

rection, running up the flank in SE direction turning west at the crest following the rim of a west pointing spur. Dive GeoB 9267 (10.5h) crossed the mound on an east west transect.

The last dive, GeoB 9281-2 (7.25h), started at the mounds summit following its crest to the north. Franken Mound is an asymmetric shaped mound with steep flanks facing west and low inclined eastern flanks. The facies distribution also reflects this asymmetry. The western flanks are characterised by large banks of outcropping hardgrounds several meters high that gave this flank a step-like character. In contrast, the east-facing flank was covered by sandy sediments that formed sand ripples and sand waves. Small positive morphological structures further east off Franken Mound appeared to be outcrops of hardgrounds as well.

All observed hardgrounds were overgrown by numerous organisms as for example soft corals, hydrozoans and sponges. Extensive thickets of corals up to several meters high were observed on the hardgrounds east of Franken Mound and in the crest regions. Those thickets were mainly built by *Lophelia pertusa*, but *Madrepora oculata* was also common.

The abundant hardgrounds at Franken Mound and its irregular shape indicate that this mound is an overgrown relict structure rather than an actively growing carbonate mound. An early interpretation sees Franken Mound in a phase of erosion with the exposed hardgrounds providing a settling ground for recolonisation.

3.6.3.4 Surface Samples

(S. Noé, T. Beck, A. Foubert, A. Grehan)

Franken Mound located on an isolated topographic high at the western slope of Rockall Bank was discovered during M61-1 cruise by means of PARASOUND and OFOS surveys. The elongated carbonate mound arises from about 680 to 630 m water depth with an elevation of at least 50 m above the surrounding seabed. It shows a conspicuous asymmetric shape with a steeply inclined western flank forming some kind of steep-faced embayment on the deeper sea floor, and a largely straight, smoothly dipping eastern flank which grades into the surrounding off-mound sediments. ROV dive tracks crossing the mound in a north-south and east-west transect together with crab samples clearly revealed the west face to be composed of moderately to well-lithified hardgrounds consisting of pelagic micrites and of fossil reef framework, both forming steep, thick-bedded cliffs of several meters height. The eastern flank, on the other hand, is made up of poorly lithified nannoplankton oozes forming thin-bedded chalks which are exhumed from rippled calcareous sands largely covering this flank and the adjacent off-mound regions.

Facies distribution

Franken Mound and its surroundings were sampled by 11 box corer deployments, with 9 being successful. Their recovery clearly reflects the asymmetry of the mound and corresponds well with the ROV observations.

Summit and crest: Coral framework occurs on the summit and along the southward dipping crest down to 670 m water depth. The summit is covered by coral thickets (GeoB 9256), made up of dead to subfossil *Lophelia pertusa* and to a minor degree of *Madrepora oculata* (Fig. 3.19). The dead framework with its lower part being clogged by soft, fine-grained sediments is patchily overgrown by living *Madrepora* colonies and solitary corals (*Desmophyllum cristagalli* and *Caryophyllia sarsiae*). The scleractinians represent by far the most important frame builders. Tracing the crest towards the south (GeoB 9270) and

towards the north (GeoB 9268), the same framework of prevailing dead *Lophelia pertusa* and associated *Madrepora oculata* colonized by some living *Lophelia* specimens and solitary corals occurs also at greater water depths (668 or 656 m respectively; Fig. 3.19). Sampling in the area of expended growth of large living coral colonies has been avoided.

The dominance of dead framework on the summit and crest as recovered by selective box corer deployments contrasts the observations gained during three ROV dives and an OFOS survey carried out on M61-1 cruise which clearly revealed extended areas of living corals growing on top of dead corals and exposed hardgrounds on the central part of the crest, while dead framework showing a patchy distribution is restricted to the western flank.

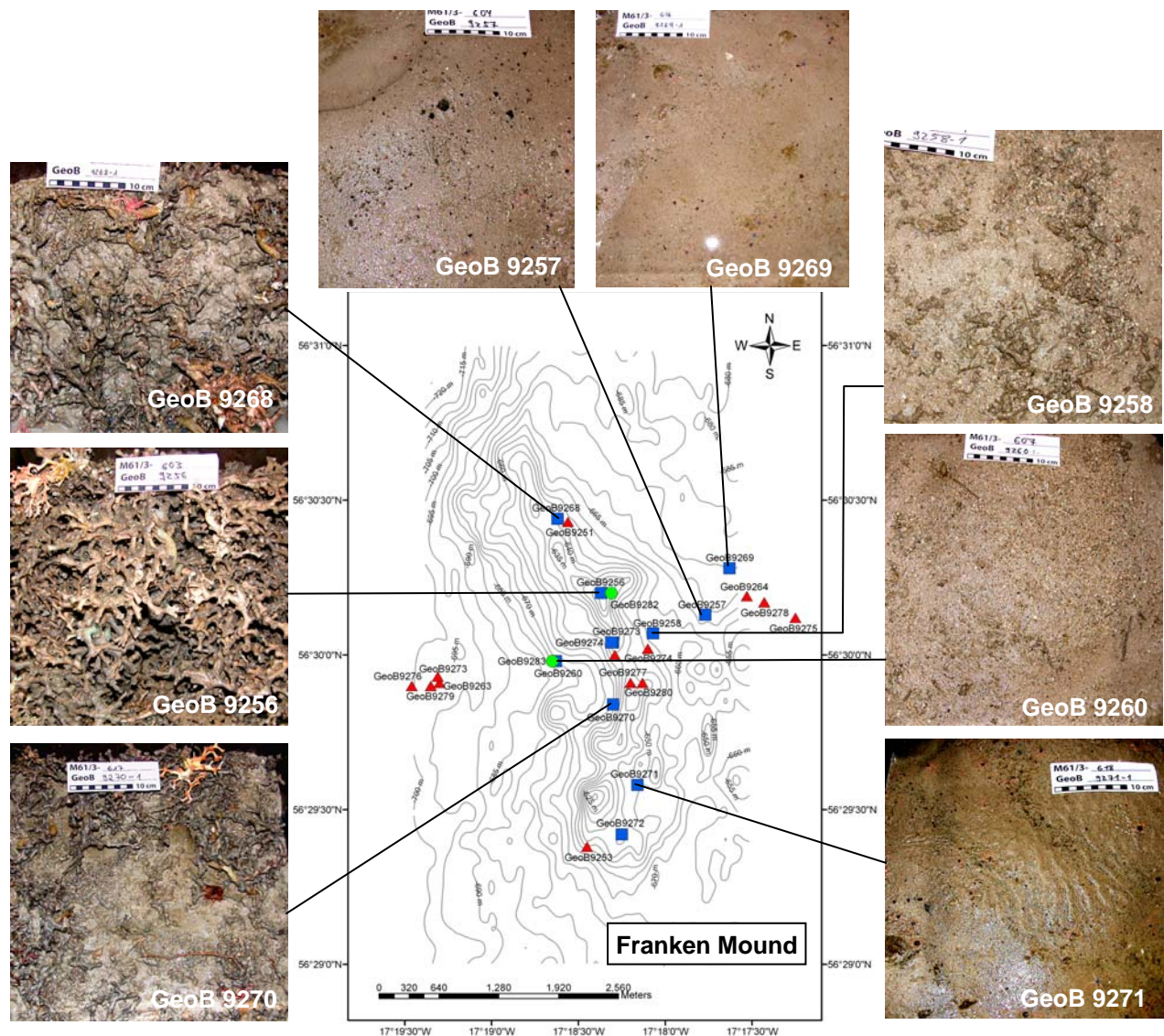


Fig. 3.19 Box core sampling stations and surface sediments in the Franken Mound area. Circles: gravity corer; quares: box corer; triangles: CTD.

Flank deposits: Due to the lack of sediment cover on the steeply dipping west face composed of lithified carbonates, box corers deployed on that flank did not provide any recovery (GeoB 9259-1, 9259-2). At the foot of slope, however, well-sorted calcareous sands containing some subfossil *Lophelia* fragments and carbonate pebbles eroded from the mound were recovered together with a few dropstones (GeoB 9260; Fig. 3.19). This facies type composed of fine-grained carbonate sands, some dropstones and scattered coral rubble largely resembles that of the eastern flank (GeoB 9258); the latter differs, however, by the fact that the coral rubble is composed of subfossil *Madrepora* fragments (Fig. 3.19).

Off-mound areas: Two box corers deployed east (GeoB 9257) and further northeast (GeoB 9269) of the carbonate mound revealed well-sorted calcareous sands with scattered dropstones and admixed shell fragments, serpulids and worm tubes; the sediment surfaces being covered by abundant living ophiuroids (Fig. 3.19). Off-mound sites to the south (GeoB 9271 and 9272) are characterized by well-sorted rippled sands composed of planktic foraminifers with admixed dark lithoclasts derived from dropstones (Fig. 3.19). Ripples showing wave lengths of 1-3 cm and a ripple height of the steep leeward slope of 0.3 cm are asymmetric, slightly curved and locally bifurcated, thus being formed by unidirectional currents. Invertebrate fauna, clearly dominated by ophiuroids, shows a low apparent diversity.

Sediment column

By analogy to the mounds of the Porcupine Seabight, samples taken on the summit and crest of Franken Mound revealed a moderate content of dead coral framework and subfossil coral rubble embedded in fine-grained sediments. Penetration depths of 15-28 cm were generally less than in the sandy facies of the deep mound flanks and off-mound areas which provided a recovery of more than 30 cm. Most sediment columns showed a distinct reduction horizon at 5-13 cm depth, characterized by the change from brownish to olive-grey colours.

The recovery of the coral-dominated on-mound cores taken on the summit and deeper crest revealed oxic and reducing zones in the sediment column. Box cores from the deep-flank and off-mound sites surrounding the carbonate mound showed three to four horizons, characterized by a thick oxic interval following beneath a thin reducing zone. Identified horizons are from top to base: (1) a coarse-grained oxic zone rich in skeletal grains; (2) a finer-grained reducing zone mainly composed of planktic foraminifera following beneath the reduction horizon; (3) a change to oxic Eh conditions documented by reddish-brown slightly cohesive muddy silts with abundant worm burrows blurring the boundary to the overlying reducing zone; (4) a zone of highly liquefied muddy silt of a prevailing oxic environment; this horizon recovered from the southern off-mound site revealed abundant siliceous sponge spicules deriving from the decay of a large hexactinellid sponge.

Biological features

On Franken Mound the framework-building scleractinians *Madrepora oculata* and *Lophelia pertusa* are, similar to the previous stations, associated with stylasterids (here with *Stylaster* sp.), hydroids, bryozoans, and other sessile organisms. In contrast to all other stations from coral habitats sampled during the cruise, the hexactinellid sponge *Aphrocallistes bocagei* does not occur on Franken Mound.

Very distinctive features in the fauna of Franken Mound are several polychaetes. A species of *Chaetopterus* was frequently present with its u-shaped tubes. These tubes are reminding the

parchment-like *Eunice* tubes but are recognizable by a clear narrowing towards both ends of the tube and by its typical u-shaped appearance. In the samples GeoB 9256, GeoB 9270 and GeoB 9268 also several specimens of feather-worms (Sabellidae) were found. Feather worms have not been reported from other areas studied during M61-3. The probably most striking characteristic of Franken Mound is the high abundance of bivalves with *Heteranemonia squamula* and *Hiatella arctica* by far dominating the other invertebrate fauna.

A very interesting observation was the finding of a sponge species growing on parts of living *Lophelia* that are normally covered by the mucus layer. The sponge seems to compete with the living tissue of *Lophelia*. In some *Lophelia* specimens an abnormal growth form was observed where that sponge settled on. This yellow encrusting sponge showed to be frequently co-occurring with a small actinian of orange colour which also seemed to be competing with living tissue of *Lophelia*. Some specimens were even growing into the thecae of living *Lophelia* polyps. These two species have also been found on a piece of *Lophelia* from Bremen Mound (ROV dive 20, GeoB 9249) and in sample GeoB 9287 from Connaught Mound.

Conclusions

Franken Mound formed on a topographic high which may in part be responsible for the strongly asymmetric flanks of the mound structure. Living coral framework was observed to cover wide areas along the crest, whereas the patchy coral cover on the steeply inclined western flank is mostly dead. This is in contrast to the mounds in the Belgica Mound Province, where the crests and flanks are being equally colonized by actively growing coral reef communities.

The flanks of Franken Mound are composed of lithified carbonates showing Fe/Mn-stained and strongly bored surfaces, thus representing real hardgrounds that are indicators of current erosion. Age determination and facies analysis of the sampled hardgrounds will help to answer the question if the outcropping hardgrounds forming the flanks of the structure are constructed by frame-building organisms, which would suggest that they belong to the carbonate mound itself, or if they are part of the topographic high, forming the basement of the actively growing mound. In the latter case they would represent a relict structure of Pleistocene or Tertiary age that was later colonized by mound-forming organisms.

3.6.3.5 Sediment Cores

(C. Hayn, A. Jurkiw, J. Kaiser, M. Lutz, F. Schewe, C. Wienberg)

In the region of the West Rockall Bank, we recovered two gravity cores from Franken Mound; one from the top of the mound (GeoB 9282) and one off-mound (GeoB 9283; Tab. 3.3). The core from the top of Franken Mound is composed of mud containing abundant bioclasts of primarily *Lophelia pertusa* and secondary *Madrepora oculata*, molluscs, echinoids and planktic foraminifers throughout the entire core. The off-mound core is dominated by a white to pale yellow/very pale brown clay with rare organisms (shells, planktic and benthic foraminifers) and occasional bioturbation. In particular, the lower part of the core shows semi-lithification.

3.6.4 Working Area 4: Northern Porcupine Bank

3.6.4.1 Bathymetry and Sampling Stations

(A. Foubert, L. Beuck, J. Gault)

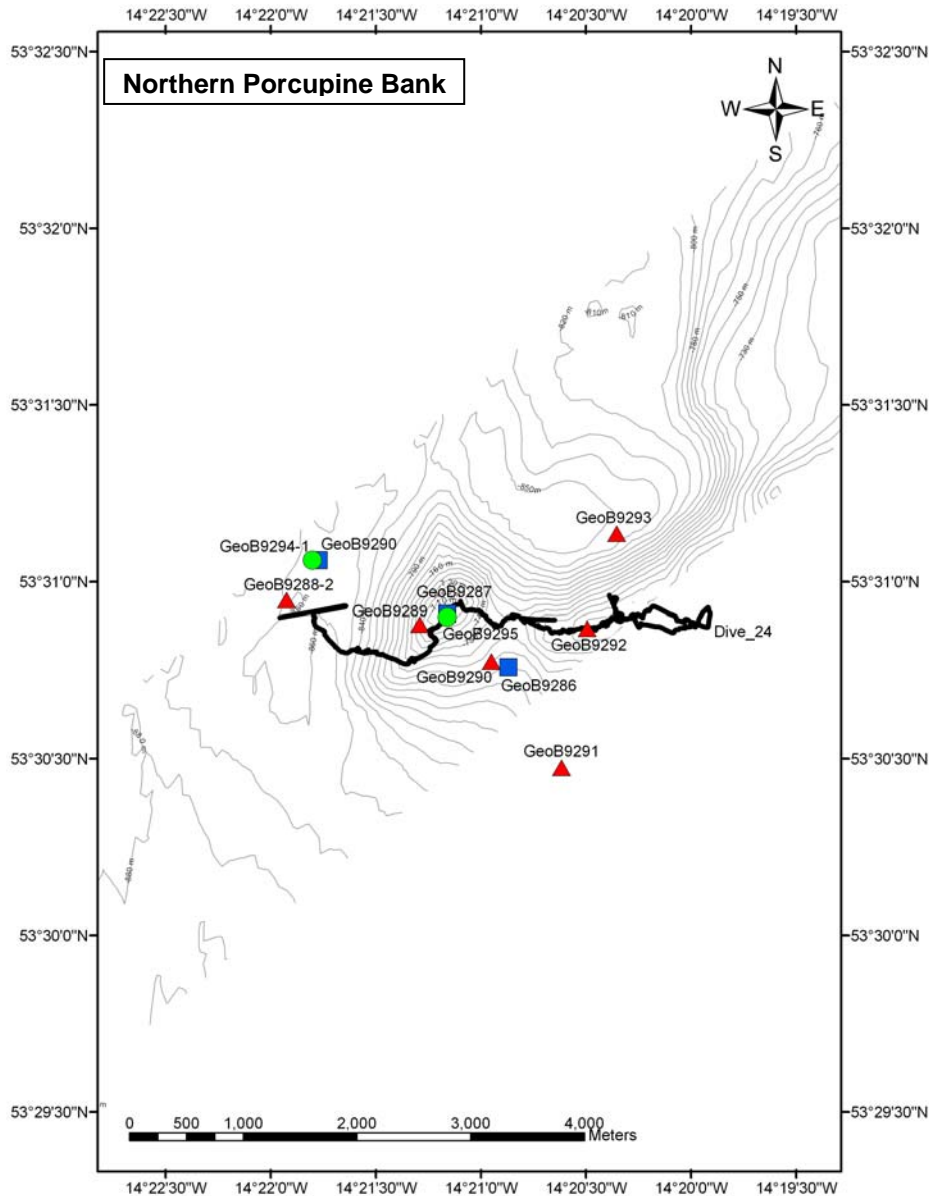


Fig. 3.20 Map of bathymetry, QUEST dives (bold line) and sampling stations along the Northern Porcupine Bank. Circles: gravity corer; squares: box corer; triangles: CTD.

3.6.4.2 Hydrography along the Northern Porcupine Bank

(A. Rüggeberg, L. Dodds)

Along the northern Porcupine Bank, six CTD casts were taken to analyse the water mass distribution in NS-transects across Connaught Mound and a submarine ridge further east. A typical CTD profile is illustrated in Fig. 3.21, presenting a water mass signature similar to a combination of previous analysed sites (Porcupine Seabight and West Rockall Bank). The surface water was slightly colder and less saline, as found within the Seabight, further to the

southeast. The water mass underlying the Surface water (SW) showed a continuous decrease in temperature and salinity down to 9°C and 35.25 psu, indicating the contribution of both ENAW down to ~570 m and NACW between 600 and 780 m water depth (Fig. 3.21). The slight increase in salinity below 800 m may indicate a minor contribution of MOW or another high saline water mass similar to the West Rockall Bank site, although the general circulation of intermediate water masses is described to flow northwest passing the Rockall Bank further west (Bower et al., 2002).

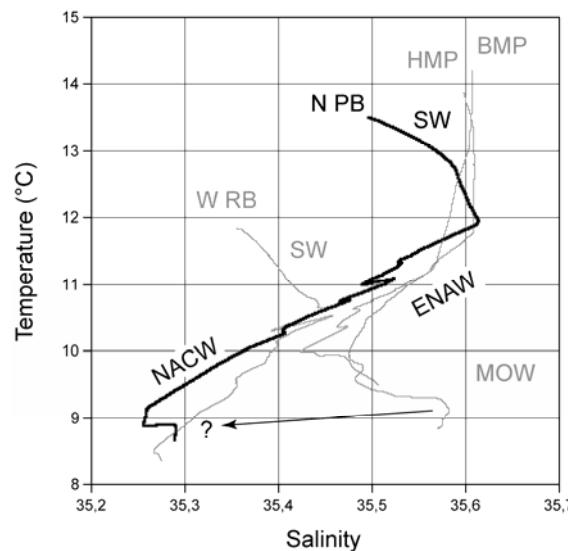


Fig. 3.21 TS-plot of a typical CTD profile of the Northern Porcupine Bank (NPB, GeoB 9288-2). SW: Surface Water; ENAW: Eastern North Atlantic Water; NACW: North Atlantic Central Water.

3.6.4.3 ROV Video Observations

(B. Dorschel, T. Beck, A. Foubert, J. Gault, A. Grehan, V. Ratmeyer, G. Ruhland)

At the Northern Porcupine Bank a feature that consisted of a small mound (Connaught Mound) extending into a scarp towards the north-east was investigated. The mound extends ~3 km in north-south direction and 1.7 km in east-west direction and rises 180 m above the surrounding seafloor (summit at 680 m water depth). The scarp continues east of the mound in a ~2.6 km long curve towards the north. At the scarp the water depth increases rapidly from 680 to 900 m.

Dive GeoB 9267 started west of the mound continued to the top, went east of the scarp crest, changed direction to north-west, crossed the scarp crest and descended the steep western slope (Fig. 3.20) and lasted for 11:30h. During that dive large coral colonies were found in the summit area of the mound and at the scarp crest. These settled on exposed hardgrounds which were common at the small mound as well as at the scarps crest and on the scarp itself. The hardgrounds were structured in decimetre to meter size banks, some showing internal structures as for example coral frameworks. The hardgrounds were sampled on a profile down the scarp using the ROV manipulators.

Comparable to the Franken Mound, the structure on the northern Porcupine Bank appeared to be a relict structure rather than a growing mound. The high abundance of hardgrounds indicate erosive current regimes at the location at present. Indications for active sedimentation had not been found in the mound and scarp area.

3.6.4.4 Surface Samples

(S. Noé, T. Beck, A. Foubert, A. Grehan)

On the northern slope of Porcupine Bank, a small coral-topped carbonate mound (Connaught Mound) extending into a scarp towards the northeast is exposed in the bathymetric interval of 870 m (western slope) and 800 m (eastern slope) with a summit at 700 m water depth. Hence the structure reaches an elevation of about 150 m over the seafloor to the west. The mound was sampled by three box corer deployments: one from the summit (GeoB 9287-1), one from the south-east (GeoB 9286-1) and one from the northwest (GeoB 9288-1) of the mound (Fig. 3.22).

Facies distribution

The summit is colonized by live *Lophelia pertusa* and associated invertebrate fauna. Underneath the living reef surface dead *Lophelia* framework is clogged by poorly sorted calcareous sands. The sampled sediment column of 12 cm thickness does not show any distinct reduction horizon due to strong bioturbation; a colour change from brownish to more olive-grey is visible, however. Underlying hardgrounds forming the substratum for the corals to settle on may have caused the low penetration of the box corer.

Poorly sorted sands with some dropstones characterized the site located at the upper slope southeast of the mound. An unusual abundance of living brachiopods and siliceous sponge spicules observed in the oxic sediment horizon demands to add a new facies type to the cool-water carbonate classification which is herewith described as BRACHIOHYALOSPONGE facies. Sediment recovery of 35 cm thickness reveals 3 horizons: the brownish oxic zone reaching down to 14 cm is rich in brachiopods and siliceous sponge spicules and shows a fining- and darkening-downward trend. Beneath a distinct reduction horizon, an olive-grey muddy silt grades into a dark-grey silty mud rich in organic matter.

The sample from the northwestern base of the mound slope revealed a dropstone pavement on top of well-sorted sands, colonized by stylasterids (*Pliobothrus symmetricus*) and abundant living ophiuroids. This off-mound facies resembles the sediments in the surroundings of Franken Mound. Sediment column of 12 cm thickness reveals a coarsening-upward succession from muddy silt to medium sand, lacking any distinct colour change indicative for changes in the redox state.

Biological features

The coral habitat fauna on Connaught Mound, sampled with box core GeoB 9287, showed to be somehow intermediate between the previous study sites. The coral framework was exclusively built up of *Lophelia*. Sands clogged the dead parts of the framework. Sessile organisms including stylasterids, sea anemones and hydrozoans, were commonly growing on dead coral fragments. The vagile fauna was represented by several ophiuroids, a stalked crinoid (presumably the same species that was found on one of the settlement plates mounted on the current meters from Galway Mound), two specimens of *Porania pulvillus* (Asteroidea) and the brachyuran *Bathynectes maravigna*. Also present were some gastropods, polychaetes and a large number of very juvenile specimens of the crab *Rochinia carpenteria*. The juvenile *Rochinia* were of about the same size than the ones found on Propeller Mound. Very characteristic features were numerous amphipod (Ampeliscidae) tubes attached in the thecae of dead *Lophelia*. Such amphipod tubes have not been reported from any other station of the whole M 61 cruise. The large living *Lophelia* colony

collected at site GeoB 9287-1 was settled by numerous actinians sitting very close to the thecae of living polyps. Most probably it is the same species as on Franken Mound. In coincidence with Franken Mound, this actinian is here co-occurring with a yellow encrusting sponge growing on living parts of *Lophelia*.

Conclusions

Carbonate mound facies from the Northern Porcupine Bank sloping towards the Rockall Trough more closely resembles the sedimentary pattern exposed on Franken Mound at West Rockall Bank than that within the Porcupine Seabight. This may be controlled by oceanographic properties of the intermediate water masses and current patterns prevailing at depths of carbonate mound growth.

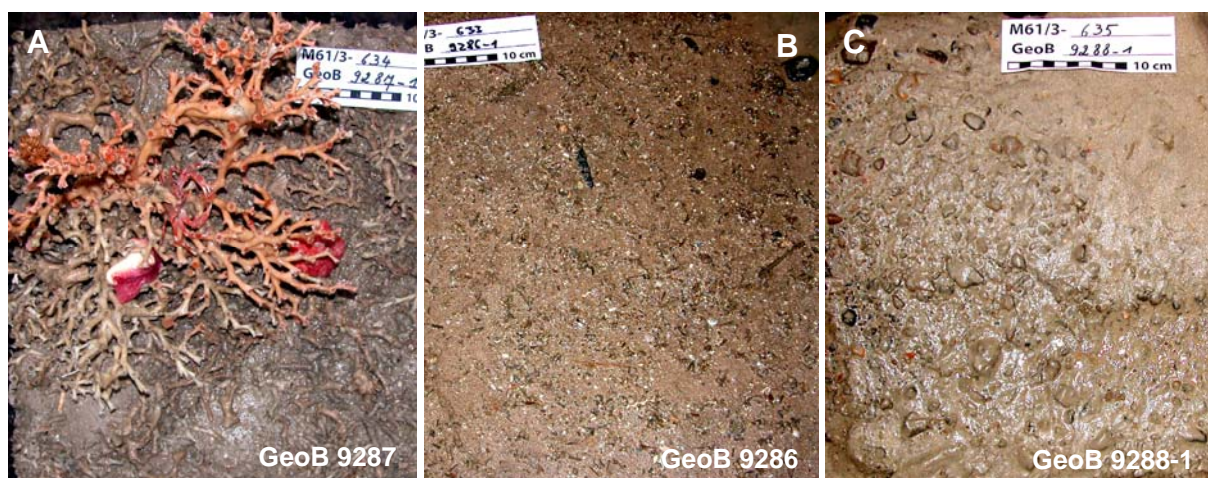


Fig. 3.22 Box core surfaces collected from (A) the summit, (B) southeastern off-mound and (C) northwestern off-mound areas of Connaught Mound.

3.6.4.5 Sediment Cores

(C. Hayn, A. Jurkiw, J. Kaiser, M. Lutz, F. Schewe, C. Wienberg)

At the northern part of the Porcupine Bank two gravity cores were retrieved; one from the top of Connaught Mound (GeoB 9294-1) and one from an off-mound setting (GeoB 9295), however, with the off-mound core yielding no sediment recovery (Tab. 3.3). The core from the top of the Connaught Mound is like the other top mound cores from Galway Mound and Franken Mound. It is primarily made up of silty to fine sandy mud which contains bioclasts dominated by fragments of *Lophelia pertusa*.

3.7 Metereological Station (DWD)

(G. Kahl)

When R/V METEOR left Cork, Ireland, on June 4th, 2004, a high of 1028 hPa was situated south of Ireland and a gale center of around 990 hPa over the southern rim of the Irminger Sea. There were just 15 hours of sailing after passing Cobh to reach the “Galway Mound” in Porcupine Seabight’s Belgica Mound Province. The vessel was accompanied by light southerly winds. These favourable conditions extended into June 6th. Until then, a low had moved from the area of Newfoundland to 50 North 33 West, intensifying to 995 hPa thereby. A flat low south of the area had been incorporated in the flow around the gale center. Hence, southeasterly winds of 5 Bft were reported on June 7th, veering southwest and abating 4 Bft soon while the flat low passed the ship. On June 8th, R/V METEOR moved to the “Propeller Mound”. Southeasterly strong winds of 6 Bft for a few hours while a frontal trough was passing did not inhibit sampling. The winds then veered to southwesterly 5 Bft.

R/V METEOR went on to the Rockall Bank, arriving there on June 10th. Southerly strong winds of 6 Bft while on the way brought no problems. The third working area welcomed the research vessel with light and variable conditions, being due to the fact that the gale center mentioned earlier had moved to Rockall Bank, too. The low then moved on to Scotland and further eastward. During June 11th, the vessel experienced northwesterlies of 5 Bft, abating 4 Bft and backing southwest.

The next day began with light westerly winds, backing southerly increasing 5 Bft in the evening. Meanwhile, another high 1032 hPa had established itself south and southwest of Ireland and on the other hand a gale center had gone up the west coast of Greenland, thereby inducing another one on the southeastern coast of Greenland, intensity being 990 hPa on June 13th. A frontal trough extending from the gale center was swinging towards Rockall Bank, and on the other hand the high was forecast to put on some more strength, 1036 hPa appearing on the forecast maps. In consequence, R/V METEOR reported southwesterly near gales of 7 Bft with gales 8 Bft in the forecast. As such conditions would have made further dives of the “QUEST” impossible, it was decided to move to a position on Porcupine Bank where better weather conditions were expected. When the ship arrived at the new position on June 15th, southwesterlies were down to 4 to 5 Bft.

On the frontal trough waves were developing and one of these managed to intensify into a gale center of its own. Central pressure was 1010 hPa on June 15th at 57 North 28 West. From there, the gale center moved to Scotland by June 17th and later further on to Northern Germany, steadily deepening. On the other hand, the high south of Ireland finally weakened.

These developments were of waning interest because time was running out, and when there were strong westerlies of 6 Bft on June 16th, sampling had to stop in favour of the course being set to Ponta Delgada on Sao Miguel in the archipelago of the Azores. The voyage there began by crossing of what was left of the high which had been such a dominating feature of the synoptic chart for quite a few days. Forecasts then saw a gale center moving southeast from the Newfoundland area, swinging east north of the Azores so that the ship may have to report strong southeasterly winds veering southwest and then just before calling port strong to gale force westerlies.

3.8 Station List M61-3

Tab. 3.5 Station List M61-3.

Station No.		Device	Cast No.	Area	Date (dd/mm/yy)	Time (UTC)	Coordinates		Depth (m)	Observations and subsamples
GeoB	METEOR						Lat. °N	Long. °W		
9200	547	CTD	1	BMP; S of Galway Mound	05/06/2004	05:30	51°56.75'	11°45.11'	890	12 bottles; see rosette protocol
9201	548	CTD	2	BMP; Top of Galway Mound	05/06/2004	06:34	51°27.10'	11°45.06'	810	13 bottles; see rosette protocol
9202-1	549-1	Mooring	1	BMP; Galway Mound	05/06/2004	08:25	51°27.14'	11°45.17'	828	
9202-2	549-2	HN	1	BMP; Galway Mound	05/06/2004	08:30	51°27.14'	11°45.11'	846	
9203	550	ROV+GAPS (dive 16)	1	BMP; Galway Mound	05/06/2004	09:48	51°26.70'	11°45.03'	892	3 sensors recovered
9204	551	GKG	1	BMP; S of Galway Mound	05/06/2004	21:44	51°26.94'	11°45.16'	8379	15 cm recovery; Madrepora, Lophelia, Aphrocallistes, little sediment
9205	552	GKG	2	BMP; Top of Galway Mound	05/06/2004	22:49	51°27.04'	11°45.12'	810	16 cm recovery; living and dead coral framework
9206	553	GKG	3	BMP; NE of Galway Mound	05/06/2004	23:47	51°27.31'	11°45.12'	857	box tilted, no section; living corals, little sediment, only surface sediment samples
9207	554	CTD	3	BMP; N of Galway Mound	06/06/2004	00:54	51°27.61'	11°45.31'	920	9 bottles; see rosette protocol
9208	555	CTD	4	BMP; W of Galway Mound	06/06/2004	01:56	51°27.13'	11°45.44'	932	see rosette protocol
9209-1	556-1	GKG	4	BMP; W of Galway Mound, off-mound	06/06/2004	02:51	51°26.92'	11°45.84'	983	not released
9209-2	556-2	GKG	5	BMP; W of Galway Mound, off-mound	06/06/2004	03:40	51°26.89'	11°45.81'	982	27 cm recovery; many corals and sponges, little sediment
9210-1	557-1	GKG	6	BMP; Top of Galway Mound	06/06/2004	04:49	51°27.11'	11°45.20'	810	not released; 1 coral on gear
9210-2	557-2	GKG	7	BMP; W of Galway Mound	06/06/2004	05:34	51°27.08'	11°45.25'	833	not released; coral rubble on box
9210-3	557-3	GKG	8	BMP; W of Galway Mound	06/06/2004	06:11	51°27.09'	11°45.24'	828	released but no recovery
9211-1	558-1	HN	2	BMP; Galway Mound	06/06/2004	06:45	51°27.10'	11°45.20'	804	start: 06:45, end: 19:10
9211-2	558-2	ROV (dive 17)	2	BMP; Galway Mound	06/06/2004	09:38	51°27.10'	11°45.20'	795	ROV technical problems, dive cancelled
9212	559	SL	1	BMP; Top of Galway Mound	06/06/2004	16:09	51°27.13'	11°44.99'	847	6 m tube; 193 cm recovery; 2 segments
9213	560	SL	2	BMP; Top of Galway Mound	06/06/2004	17:07	51°27.09'	11°45.16'	793	6 m tube; 515 cm recovery; 6 segments
9214	561	SL	3	BMP; Galway Mound	06/06/2004	18:15	51°27.06'	11°45.28'	857	6 m tube; 489 cm recovery; 5 segments
9215	562	CTD	5	BMP; E of Galway Mound	06/06/2004	19:38	51°27.20'	11°44.44'	923	4 bottles; bottles 5-6 did not release
9216-1	563-1	GKG	9	BMP; E of Galway Mound	06/06/2004	20:29	51°27.09'	11°44.81'	890	30 cm recovery; living and coral framework, little sediment

Tab. 3.5 (continued) Station List M61-3.

Station No.		Device	Cast No.	Area	Date (dd/mm/yy)	Time (UTC)	Coordinates		Depth (m)	Observations and subsamples
GeoB	METEOR						Lat. °N	Long. °W		
9216-2	563-2	GKG	10	BMP; E of Galway Mound	06/06/2004	21:36	51°27.14'	11°44.79'	903	not released
9217	564	GKG	11	BMP; Galway Mound	06/06/2004	22:37	51°27.35'	11°44.77'	925	released but no recovery
9218	565	GKG	12	BMP; N of Galway Mound	06/06/2004	23:39	51°27.47'	11°45.33'	889	20 cm recovery; coral framework, mostly dead
9219	566	GKG	13	BMP; E of Galway Mound	07/06/2004	01:44	51°27.05'	11°45.40'	920	18 cm recovery; living coral frame work
9220-1	567-1	GKG	14	BMP; Galway Mound, off-mound	07/06/2004	02:46	51°26.69'	11°45.04'	891	8 cm recovery; sand with some coral rubble
9220-2	567-2	GKG	15	BMP; Galway Mound, off-mound	07/06/2004	03:47	51°26.68'	11°45.04'	892	6 cm recovery; sand with some coral rubble
9221	568	PS	1	BMP; Galway Mound	07/06/2004	04:57	51°26.90'	11°48.50'	1040	Parasound transect start
					07/06/2004	07:21	51°27.60'	11°46.60'	997	Parasound transect end
9222-1	569-1	SL	4	BMP; Galway Mound	07/06/2004	08:11	51°27.48'	11°45.39'	900	6 m tube; 376 cm recovery; 4 segments
9222-2	569-2	HN	3	BMP; Galway Mound	07/06/2004	08:04	51°27.50'	11°45.30'	898	
9223	570	SL	5	BMP; Galway Mound	07/06/2004	09:30	51°26.90'	11°45.10'	839	6 m tube, 465 cm recovery; 5 segments
9224	571	Mooring	2	BMP; Galway Mound	07/06/2004	11:05	51°27.20'	11°45.10'	852	Deployment from June 6, 2004, recovered
9225	572	SL	6	BMP; Galway Mound	07/06/2004	12:06	51°26.76'	11°48.55'	1072	12 m tube m; 376 cm recovery; 4 segments
9226-1	573-1	SL	7	BMP; Galway Mound	07/06/2004	13:57	51°27.75'	11°43.03'	887	12 m tube; 251 cm recovery; 3 segments
9226-2	573-2	GAPS	1	BMP; Galway Mound	07/06/2004	15:10				GAPS USBL test
9227	574	GKG	16	BMP; E of Poseidon Mound	07/06/2004	19:09	51°27.40'	11°41.70'	731	41 cm recovery; dropstone pavement on fine sediment
9228	575	GKG	17	BMP; NE of Poseidon Mound	07/06/2004	20:08	51°27.70'	11°41.59'	752	10 cm recovery; coral rubble on little sediment
9229	576	GKG	18	BMP; SSE of Poseidon Mound	07/06/2004	21:10	51°26.61'	11°41.77'	772	36 cm recovery; dropstone pavement on fine sediment
9230	577	GKG	19	BMP; Poseidon Mound	07/06/2004	22:24	51°27.09'	11°44.80'	899	12 cm recovery; coral/sponge framework, little sediment
9231	578	CTD	6	BMP; Top of Galway Mound	07/06/2004	23:45	51°27.03'	11°45.82'	978	see rosette protocol
9232	579	CTD	7	BMP; E of Galway Mound	08/06/2004	00:45	51°26.98'	11°45.10'	837	see rosette protocol
9233	580	CTD	8	BMP; W of Galway Mound	08/06/2004	01:42	51°27.13'	11°44.57'	929	see rosette protocol
9234	581	CTD	9	BMP; W of Galway Mound	08/06/2004	02:45	51°26.98'	11°45.93'	987	2 bottles; see rosette protocol
9235	582	CTD	10	BMP; Top of Galway Mound	08/06/2004	03:45	51°27.10'	11°45.22'	820	2 bottles; see rosette protocol
9236	583	CTD	11	BMP; E of Galway Mound	08/06/2004	04:42	51°27.22'	11°44.39'	922	2 bottles; see rosette protocol
9237	584	CTD	12	BMP; W of Galway Mound	08/06/2004	05:45	51°27.08'	11°45.78'	972	2 bottles; see rosette protocol
9238	585	CTD	13	BMP; Top of Galway Mound	08/06/2004	06:43	51°27.08'	11°45.16'	805	2 bottles; see rosette protocol
9239-1	586-1	ROV	3	BMP; Top of Galway Mound	08/06/2004	07:25	51°27.10'	11°45.20'	781	Dive 18, 4 sensors recovered; 1 net sample

Tab. 3.5 (continued) Station List M61-3.

Station No.		Device	Cast No.	Area	Date (dd/mm/yy)	Time (UTC)	Coordinates		Depth (m)	Observations and subsamples
GeoB	METEOR						Lat. °N	Long. °W		
9239-2	586-2	HN	4	BMP; Top of Galway Mound	08/06/2004	14:18	51°26.90'	11°45.00'		start: 14:18, end: 21:03
9240	587	ROV	4	BMP; S of Poseidon Mound	08/06/2004	17:50	51°24.30'	11°41.20'	700	Dive 19, samples of hardgrounds
9241	588	CTD	14	HMP; N of Propeller Mound	09/06/2004	03:12	52°09.34'	11°45.94'	805	2 bottles; see rosette protocol
9242	589	CTD	15	HMP; Top of Propeller Mound	09/06/2004	04:02	52°08.89'	12°46.27'	728	2 bottles; see rosette protocol
9243	590	CTD	16	HMP; S of Propeller Mound	09/06/2004	05:01	52°08.24'	12°46.41'	732	2 bottles; see rosette protocol
9244	591	GKG	20	HMP; S of Propeller Mound	09/06/2004	06:01	52°08.61'	12°46.34'	758	not released
9245	592	GKG	21	HMP; SE-flank Propeller Mound	09/06/2004	06:59	52°08.84'	12°47.14'	769	40 cm recovery; fine-grained sediment
9246-1	593-1	GKG	22	HMP; Top of Propeller Mound	09/06/2004	07:54	52°08.17'	12°46.20'	756	tipped over
9246-2	593-2	GKG	23	HMP; Top of Propeller Mound	09/06/2004	08:38	52°09.00'	12°46.22'	746	not released
9246-3	593-3	GKG	24	HMP; Top of Propeller Mound	09/06/2004	09:17	52°08.99'	12°46.20'	750	24 cm recovery; fine-grained sediment with coral rubble
9246-4	593-4	HN	5	HMP; Propeller Mound	09/06/2004	09:08	52°09.00'	12°46.20'		start: 09:08, end: 19:36
9247	594	PS	2	HMP; Propeller Mound	09/06/2004	10:02	52°08.60'	12°46.80'	804	Parasound transect start
					09/06/2004	10:24	52°09.60'	12°45.30'	873	Parasound transect end
9248	595	HS	1	WRB; Bremen Mound	10/06/2004	14:13	57°05.20'	16°35.50'	933	Hydrosweep transect start
					10/06/2004	16:43	57°05.80'	16°36.60'	940	Hydrosweep transect end
9249	596	ROV	5	WRB; Bremen Mound	10/06/2004	18:42	57°06.40'	16°35.30'	803	Dive 20, stopped, no visibility
9250	597	CTD	17	WRB; N of Franken Mound	11/06/2004	04:47	56°31.25'	17°18.94'	729	2 bottles; see rosette protocol
9251	598	CTD	18	WRB; N-flank Franken Mound	11/06/2004	05:36	56°30.43'	17°18.56'	661	6 bottles; see rosette protocol
9252	599	CTD	19	WRB; Top Franken Mound	11/06/2004	06:24	56°30.00'	17°18.29'	655	18 bottles; see rosette protocol
9253	600	CTD	20	WRB; S-flank Franken Mound	11/06/2004	07:27	56°29.38'	17°18.45'	657	6 bottles; see rosette protocol
9254-1	601-1	CTD	21	WRB; S of Franken Mound	11/06/2004	08:24	56°28.80'	17°18.45'	690	2 bottles; see rosette protocol
9254-2	601-2	HN	6	WRB; Franken Mound	11/06/2004	09:06	56°28.80'	17°00.80'	681	
9255-1	602-1	ROV	6	WRB; Franken Mound	11/06/2004	09:46	56°30.16'	17°18.16'	607	Dive 21, mapping, sampling coral and carbonate crusts
9255-2	602-2	HN	7	WRB; Franken Mound	11/06/2004	10:00	56°30.22'	17°18.30'	641	start: 10:00, end: 10:30; at 10 m water depth
9255-3	602-3	HN	8	WRB; Franken Mound	11/06/2004	18:25	56°29.87'	17°18.66'		start: 18:25, end: 18:50; at 10 m water depth
9256	603	GKG	25	WRB; Top of Franken Mound	11/06/2004	20:07	56°30.20'	17°18.37'	629	28 cm recovery; coral framework, mostly dead
9257	604	GKG	26	WRB; E of Franken Mound	11/06/2004	20:58	56°30.13'	17°17.77'	678	33 cm recovery; fine-grained sediment with dropstones
9258	605	GKG	27	WRB; Franken Mound	11/06/2004	21:55	56°30.07'	17°18.07'	674	22 cm recovery; fine-grained sediment with coral rubble

Tab. 3.5 (continued) Station List M61-3.

Station No.		Device	Cast No.	Area	Date (dd/mm/yy)	Time (UTC)	Coordinates		Depth (m)	Observations and subsamples
GeoB	METEOR						Lat. °N	Long. °W		
9258	605	GKG	27	WRB; Franken Mound	11/06/2004	21:55	56°30.07'	17°18.07'	674	22 cm recovery; fine-grained sediment with coral rubble
9259-1	606-1	GKG	28	WRB; W of Franken Mound	11/06/2004	22:41	56°30.04'	17°18.30'	678	released but no recovery
9259-2	606-2	GKG	29	WRB; W of Franken Mound	11/06/2004	23:16	56°30.04'	17°18.31'	656	not released
9260	607	GKG	30	WRB; W of Franken Mound	11/06/2004	23:59	56°29.98'	17°18.63'	683	28 cm recovery; fine-grained sediment with dropstones
9261	608	CTD	22	WRB; W of Franken Mound	12/06/2004	02:12	56°29.54'	17°22.32'	757	2 bottles; see rosette protocol
9262	609	CTD	23	WRB; Franken Mound, W	12/06/2004	03:11	56°29.85'	17°20.35'	734	2 bottles; see rosette protocol
9263	610	CTD	24	WRB; Franken Mound, W	12/06/2004	04:04	56°29.91'	17°19.30'	709	6 bottles; see rosette protocol
9264	611	CTD	25	WRB; E of Franken Mound	12/06/2004	05:01	56°30.19'	17°17.53'	689	6 bottles; see rosette protocol
9265	612	CTD	26	WRB; E of Franken Mound	12/06/2004	05:55	56°30.26'	17°16.01'	671	2 bottles; see rosette protocol
9266	613	CTD	27	WRB; E of Franken Mound	12/06/2004	06:45	56°30.36'	17°14.48'	658	2 bottles; see rosette protocol
9267	614	ROV	7	WRB; Franken Mound	12/06/2004	08:25	56°30.30'	17°17.30'	685	Dive 22, mapping and sampling
9268	615	GKG	31	WRB; N of Franken Mound	12/06/2004	19:35	56°30.44'	17°18.62'	656	18 cm recovery; coral frameowrk, mostly dead
9269	616	GKG	32	WRB; NW of Franken Mound	12/06/2004	20:32	56°30.28'	17°17.63'	686	35 cm recovery; fine-grained sediment with dropstones
9270	617	GKG	33	WRB; SW of Franken Mound	12/06/2004	21:26	56°29.84'	17°18.30'	668	15 cm recovery; coral framework, mostly dead
9271	618	GKG	34	WRB; SE of Franken Mound, off-mound	12/06/2004	22:16	56°29.58'	17°18.16'	664	33 cm recovery; rippled sands with dropstones
9272	619	GKG	35	WRB; S of Franken Mound, off-mound	12/06/2004	23:03	56°29.42'	17°18.25'	651	25 cm recovery; rippled sands with dropstones
9273	620	CTD	28	WRB; W of Franken Mound	13/06/2004	01:01	56°29.93'	17°19.31'	709	no data
9274	621	CTD	29	WRB; Top Franken Mound	13/06/2004	01:58	56°30.02'	17°18.10'	652	no samples
9275	622	CTD	30	WRB; E of Franken Mound	13/06/2004	02:44	56°30.12'	17°17.25'	690	no samples
9276	623	CTD	31	WRB; W of Franken Mound	13/06/2004	03:40	56°29.90'	17°19.46'	709	no samples
9277	624	CTD	32	WRB; Top Franken Mound	13/06/2004	04:32	56°29.91'	17°18.20'		no samples
9278	625	CTD	33	WRB; E of Franken Mound	13/06/2004	05:27	56°30.17'	17°17.43'	690	no samples
9279	626	CTD	34	WRB; W of Franken Mound	13/06/2004	06:23	56°29.90'	17°19.35'	708	no samples
9280	627	CTD	35	WRB; Top Franken Mound	13/06/2004	07:10	56°29.91'	17°18.13'	641	no samples
9281-1	628-1	ROV	8	WRB; West Rockall Bank	13/06/2004	08:45	56°29.90'	17°18.20'	651	Dive 23, mapping and sampling
9281-2	628-2	HN	9	WRB; West Rockall Bank	13/06/2004	11:50	56°30.20'	17°18.40'	633	start: 11:50, end: 15:24
9282	629	SL	8	WRB; Top Franken Mound	13/06/2004	16:03	56°30.20'	17°18.31'	643	6 m tube; 169 cm recovery; 2 segments
9283	630	SL	9	WRB; Franken Mound	13/06/2004	16:45	56°29.98'	17°18.65'	684	6 m tube; 489 cm recovery; 5 segments

Tab. 3.5 (continued) Station List M61-3.

Station No.		Device	Cast No.	Area	Date (dd/mm/yy)	Time (UTC)	Coordinates		Depth (m)	Observations and subsamples
GeoB	METEOR						Lat. °N	Long. °W		
9284	631	PS	3	NPB; Northern Porcupine Bank	14/06/2004	16:15	53°37.60'	14°27.50'	1260	Parasound transect start
					15/06/2004	07:15	53°32.20'	14°18.50'	671	Parasound transect end
9285-1	632-1	ROV		NPB; Connaught Mound	15/06/2004	08:00	53°30.99'	14°22.00'	876	Dive 24, mapping and sampling
9285-2	632-2	HN	10	NPB; Connaught Mound	15/06/2004	14:00	53°30.91'	14°19.91'	739	
9286	633	GKG	36	NPB; SE of Connaught Mound	15/06/2004	19:44	53°30.76'	14°20.87'	799	35 cm recovery; fine-grained sediment with dropstones
9287	634	GKG	37	NPB; Top of Connaught Mound	15/06/2004	20:46	53°30.91'	14°21.16'	696	12 cm recovery; living and dead coral framework
9288-1	635-1	GKG	38	NPB; NW of Connaught Mound	15/06/2004	21:41	53°31.06'	14°21.77'	870	12 cm recovery; dropstone pavement on fine sediment
9288-2	635-2	CTD	36	NPB; NW of Connaught Mound	15/06/2004	23:36	53°30.94'	14°21.92'	873	see rosette protocol
9289	636	CTD	37	NPB; Top of Connaught Mound	16/06/2004	00:31	53°30.88'	14°21.29'	727	see rosette protocol
9290	637	CTD	38	NPB; SE of Connaught Mound	16/06/2004	01:30	53°30.77'	14°20.95'	790	no data
9291	638	CTD	39	NPB; E of Connaught Mound	16/06/2004	02:50	53°30.47'	14°20.61'	827	see rosette protocol
9292	639	CTD	40	NPB; Top of Connaught Mound	16/06/2004	03:43	53°30.86'	14°20.49'	703	no data
9293	640	CTD	41	NPB; N of Connaught Mound	16/06/2004	04:41	53°31.13'	14°20.35'	856	see rosette protocol
9294-1	641-1	SL	10	NPB; Connaught Mound, off-mound	16/06/2004	05:39	53°31.06'	14°21.80'	871	no recovery
9294-2	641-2	HN	11	NPB; Connaught Mound, off-mound	16/06/2004	05:27	53°31.05'	14°21.77'		
9295	642	SL	11	NPB; Top of Connaught Mound	16/06/2004	06:36	53°30.90'	14°21.10'	723	6 m tube; 475 cm recovery; 5 segments

Abbreviations					
Device	CTD	Conductivity Temperature Depth Profiler with Water Sampler Rosette	Area	BMP	Belgica Mound Province
	GKG	Giant Box Corer		HMP	Hovland Mound Province
	SL	Gravity Corer		WRB	West Rockall Bank
	HN	Plankton Hand Net		NPB	Northern Porcupine Bank
	ROV	QUEST 4000m Remotely Operated Vehicle			
	GAPS	USBL Acoustic Positioning System			
	PS	Parasound Sediment Echosounder			
	HS	Hydrosweep Bathymetric Multibeam Sonar			

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