SMART-AWI Atlantic Summer School

RV Celtic Explorer

Belgica Mound Province, Ireland

11th – 17th September 2014

Survey Report

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Contents

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Aaron Lim	UCC, Geologist, cold water corals, camera/ video analyst
Dr Alex Kraberg	AWI, Plankton Net coordinator, biological oceanographer
Dr Chris McGonigle	UU, Benthic ecologist, habitat mapping, GIS.
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Lar Kirwan	Chief Officer
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Mark Ivory	2nd Cook
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Jimmy Moran	Cook
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Michilin Faherty	Deck
Tom Gilmartin	Deck
Mark Masson	2nd Engineer
Phillip Gordon	Technician
Brendan Goggins	Deck
John Burke	Deck

1. Executive Summary

The Atlantic Summer School was a collaboration between Strategic Marine Alliance for Research and Training (SMART) and the Alfred-Wegener Institute (AWI) for Polar and Marine Research of Germany that was designed to provide offshore marine research and training for early stage career scientists with the knowledge and skills necessary to act as Chief Scientists on their own research surveys. The course ran from 11th to 17th September and was composed by pre-survey workshops at University College Cork (UCC), one-day sea survival training course at the National Maritime College of Ireland in Cork, four days of research at sea onboard the RV Celtic Explorer (Survey CE14013), and post-survey data analysis and reporting at National University of Ireland, Galway (NUIG).

This survey provided a platform for young emerging researchers to gain technical proficiency, conducting a multidisciplinary investigation of cold water carbonate (CWC) ecosystems. This encompassed the disciplines of oceanography, geology, acoustics, benthic fauna sampling and underwater video acquisition. It represented the coming together of scientists from eight different countries from around the world and nine different institutions across Europe.

The survey was a success as all participants had the opportunity to develop their own cruise plan and learn about the work and responsibility that the chief scientist has pre and post cruise. All young researchers had the chance to garner new skills which will be of direct benefit to science and industry, particularly in new and emerging technologies.

The connections made between participants can act as a framework for further collaborative arrangements in marine research and training. This also allowed students to discuss their current research with their peers and potential future collaborations. Working with the instructors gave the students the opportunity to both observe experienced researchers in the field and also have the benefit of their guidance and knowledge.

2. Acknowledgements

We would like to express our gratitude to the facilitators: our chief scientist Dr Pauhla McGrane, Prof Andy Wheeler, John Boyd, Dr Alex Kraberg, Dr Chris McGonigle, Aaron Lim and Jay Calvert. The course was a wonderful experience for all involved and all the students have come away with new interdisciplinary skills, knowledge and interests. We would also like to express our thanks and gratitude to Dennis Rowan (Captain) and the crew of the RV. Celtic Explorer for their hard work and professionalism during the survey. In addition we would like to thank all support services including Research Vessel Operations in the Marine Institute and P&O Maritime Services for mobilisation and technical support.

3. Background

The Atlantic Summer School was a collaboration between Strategic Marine Alliance for Research and Training (SMART) and the Alfred-Wegener Institute (AWI) for Polar and Marine Research of Germany, that gathered equipment and expertise from Ireland's Marine Institute and HEIs with Europe's foremost Polar research institute for the benefit of marine-related postgraduates from across the island of Ireland and Germany.

The 2014 Summer School specifically focused on a multidisciplinary investigation of cold-water coral (CWC) ecosystems, off the Belgica Mound Province which is a Special Area of Conservation (SAC) approximately 100 km south west of Ireland. These environments are biological "hot-spots" characterised by a diverse fauna associated with the reef-building corals that give rise to giant carbonate mounds up to 300 m high, at depths of between 550 and 1060 m. Formed over millennia, carbonate mounds provide high-resolution records of long term climate change.

3.1 Location Summary

Belgica Mound Province

The Belgica Mound province is located between 51°0′N–51°36′N and 11°30′W–11°48′W and is one of three provinces where carbonate mounds are associated with cold-water coral species on the eastern edge of the Porcupine Seabight (Fig. 1). This province extends around 45 km in length and 10 km wide and comprises of 66 conical mounds, which occurs as single mounds or in elongated clusters, between the 500 and 1100 m depth. The average slope area slopes 10°- 15° (Fig. 2) (De Mol et al. 2002, Van Rooij et al. 2003).

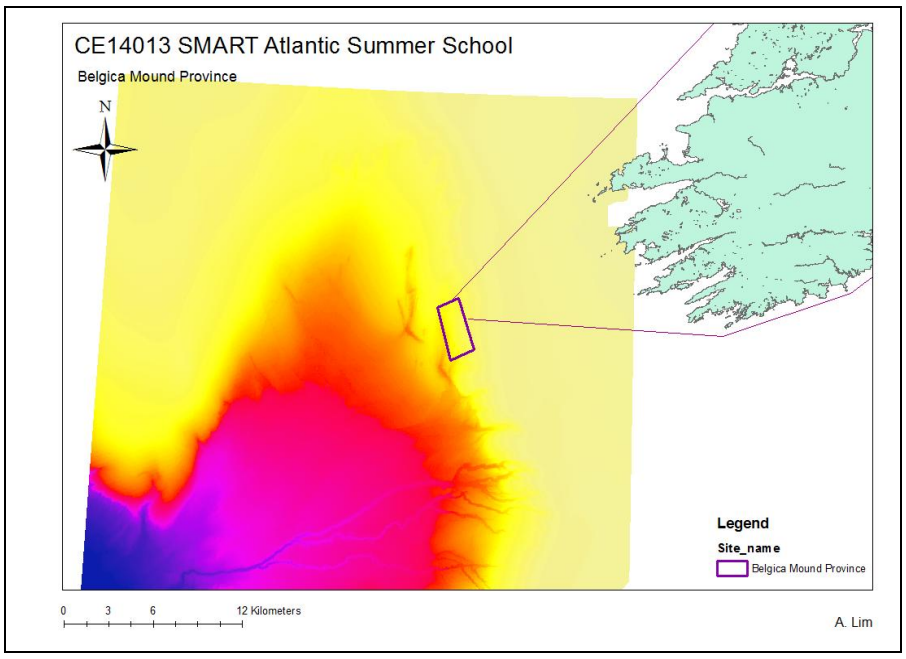

Figure 1. Belgica Mound Province.

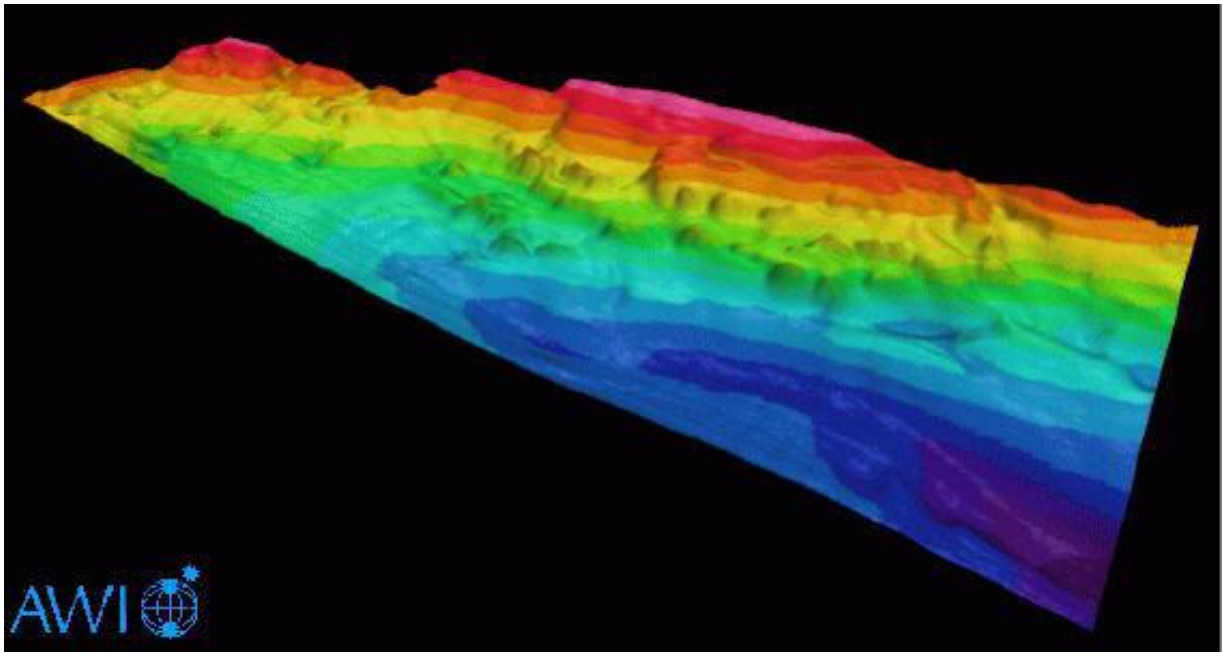

Figure 2. Belgica mounds area (height exaggeration 6x). GEOMOUND project - AWI.

Some of the mounds within the Belgica province have been specifically named and catalogued, and De Mol et al (2002) have coded them. This survey focused on four mounds, which includes Poseidon, Thérèse, Galway and Challenger Mounds.

Poseidon Mound

The Poseidon Mound is the biggest mound of the eastern mound belt (Fig. 3). It is composed by dense coverage of dead coral, which supports rich epifauna communities (e.g. antipatharians, sponges, anemones) as well as sparse paths of live *Madrepora oculata* (Wheeler et al. 2005).

Thérèse Mound

The Thérèse Mound is located in the Northwest and deepest part of Belgica Mound Province (Fig. 3), in a relatively flat area with the average depth around 950 m (De Mol et al. 2002). This mound has been indicated as one of the richest deepwater ecosystems in the Porcupine Seabight, composed particularly by *Lophelia pertusa* and *Madrepora oculata* colonies. It was selected as a special target site to study processes involved in mound development for European Union (EU) Fifth Framework research projects (Galanes-Alvarez 2001, Foubert *et al.* 2005).

Galway Mound

The Galway Mound is a 100m high carbonate mound located in the Northwest of the province (Fig. 3). It is situated around 870 m water depth. Together with its neighbor Thérèse Mound, they compose one of the highest biodiversity mount belt of Cold Water Corals in

thePorcupine Seabight province (Galanes-Alvarez 2001, De Mol *et al.* 2002, Foubert *et al.* 2005).

Challenger Mound

The Challenger Mound is a 155 m high carbonate mound covered with dead cold water coral fragments, being one of the largest situated on the eastern Porcupine Seabight continental margin (Foubert et al. 2007) (Fig. 3).

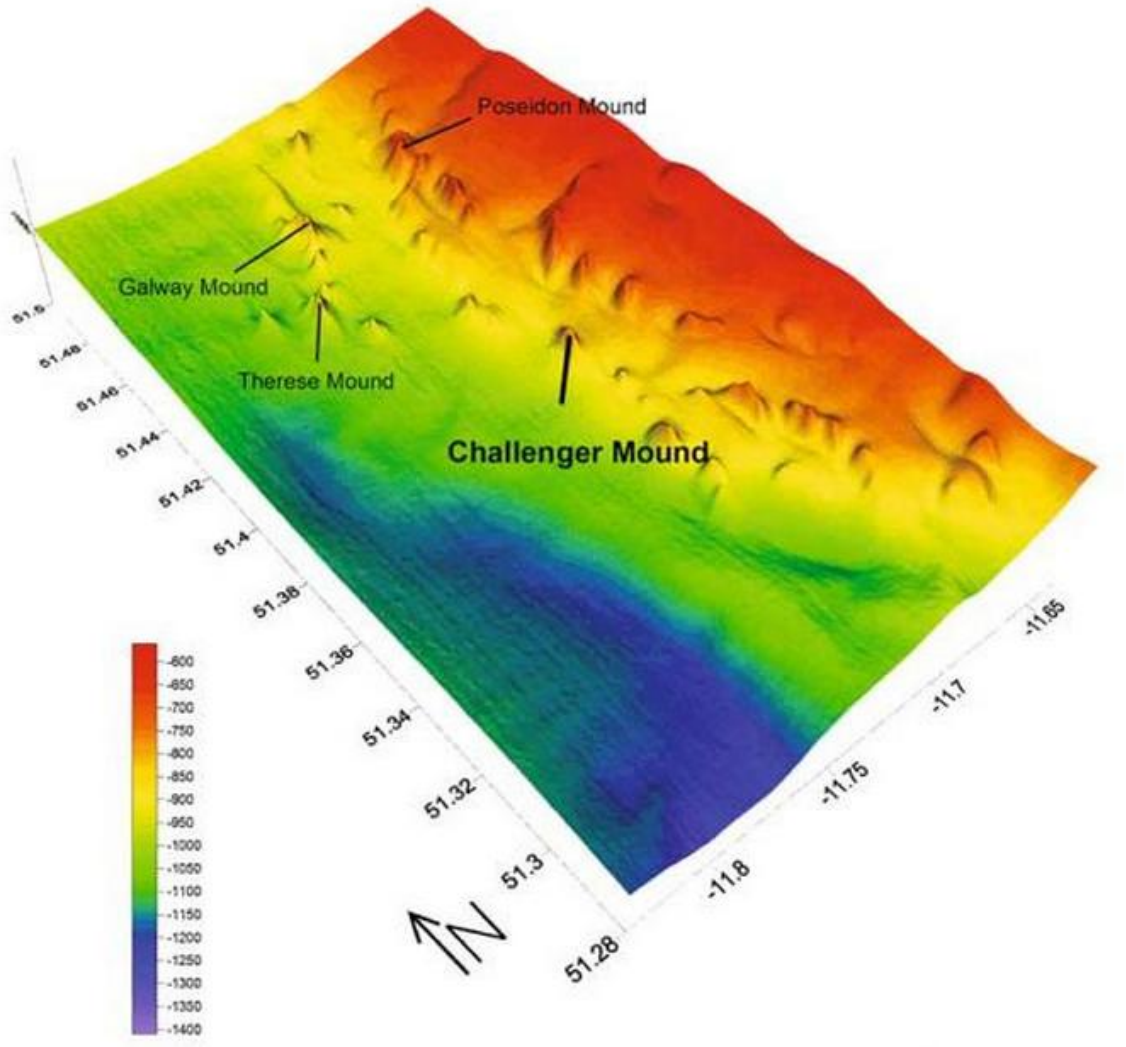

Figure 3. Three-dimensional view of the out-cropping Belgica Mounds (Henriet & Founbert 2009).

4. Survey Rational & Objectives

The Summer School aimed to provide offshore marine research and training for early stage career scientists with the knowledge and skills necessary to act as Chief Scientists on their own research surveys. The course ran from 11th to 17th September and was composed by pre-survey workshops at University College Cork (UCC), one-day sea survival training course at the National Maritime College of Ireland in Cork, three days of research at sea onboard the RV Celtic Explorer (CE14013), and post-survey data analysis and reporting at National University of Ireland, Galway (NUIG).

The Summer School content specially focused on:

- Pre-survey meetings and lectures on the study site, SACs and CWC ecosystems
- Practical shore-based workshop on designing and planning the survey
- Deployment and operation of novel equipment and instrumentation
- Acquisition, processing and achieving of samples
- On-board evening survey meetings and lectures from participants
- Post-survey data processing and analysis
- Compiling survey reports through working groups

The training survey focused on the biological, geological and oceanographic dynamics that control the development and decay of carbonate mounds. This was done using a variety of equipment and instrumentation, with the following objectives:

· **Multibeam echosounder:** detailed mapping of the study site.

· **Camera operations:** visual observations of deep-water ecosystems for habitat, species composition and environmental mapping.

· **Box-core sampling, day grab and gravity core:** seabed and benthic macrofaunal sampling on investigated sites.

· **Conductivity Temperature and Depth (CTD) and Acoustic Doppler Currant Profiler (ADCP) measurements:** oceanographic and hydrographic environment.

5. Vessel & Equipment

Research vessel - RV Celtic Explorer

The Celtic Explorer is a 65.5 m multi-purpose research vessel (Fig. 4). The vessel has wet, dry and chemical laboratories, which are permanently fitted with standard scientific equipment and can accommodate 20-22 scientists along with 13-15 crew who are highly skilled with the handling and deployment of scientific equipment. It has a maximum endurance of 35 days. The Celtic Explorer is equipped with two Trimble 300-D GPS and has Dynamic Positioning. On the aft deck is a 25 tonne A-frame with 4 m outward and inward reach in addition to a 3 m, 10 tonne starboard T-frame. The ship also comprises of a midship, forward and aft crane as well as a 6 tonne CTD winch.

Figure 4. Research Vessel Celtic Explorer – Marine Institute – Ireland.

SBE 911 CTD

The SBE 911 CTD with SBE 32 carousel (Fig. 5) includes the following equipment: Temperature and conductivity sensors, altimeter (for bottom detection), transmissometer, fluorometer, 24 position water samplers. The Sea-Bird 911plus CTD system consists of the SBE 9plus Underwater Unit and the SBE 11plus Deck Unit (for real-time readout using conductive wire). When a deck unit is employed, underwater unit power is supplied down the same single conductor armored wire used to carry data up to the surface. The deck unit decodes the serial data and passes it to a computer for display and logging to disk. The Sea-Bird underwater hardware consists of a main pressure housing comprising power supplies, acquisition electronics, telemetry circuitry, and a suite of modular sensors all mounted within a stainless steel guard cage.

Surface hardware includes the SBE 11plus Deck Unit and a computer. The temperature sensor (model SBE 3plus) is a compact module containing a pressure-protected high speed thermistor and 'Wein bridge oscillator' interface electronics. The thermistor is the variable element in the Wein-bridge, while a precision Vishay resistor and two ultra-stable capacitors form the fixed components. The conductivity sensor (model SBE 4C) is similar in operation and configuration to the temperature sensor, except that the Wein-bridge variable element is the cell resistance. The Digiquartz® pressure sensor also provides a variable frequency output. The sensor frequencies are measured using high-speed parallel counters and the resulting digital data in the form of count totals are transmitted serially to the SBE 11plus deck unit. The deck unit reconverts the count totals to numeric representations of the original frequencies.

Valeport SVX2 combined SVP/CTD

The Valeport SVX2 is fitted with a digital time of flight sound velocity sensor, high stability conductivity sensor, a high accuracy temperature compensated piezoresistant pressure transducer and a fast response PRT temperature sensor. The instrument is depth rates to 6000m, weights 11.5 kg in its titanium housing.

Figure 5. SBE 911 CTD with SBE 32 carousel.

Camera

The Kongsberg Maritime OE14-502 Underwater HDTV Camera is designed to be used for all general purpose ROV inspection tasks. Video output is available as Component (Y, Pb, Pr) and HD-SDI on coax or fibre connectors (Single or Multi-mode). CWDM alternative wavelengths are also available. Specifications: Water Depth 4,500 m. Temperature Operating -5 °C to +40 °C in Water. Storage -20 °C to +60 °C. Vibration 10 g, 20-150 Hz, 3-axes (non-operating). Shock 30 g peak, 25 mS half-sine pulse.

Sonadyne Ranger 2 USBL Positioning Beacon

Ranger 2 (Fig.6) is a high performance acoustic position reference system designed for tracking underwater targets and positioning dynamically positioned (DP) vessels. The system (commonly referred to as a HPR system) uses the Ultra-Short Base Line (USBL) positioning method to calculate the position of a subsea target, by measuring the range and bearing from a vessel-mounted transceiver to an acoustic transponder fitted to the target. Multiple subsea targets over a wide area and range of water depths can be simultaneously and precisely positioned. In standard configuration, Ranger 2 allows up to 10 subsea targets to be simultaneously tracked from a surface vessel. Operating ranges of greater than 6,000 metres are achievable and the system supports all industry standard survey and DP output telegrams. One second position updates are achievable in any water depth.

Figure 6. Sonadyne Ranger 2 USBL Positioning Beacon

Kongsberg Simrad EM 1002 Multibeam echo sounder

The Simrad EM 1002 multibeam echo sounder (Fig.7) is designed for high resolution seabed mapping from the shoreline and down to a depth of approximately 1000 m. The EM 1002 has an accuracy surpassing the International Hydrographic Organisation (IHO) standard, including the most stringent of the latest version, 4th edition. The EM 1002 is a complete system with all necessary sensor interfaces, real-time compensation for vessel motion and ray bending, data displays for quality control including sensor calibration, and data logging included as standard. The EM1002 system has a maximum ping rate of more than 10 Hz, a large number of measurements per ping with 111 beams, 2.3 degrees beam width, and electronic roll stabilization. Mechanical pitch compensation is available with an optional hull unit. Across track coverage is up to about 1500 m in deeper waters, and in shallow waters up to 10 times depth beneath the transducer. The angular coverage is fully adjustable, and for surveying to the water surface along shorelines, river banks and man-made structures, the angular coverage to one or both sides maybe increased to 5 degrees above the horizontal. The standard EM 1002 system has three different pulse lengths to maximize coverage in deeper waters. The system's nominal sonar frequency is 95 kHz. This frequency allows for small dimensions, good range capability and high tolerance to turbid waters. Integrated seabed acoustical imaging capability (side-scan) is included as standard. A combination of phase and amplitude detection is used, resulting in measurement accuracy practically independent of beam pointing angle. Hull mounted ESE 5001S 3.5 kHz pinger system The Sonar Equipment Services Ltd Probe 5001S 3.5 kHz sub-bottom profiler comprises of a surface processor and a sub-surface transceiver. The processor is set up for 16 transducers (4 X 4 array). The

transducers are located in starboard mid sea water ballast tank. Output Power is up to 10 KW at an operating frequency of 3.5 to 9.0 kHz. Maximum repetition rate is 10 Hz.The system is triggered from a CODA DA2000.

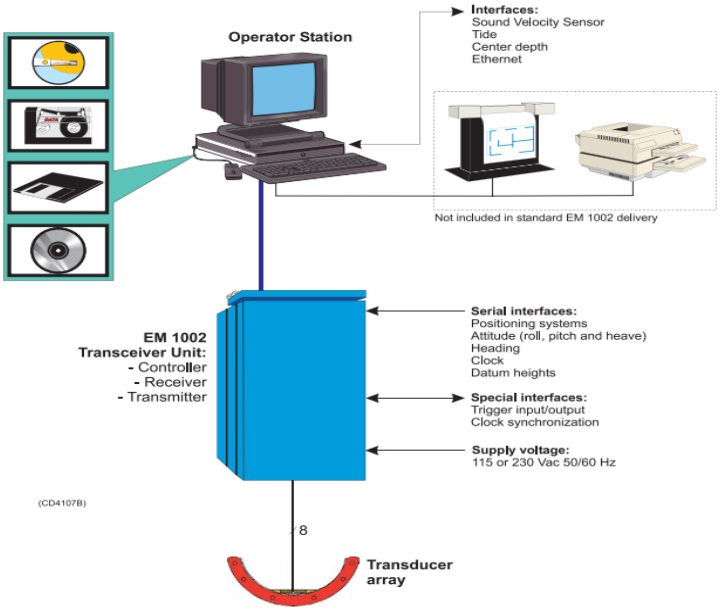

Figure 7. EM 1002 system units and interfaces (TDI-Brooks www.kongsberg.com).

Gravity core

An OSIL 800 kg gravity corer with a 7 cm diameter bore which can be deployed with a 3 m or a 6 m mode, the 6 m mode being two coupled 3 m barrels. The 3 m mode is pictured below, the additional 3m barrel and coupling (yellow) is behind. The gravity corer is fitted with a core catcher.

Reineck box corer

A Reineck box-corer was used to take undisturbed sediment samples for biological assessment. It has a sampling box area of 10 cm x 17 cm with a maximum penetration depth of 26 cm (Fig. 8).

Day Grab

Day Grab was used to recover sediment samples from the seafloor. These grab samples are used to provide a cross reference to the seabed type classifications that are made from the MBES backscatter datasets. The Grab should have a sampling area of 0.1 m² and should weigh 35 – 40 kg (for use on mud/muddy sands) or 70 – 100 kg for sandy sediments. Remove weights from the grab when sampling very soft sediment to prevent the grab from burying itself. The windows or flaps on the grab should be easy to open for inspection and coring prior to emptying.

Figure 8. Reineck box-corer (left) and Day Grab (right) being prepared for deployment.

6. Survey Narrative

Wednesday 10th: The group of this September's SMART summer school met in the Brú Hostel's bar. Everyone introduced themselves, their study area and what sparked their interest in cold-water corals (CWCs).

Thursday 11th: There was a morning of talks from Dr Pauhla McGrane, Dr Andy Wheeler, Dr Chris McGonigle, John Boyd, Dr Alexandra Krabeg, Aaron Lim and Jay Calvert (Fig. 9). With the backgrounds of all participants spanning marine biology, oceanography and geology, everyone was brought up to speed on all the types of equipment used for the different disciplines. These would include; multibeam echo sounding, underwater photographic equipment, plankton nets, box and gravity corers, to name a few. In the afternoon we were set the exercise of planning our own hypothetical cruise using the same types of gear.

Friday September12th: Equipment and sampling gear was mobilised onboard the Celtic Explorer in Cork Harbour. Registration and safety tours took place. The ship departed for the survey area at 1830 hrs. This was followed by a safety drill at the muster station (Fig. 9). At 2100 the group met to discuss the survey plan and watch shifts.

Saturday 13th: Dolphins were observed to the starboard and bow of the ship in the morning. A live-feed video rig was dropped down to observe previously unobserved mounds. The camera equipment was a new set up being tested out. Live *Lophelia* reef and some of its associated vertebrate fish species and macrofauna (such as urchins, sponges and starfish) were observed through the live feed (Fig. 9). This method was used to select areas for

macrofauna sampling using a box corer. The core samples were sorted, identifying species such as *Eunice norvegica* and *Madrepora oculata*. A gravity corer was deployed three times and successfully captured a core on the first occasion (although 13 m from the target site) and failed to recover any sediment on the following two attempts. In the evening, the multibeam echo sounder lines were run out into deeper, unknown waters in order to see if the known coral terraces in the survey area extended out further. This kind of exploratory work is important for delineating the areas of Special Areas of Conservation (SACs). SACs protect known areas of live *Lophelia pertusa* and *Madrepora oculata* reef inside of Ireland's Exclusive Economic Zone (EEZ). Late that night, Jay Calvert observed some results from the multibeam which could indicate the extension of the coral mounds terraces. These findings may be correlated with ground truthing and video on Monday.

Sunday 14th: The majority of the day was spent carrying out a transect of CTD casts, moving east to west across the Belgica Mound Province. The CTD gives a picture of what is going on vertically through the water column and can be used to map the different water masses in an area. Onboard there was quite a bit of interest in ocean chemistry and plankton, so Niskin bottles were sampled from the CTD for salinity, nutrients and phytoplankton. Water samples were also taken for the analysis of environmental DNA (eDNA) in the water column. Bongo and phytoplankton nets were deployed and plankton species were observed and identified in the wet lab onboard. Individual foam cups were attached in a net with the CTD. On retrieval of the CTD carousel we observed how the subsurface pressure transformed our drinking cups into decorative egg cups. In the evening there was video work exploring some more unobserved areas.

Monday 15th: This was the final day of the survey. In the early morning, multibeam was carried out along with one hour of single beam echosounder. A net was deployed to sample phytoplankton at 50 m. The deepest CTD cast of the survey was taken at 1166 m. Four Day grab samples were taken and were sorted in the wet lab. The survey was completed by 1600 hrs and the Celtic Explorer began the journey to Galway.

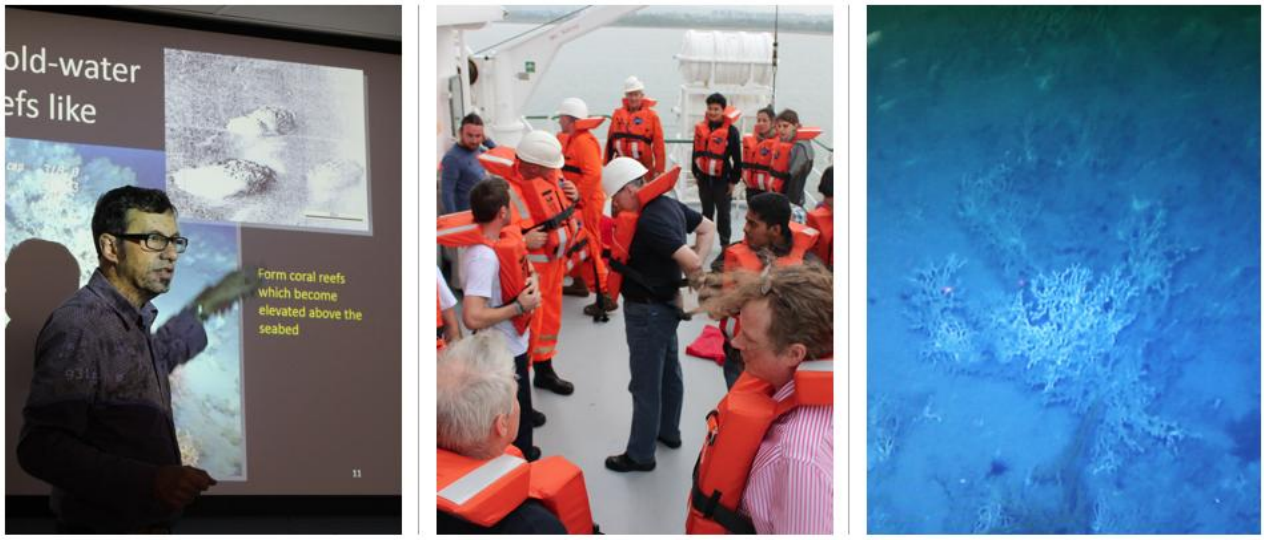

Figure 9. Dr Andy Wheeler; safety drill at the muster station; *L. pertusa* thicket.

7. Preliminary Results

7.1 Oceanographic Data

Oceanographic data was collected along eight stations where CTD casts were taken (Fig. 10). ADCP data was also taken along this transect as well as water samples for plankton.

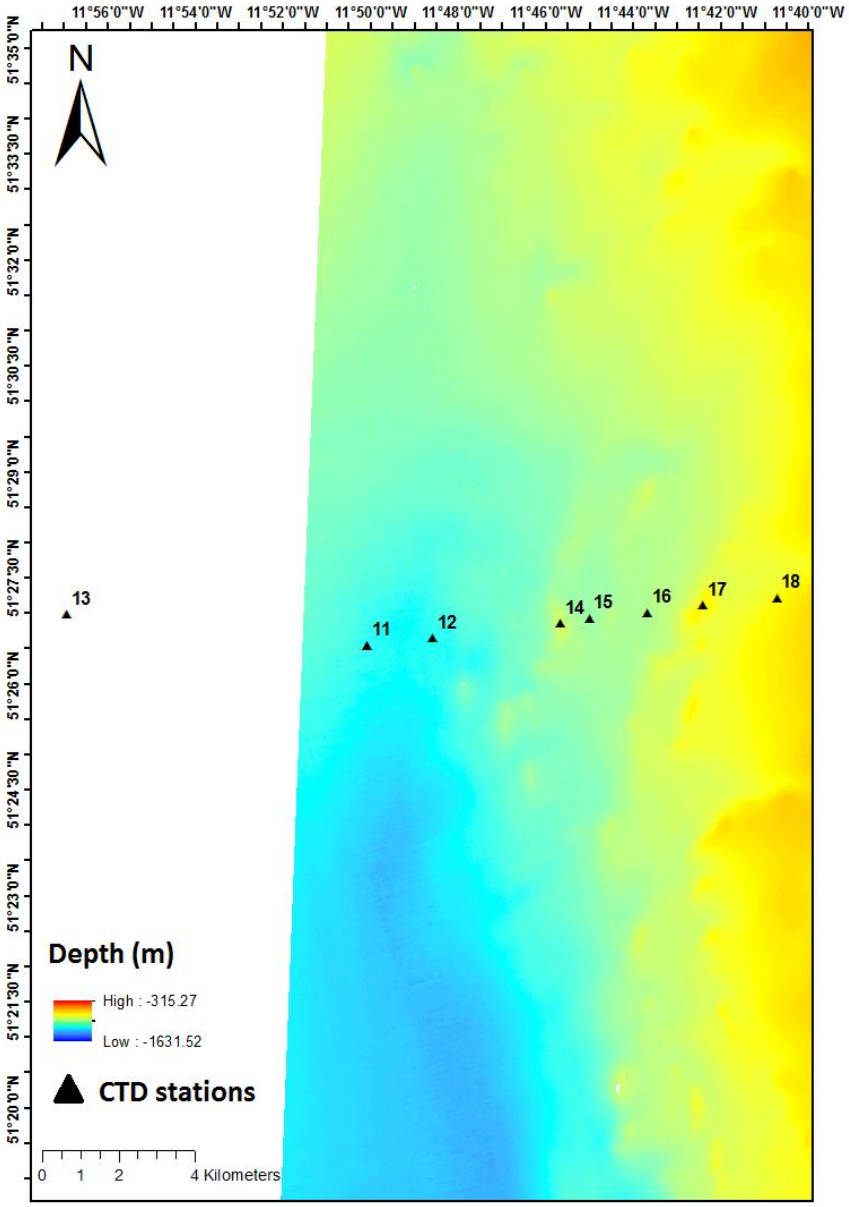

Figure 10. CTD stations occupied across the Belgica Mound Province.

CTD data analysis

Scatter plot of variables i.e. temperature, salinity, density, oxygen and fluorescence over depth or different stations is shown in Figure 12 and 13. Temperature changed constantly up to 200 m depth and then it was almost remain constant until 1000 m depth. Temperature was higher at surface layer and low at deeper layer. Salinity found high at surface layer and then decreased and then again increased from 800 m depth. Density plot showed stratification from surface to 1000m depth. Oxygen value was almost constant from 200m depth which is similar for florescence.

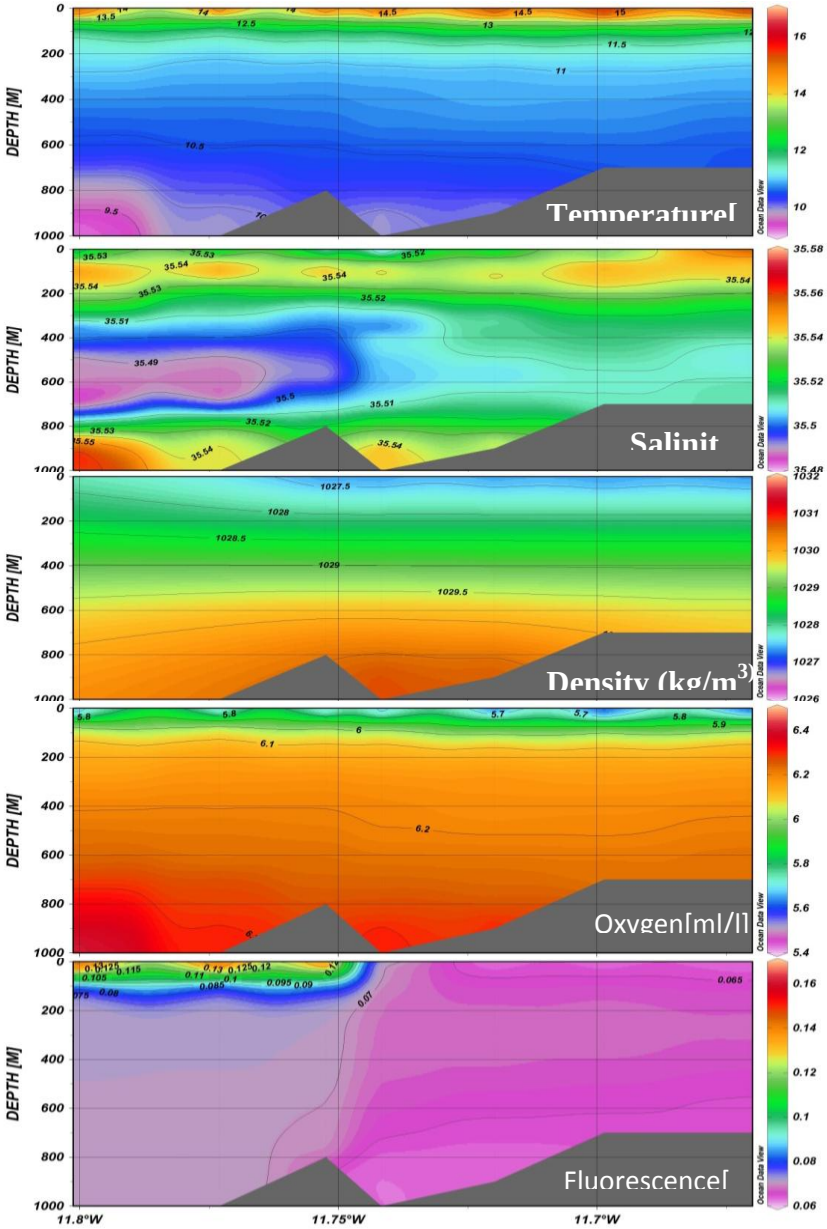

Figure 12. Section plot of different variables from CTD transect.

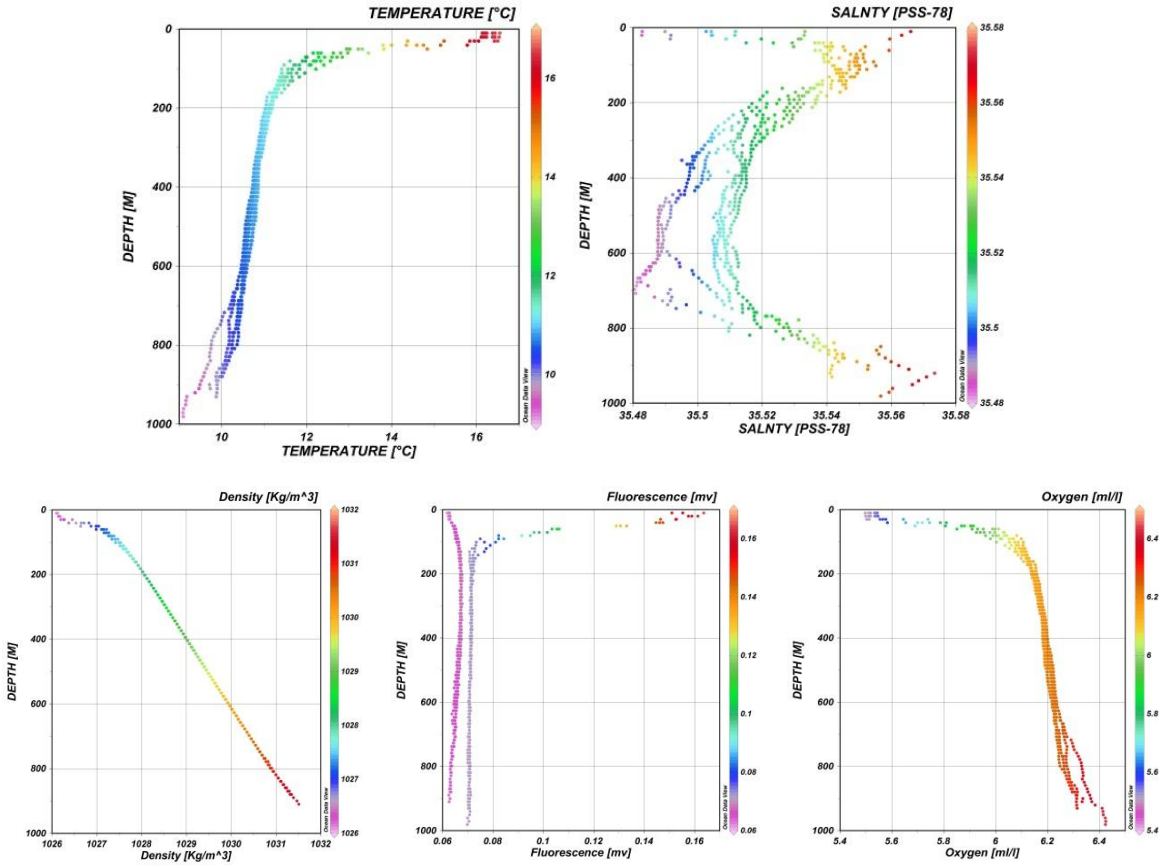

Figure 13. Scatter plot showing the profile of different variables from CTD cast.

Plankton

Phytoplankton is one of the most diverse groups in the ocean and the most abundant organisms present in eutrophic zone of the World's oceans. To assess the plankton ecology in the area of the Belgica Mound Province, we collected water samples using Niskin bottles of the CTD water sampler fired at different water depth ranging from surface to 1000m. Pelagic phytoplankton was analyzed by deploying vertical plankton net of mesh size 20µm at 50m water depth. Phytoplankton was identified to the lowest possible taxonomic level using an Olympus Compound microscope with the guide "Identifying Marine Plankton" by Carmelo R. Tomas (Fig.11). Sub sample of 100ml water samples from each Niskin bottle sample were fixed with Lugo Iodine solutions for further post-cruise analysis.

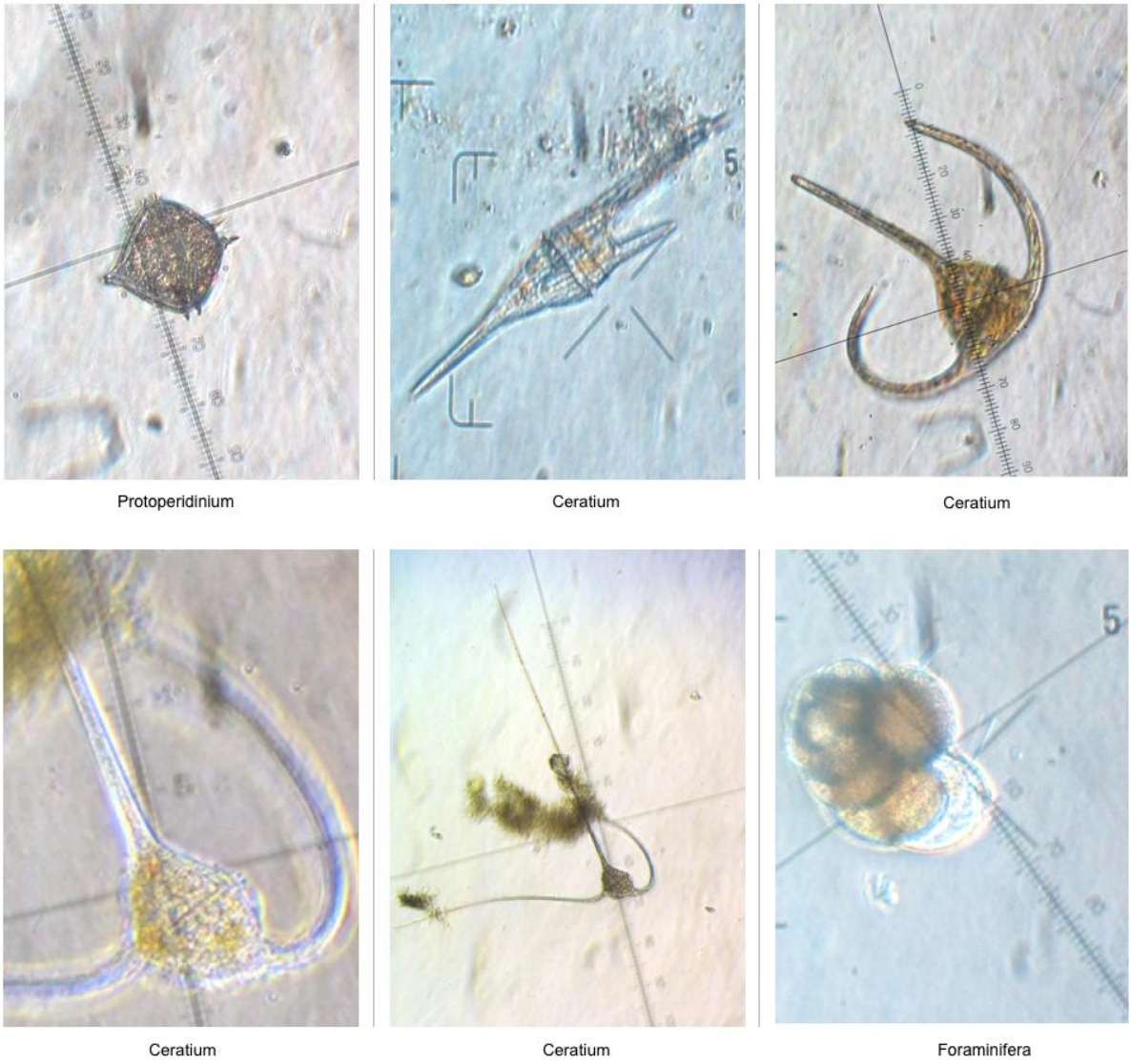

Figure 11. Phytoplankton species plate.

Acoustic Doppler Current Profiler Analysis

Estimation of suspended matter such as plankton or suspended sediment are important characteristics controlling the existence of cold water corals in this harsh environment. The depth at which these organisms exist can be problematic for usual sampling methods. Water sampling techniques often times underestimate the concentrations in highly productive areas. Acoustic sensors such as doppler current profilers usually determine current velocity in the water column, can also be used to determine suspended matter from the backscatter intensity.

A characteristic of the instrument used to derive the current velocity. This method was implemented along the transect line used to gather CTD measurements. The results of backscatter as shown below (Fig. 14) suggest a high amount of suspended matter near the sea bed. This high concentration can be derived from hydrodynamic conditions resuspending sediment or can be transporting high concentrations of plankton with the current along the cold water coral mound. High backscatter midway in the water column can also result from

fish movements detected by the ADCP. To accurately determine the composition of the suspended matter, water samples taken along the CTD can further be analysed to determine if there was higher concentrations of plankton near the sea bed. This would verify the backscatter results and also highlight the dynamics supporting cold water coral mounds.

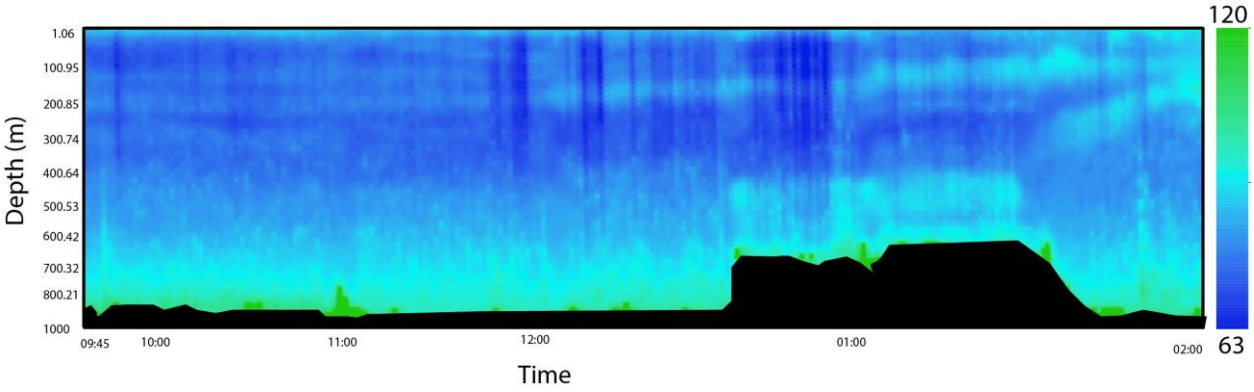

Figure 14. ADCP Backscatter profile.

7.2 Water Sampling for environmental DNA (eDNA) Analysis

Water was sampled for eDNA from CTD casts at two stations. The first was positioned in the vicinity of a live coral mound at 51º27.15 N, 11º45.14 W with a maximum water depth of 795 m. A total of 3 l of seawater was sampled from individual bottles deployed at depths of 25 m, 400 m and 780 m. The second sampling station was at 51º27.48 N, 11º41.92 W with a maximum water depth of 680 m. The water sampling procedure was repeated, this time at depths of 25 m, 350 m and 680 m. This station was positioned over a dead coral mound. Each 3 l sample was spiked with 20 µl of red deer (*Cervus elaphus*) DNA (concentration 64.6 ng/µl), in order to act as an internal positive control.

Using eDNA for species detection from water samples taken from both live and dead coral mounds could potentially provide insight into the faunal assemblages found at these sites, and may prove useful as a non-invasive method for detecting reef building corals such as *Lophelia pertusa* in similar environments. Samples were stored at -20^{o} C to preserve aquatic eDNA for later analysis using molecular techniques.

7.3 Acoustic Data

Two main components of acoustic technologies were utilized in order to map efficiently the deep water ecosystem of cold water corals. These include Multibeam Echo Sounder (MBES) and Single Beam Echo Sounder (SBES). Each instrument produced a unique dataset from which the bathymetric surface can be calculated.

Survey lines

A Mutlibeam Echounder (MBES) survey was conducted for two different areas. The southern survey (Fig. 14) consisted of dead corals and included 6 lines with 150 meters spacing using the full swath (55 degrees on each side) resulting in 15% overlap. The second Northern survey area (Fig. 14) was in water depths close to the depth limit of the MBES echo-sounder (1000 m). For that reason the swath was narrowed at 30 degrees for each side for better resolution. The line spacing was 700 meters without obtaining full coverage. The Single Beam Echosounder (SBES) survey was carried out on an area outside the coverage of baseline MBES bathymetry (Fig. 14).

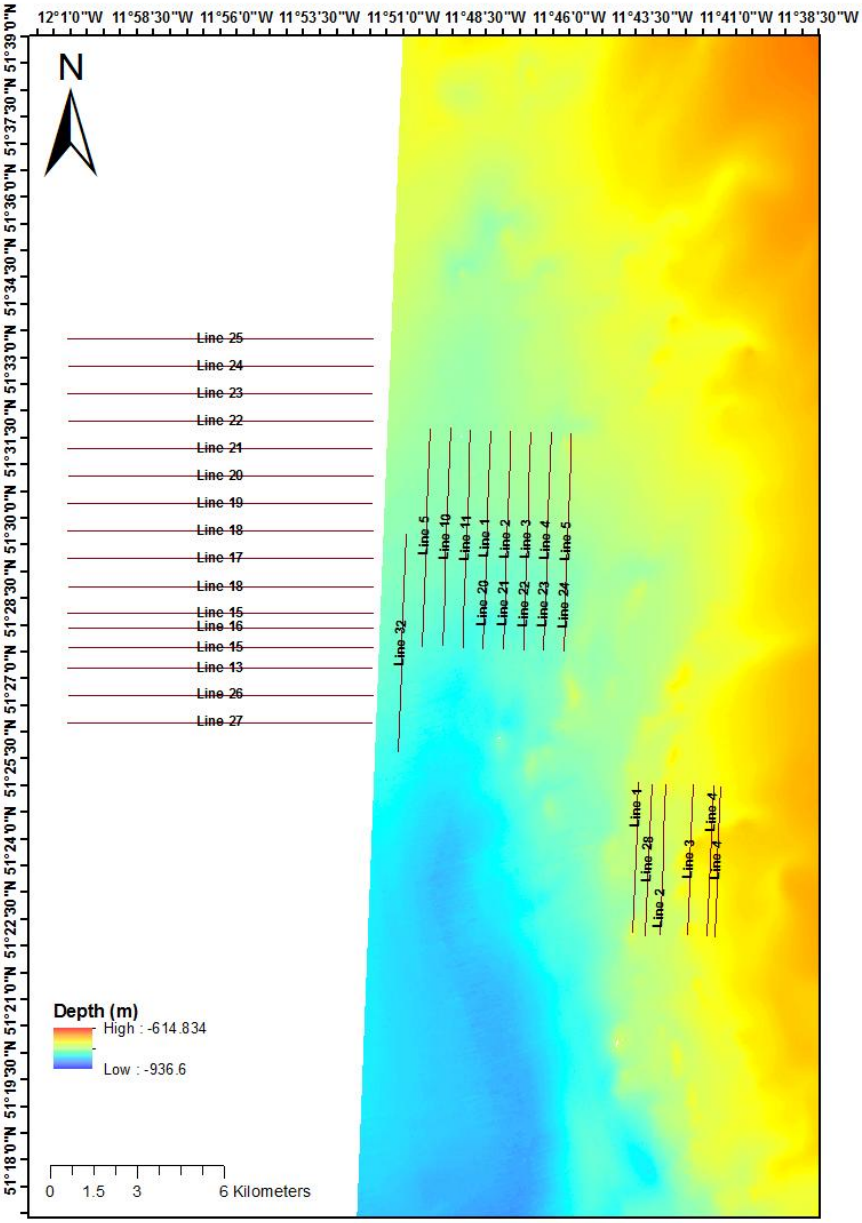

Figure 14. Navigation lines of the MBES and SBES surveys over baseline MBES bathymetry of the wider area. Track lines outside the bathymetry coverage area for the SBES.

Acoustic datasets

MBES

The raw dataset was processed using Caris Hips software. The processed MBES data were used in order to grid a 10 m resolution bathymetric surface of the survey area (Fig. 15).

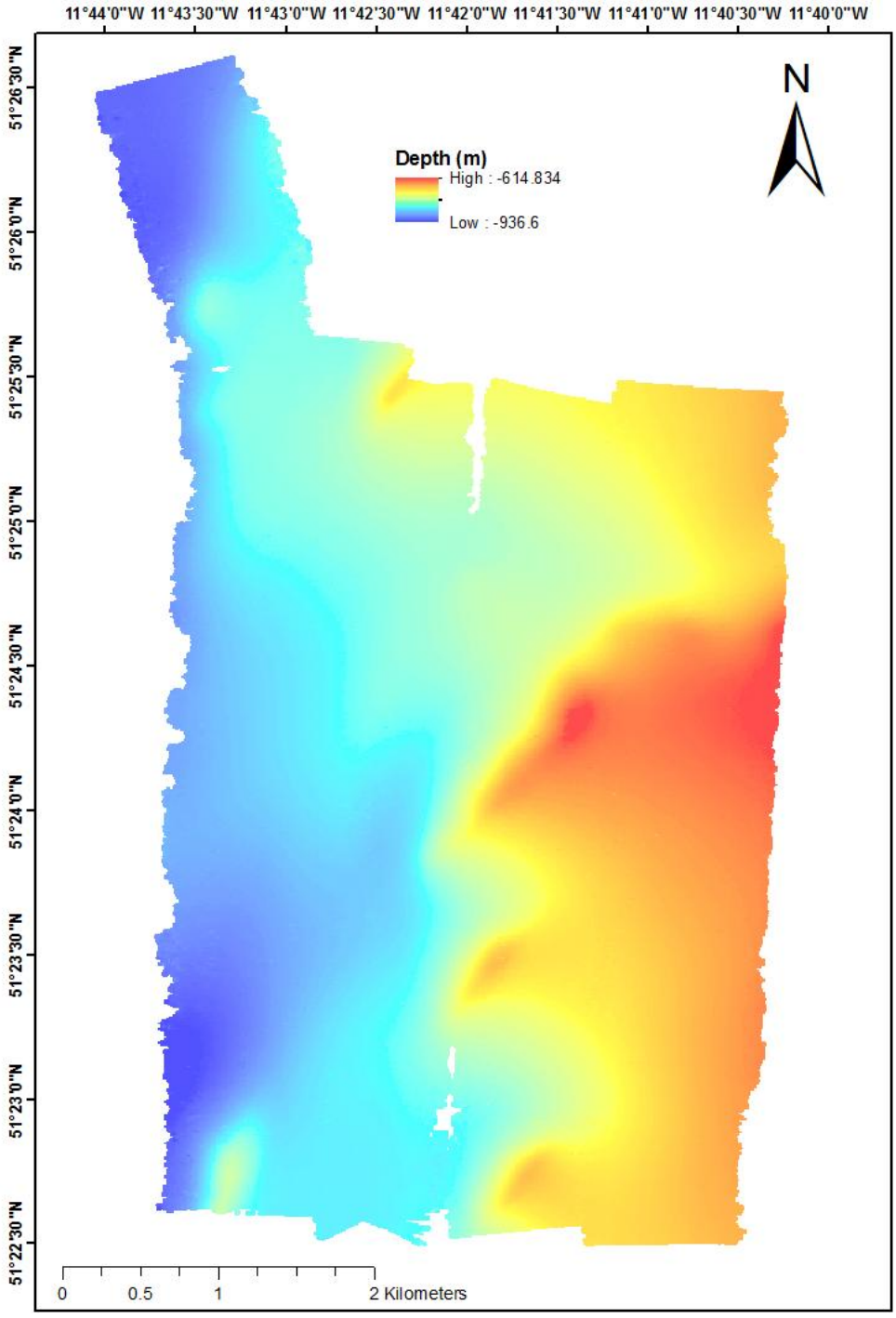

Figure 15. MBES bathymetry of the southern survey area.

SBES

While the SBES data cannot be used to create a detailed DEM of the seafloor they can provide useful information regarding the morphological profile of certain areas (Fig. 16). The area the SBES survey was conducted in is a previously unexplored area licensed to Woodside Petroleum. The SBES survey was undertaken to determine the limits of the westward extension of the reefs. Results showed the bathymetric expression of possible coral mounds.

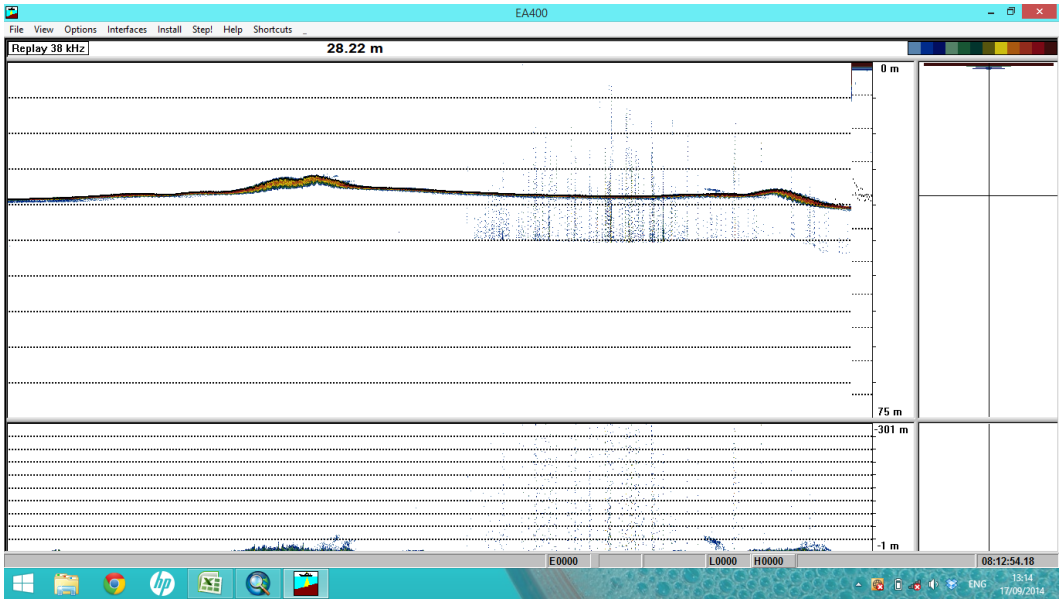

Figure 16. SBES screenshot showing the bathymetric expression of possible coral mounds.

7.4 Seabed Video Classification Data

A Kongsberg 14 502 camera, mounted on a frame with auxiliary Deep Sea Systems LED lighting, was utilised for video classification (Fig. 17). A USBL sensor was mounted upon the frame to record depths and coordinates of the camera during deployment. The frame was dropped to the desired location using a winch mounted on the ship.

Figure 17. Kongsberg OE 14-502 camera being prepared for deployment.

The camera was deployed at three sites (Fig. 20), with video classification used on the second site, the Galway Mound. Some difficulties were encountered during deployment of the camera due to strong currents in the drop locations, the camera tended to sway, causing blue water hops. This caused problems in identifying the facies of the test sites during the video classification exercise. As coral growth tends to be in areas with strong current an ROV may be a better choice for use in recording video footage. Another difficulty was encountered with the winch, which was used for the deployment of the camera and which at times during the third deployment slipped. For these reasons camera work was abandoned after the third deployments.

On the first camera drop, which was deployed at coordinates 51º27.441 N, 11º41.925 W, footage revealed that the seafloor consisted of sand and coarse substrate that appeared to be a combination of shell rubble and fragmented *Lophelia pertusa*.

On the second camera drop, deployed at 51º27.075 N, 11º45.154 W, there were recorded sightings of jellyfish, monkfish, a possible goblin shark, dogfish and soft coral. The sea facies appeared to be a combination of dead coral, live coral and fragmented biogenic material. It was on this station that the video classification method was used. After some discussion the team decided upon five classification groups for describing the facies at the test site. The groups were as follows:

1. In-situ coral framework dominated by dead coral
2. Undifferentiated biogenic material
3. In-situ coral framework dominated by live coral
4. Sand and dropstones
5. Blue water hops

ArcGIS software was used to display all the recorded data on the cruise. Upon superimposing the video classification data over the multibeam data, it was discovered that the video was recorded whilst travelling along the southern slope of the Galway mound. An example of the 3D bathymetry and the video classification route created in ArcGIS can be viewed in the Figure 18.

The third camera drop was deployed at 51º23.769 N, 11º44.072 W. Footage was recorded of a large shoal of unidentified fish (Fig. 19). Other sightings of comb jellies and salps were recorded. The seafloor consisted of coarse sand, dropstones and fragmented shells. Due to fear of damaging the camera and equipment because of winch slippage, it was decided that the third camera drop would be the last.

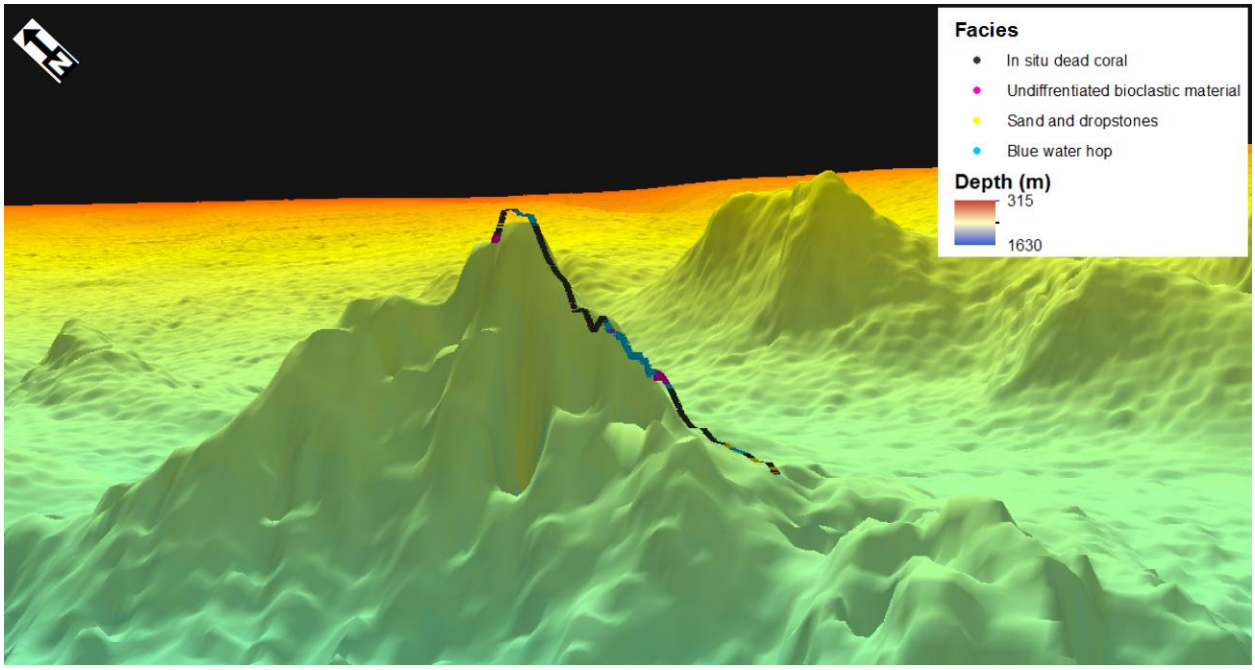

Figure 18. Galway Mound 3D bathymetry and the video classification route.

Figure 19. Footage of a large shoal of unidentified fish at third camera station.

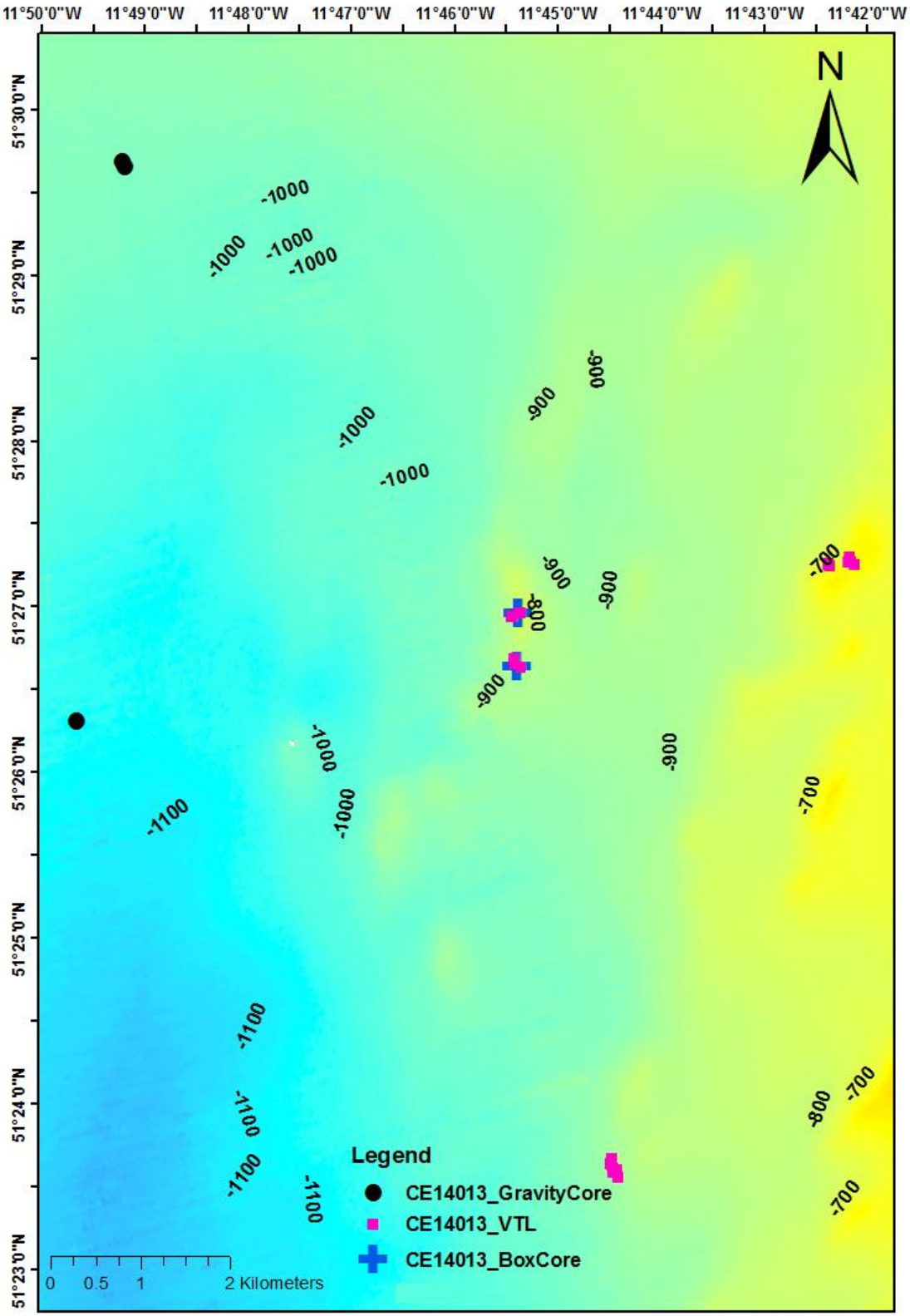

Figure 20. Position of the VTL (camera), Gravity Core and Box Core stations.

7.5 Geological Data

In order to identify sediment characteristics of the research area, Gravity cores, Box cores and Day Grabs have been used (Table 1 and 2). Sediments recovered by the Box core and the Day Grab were directly characterized.

Table 1. Day Grab and Box Core stations in the area of the Belgica Mounds.

Station No.	Date	Time (Local)	Lat (N) (deg)	Lat (N) (min)	Long (W) (deg)	Long (W) (min)	Depth (m)	Day Grab	Box Core	Notes (weather etc.)
2	13.09.2014	14:42	51	26,752	11	45,156	866		X	Bio Geo
3	13.09.2014	15:39	51	27,075	11	45,160	786		X	only Bio, Sediment was not recovered
29	15.09.2014	12:50	51	29,095	11	48,770	1157	X		Sunny Day, wind direction east, windspeed 13kn
30	15.09.2014	13:18	51	25,870	11	49,890	1060	X		Sunny wind dir 91.80, windspeed 16.6kn
31	15.09.2014	14:23	51	26,090	11	49,335	1063	X		Sunny, wind dir 91.9, windspeed 14.7kn
32	15.09.2014		51	26,157	11	49,295	1073	X		Sunny, wind dir ESE, windspeed 14.kn

Gravity Core

The samples of the Gravity core were labeled and chilled to be processed at UCC under supervisor of Dr. Andy Wheeler (Table 2).

Table 2. Gravity core stations in the area of the Belgica mounds.

Date	Station	USBL Lat (bottom)	USBL Long (bottom)	Water depth (m)	Comments
13.09.14	4	51º 26.318	11º 49.391		Sample labeled and preserved
13.09.14	5	51º 29.709	11º 49.166	968	no core retrieved
13.09.14	6	51º 29.676	11º 49.135	966	no core retrieved

Box Core

The box core samples were colected in two stations and their sediments were described (Tables 1 and 3; Fig. 21).

Table 3. Box Core details in the area of the Belgica mounds.

Sta	Sample ID	USBL Lat	USBL Long	Depth (m)	Facies	Matrix	Martix Sorting	Clast sz (mm)
2	CE14013_02	51°26.752	11°45.153	866	Medium to fine sand with coral rubble	Medium to fine sand	Moderatel y sorted	0.5-30
3	CE14013_03	51°26.749	11°45.167	785.5	No sediment – coral rubble only	n/a	n/a	large

Figure 21. Box core sediment sample at Station 31.

Day Grab

The details of the Day grab samples are presented in the Table 2 and 3.

Table 3. Day grabs recovered in the area of the Belgica Mounds.

Sta	Sample ID	USBL Lat	USBL Long	Depth (m)	Facies	Matrix	Martix Sorting	Clast size (mm)
29	CE14013_29	51°24.095	11°48.764	1150	Muddy sand with dropstones	mud and sand	moderate to poor	0.179- 6
30	CE14013_30	51°25.874	11°49.895	1060	Fine sands with dropstones, coral and shelly hash	fine sand	matrix=sorted dropstones= poor	1- 40
31	CE14013_31	51°26.096	11°49.335	1063	Well sorted fine sand with poorly sorted clastic component	fine sand	Well sorted fine sand with poorly sorted clastic component	0.006- 1

7.6 Benthic Faunal Sampling Data

Benthos

During the cruise, benthic sampling was conducted using a Reineck (Box core) and a Day Grab (Fig. 8). In total, two Box Cores and four Day Grabs were used to recover biogeological samples at different depths and areas (Table 1). Two of each grabs were directly analyzed on board including sediment description and broad identification of macrofauna.

Some of the taxa found at the surveyed area include: *Madrepora oculata*, ophiuroids, bivalves, polychaetes (Fig. 22, 23 and 24). A preliminar list of the species is presented in the appendices section.

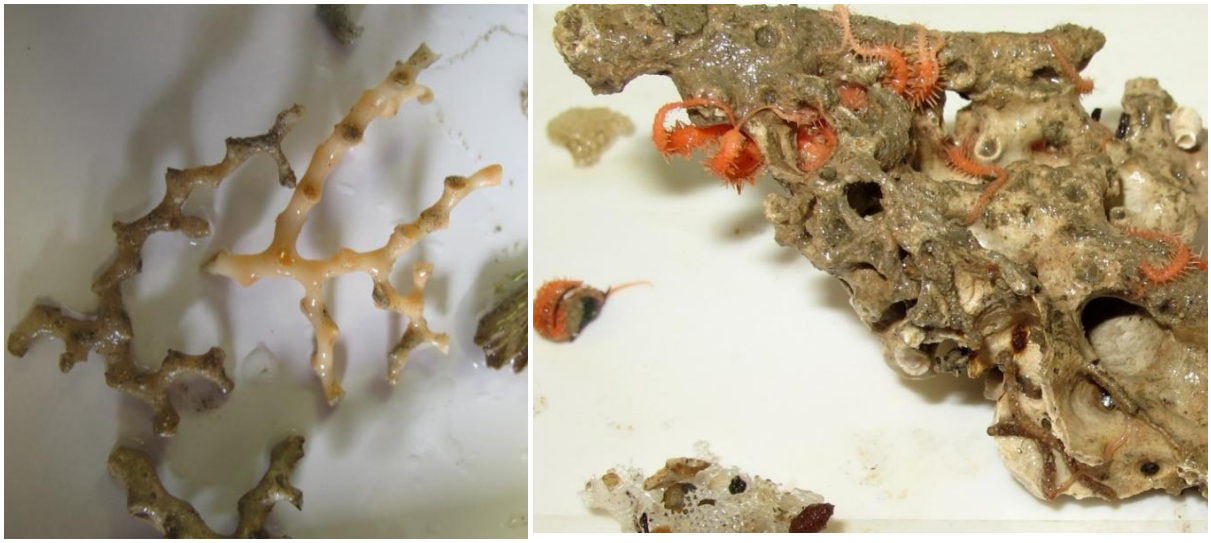

Figure 22. *Madrepora oculata* (left) and ophiuroides (right).

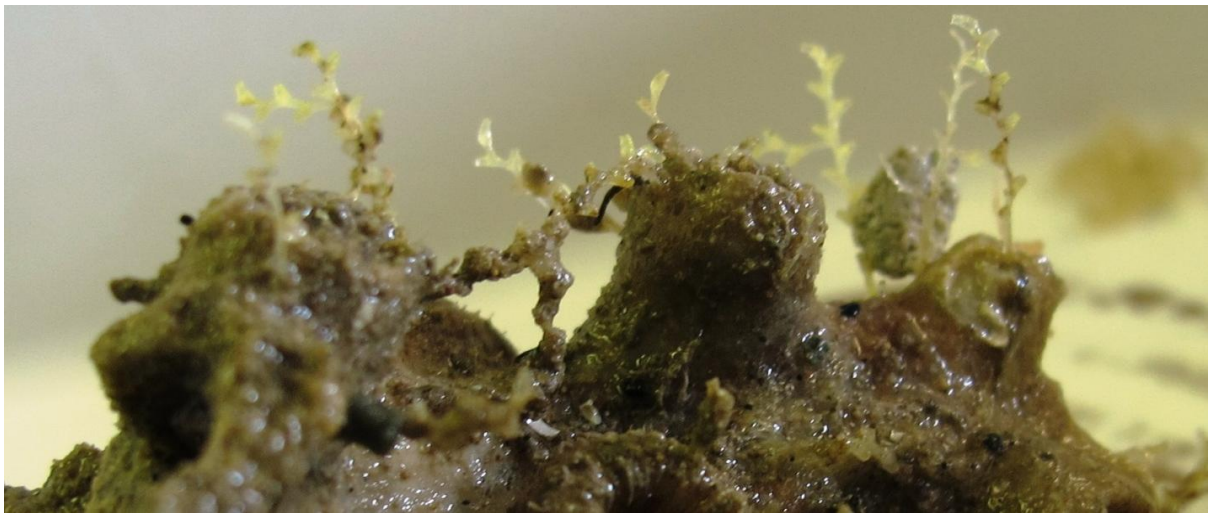

Figure 23. Hydroids.

Figure 24. Unidentified Bivalve (top left), *Eunice norvegica (top right)*, unidentified polychaete (bottom).

Figure 25. Phylum Sipuncula or Phylum Echiura (left) and *Hiatella arctica* (right).

8. References

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Wheeler, A.J., Kozachenko, M., Beyer, A., Foubert, A., Huvenne, V.A.I., Klages, M., Masson, D.G., Olu-Le Roy, K. & Thiede, J., 2005. Sedimentary processes and carbonate mounds in the Belgica mound province, Porcupine Seabight, NE Atlantic. . In: A. Freiwald & J.M. Roberts (Eds), Cold-water corals and Ecosystems. Springer-Verlag, Berlin. p. 533- 564.

9. Appendices

List of Species Identified from vertical plankton net

Dinoflagellate:

Ceratium arietinum
Ceratium furca
Ceratium hexacanthus
Ceratium lineatum
Ceratium tripas
Gonyoulax polygramma
Ligulodinium polyedro
Oblea spp.
Oxytoxum spp.
Protocentrum recticulum
Prorocentrum spp.
Protoperidinium depressum
Protoperidinium curtepis/crassipes
Protoperidinium pellucidum
Protoperidinium steinii
Protoperidinium spp.
Pyrophycus spp.
Torodinium
Gymnodinum spp.

Diatom:

Coscinodiscus radiatus
Coscinodiscus spp.
Paralia sulcata
Proboscia alata
Thalasiosira/Roperia tesselata
Pseudo-nitzschia spp.
Pennate diatom

Others:

Phaeocystis
Globigerines aspinous
Globigerines spinous
Tintinnids
Spumellarian radiolarians

List of Species Identified from Benthic Fauna Sampling

Station 3 – Box Core

Sediment:

No sediment recovered

Species:

Sipuncula spp.
Echiura spp.
Lametlia abyssorum
Amphissa acutecostata
Antinoelloa finmarchia
Dead corals

Station 29 – Day Grab

Sediment:

Biogenic coral rubbles, coarse sand, well oxygenated

Species:

Phylum Porifera
Class Ophiuroidea

Station 30 – Day Grab

Sediment:

Biogenic, coral rubbles, coarse sand, sandy Mud

Species:

Phylum Echiura or Sipuncula

Station 31 and Station 32 – Day Grab

Could not be analyzed onboard