CE20011 - Systematic Monitoring Survey of the Moira Mound Chain (SyMonS_MoM)

RV Celtic Explorer and Holland 1 ROV - Cruise Number CE20011

Galway - Porcupine Bank Canyon - Galway

22th September 2020 to 3rd October 2020

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Executive Summary

The Moira Mounds are small-sized cold-water coral reefs that exist within the Belgica Mound Province, NE Atlantic. They range form 3 to 12 m in height and occur in water depths of down to 1100 m. Recent research shows that one of the Moira Mounds, the Piddington Mound has shown significant variation in surface coral coverage and type from 2011 to 2015. This survey aims to map, core, 3D model and monitor cold water coral reefs from the Moira Mounds and adjacent Macnas mounds in order to understand spatial and temporal variability. To do this, the *RV Celtic Explorer* and *Holland 1 ROV* were utilised to map the area by hull- and ROV-mounted multibeam sonar. Multibeam data show that the Macnas Mounds are small (3 m tall) with very gentle slopes while the Moira Mounds are notably steeper (<45 degrees). Seven lander systems, each measuring current speed and direction, temperature, biofouling and trapping current-suspended particles, were deployed: five in the downslope area; 1 in the midslope area and; 1 in the western segment of the Macnas mounds. The Piddington Mound was imaged by downward-facing 1080i HD video camera using the ROV. Multibeam data show that the surveyed areas are dominated by rippled sands surrounding coral mounds. ROV video data show that there are large sediment waves which are colonised by cold water coral (e.g. the midslope area). In the downslope area, these coral-colonised sediment wave trains can be located as sets to the south of many coral mounds. Video footage shows that the Macnas Mounds are predominantly covered by coral rubble and mainly sediment. Data will be acquired from the landers in a follow up survey in 2021. Data will feed into a number of projects including: the H2020 project "Integrated Assessment of Atlantic Marine Ecosystems in Space & Time" (*iATLANTIC*) and the SFI-, GSI- and MI-funded "Mapping, Modelling and Monitoring Key Processes and Controls on Cold Water Coral Habitats in Submarine Canyons" (MMMonKey_Pro) programme and the Marine Institute Post-doctoral Fellowship project, 'Mop_Up' (www.marinegeology.ucc.ie).

Background

Cold-water corals are slow-growing organisms that have $CaCO_3$ branch-like skeletons (Freiwald et al., 2003). These sessile filter-feeders use these skeletons to baffle current-suspended food for biological growth. In addition, current-suspended particles can become baffled around the coral framework, resulting in sediment accumulation in and around the coral framework . This flux of allogenic sediment and authocthonous coral rubble can result in the growth of a cold-water coral-induced positive topographic feature called a cold-water coral reef or mound (Wheeler et al., 2008; Pirlet et al., 2011). On the Irish margin, cold water coral mounds range in size from just 3 m to > 100 m in height and from tens of metres to several kilometres long (Wheeler et al., 2007).

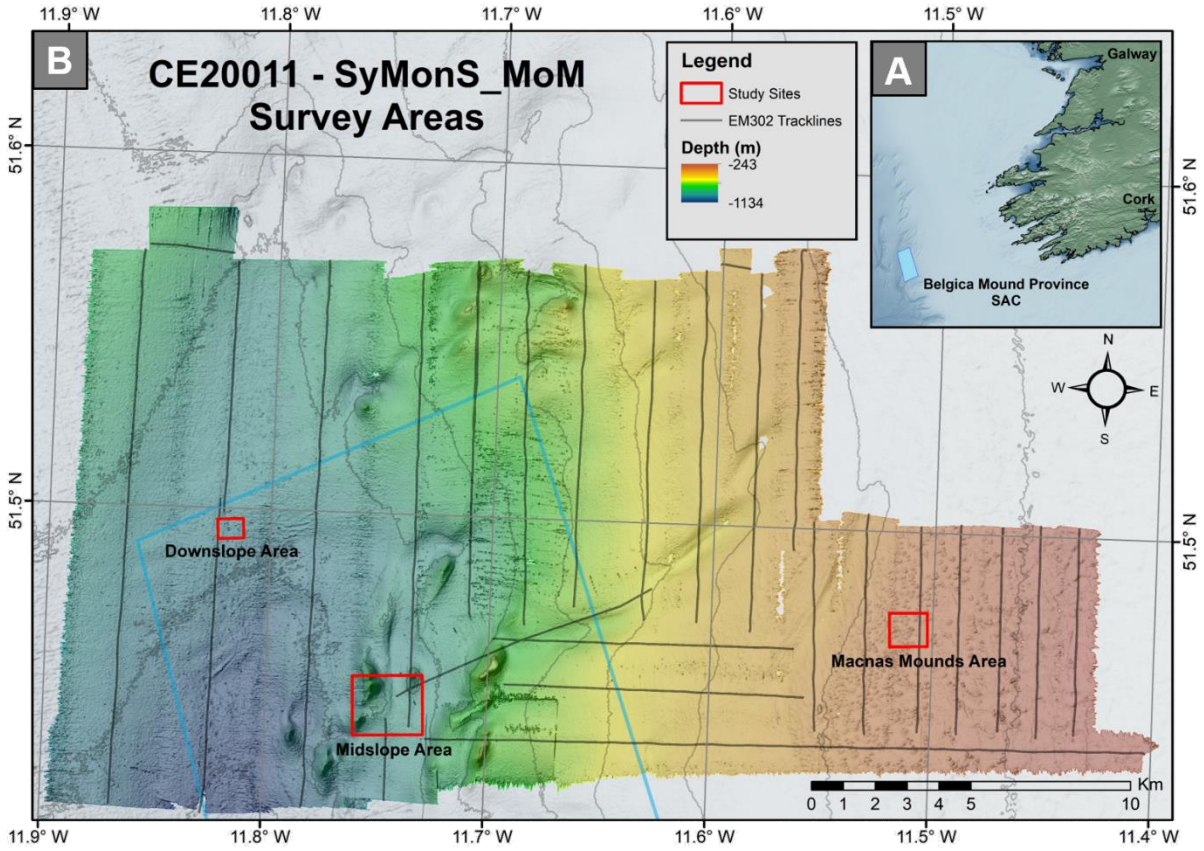

Figure 1. A) Map showing the location of the Belgica Mound Province relative to Cork, Ireland and B) SyMonS_MoM survey areas (red boxes).

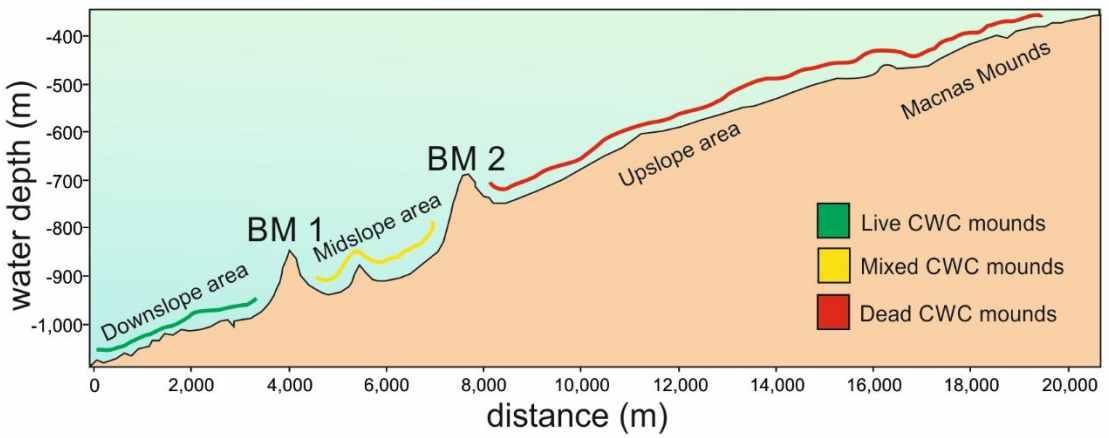

Figure 2. Schematic cross section, east-to-west through through the study areas showing the depth gradient and coral mound status from the downslope Moira Mounds to the Macnas Mounds. BM1 = Belgica mounds chain 1, BM2= Belgica mounds chain 2.

The Belgica Mound Province is a Special Area of Conservation within the eastern Porcupine Seabight, Offshore Ireland. It was designated as an SAC to protect the large coral mound features there. The Belgica Mound Province consists of 2 chains of contour-parallel 'giant' cold water coral mounds (Kozachecko, 2005). In addition, there are over 300 small sized cold water coral reefs known as the

Moira Mounds (Wheeler et al., 2005; Foubert et al., 2011; Wheeler et al., 2011; Lim et al., 2018). The Moira Mounds can be divided geographically into 4 separate regions: the downslope area; the midslope area; the northern area and the upslope area (Wheeler et al., 2011). The Mounds in the downslope area are dominated by *desmophylum pertusum* and are composed primarily of living coral frameworks (Lim et al., 2017). Conversely, the Mounds in the midslope area are dominated by *madrepore occulata* and a primarily dead (Foubert et al., 2011). Although the Moira Mounds are relatively small, there is considerable variation between them (Lim et al., 2018). One such Moira Mound, known as the Piddington Mound, has been subject to considerable high resolution mapping and videomosaicking (Lim et al., 2017; Lim et al., 2018b, Conti et al, 2019; Boolukos et al., 2019 and Price et al., in review). Results show that the mound demonstrates a clear organisation of the coral framework and that mound shows a significant decline in coral cover between the years 2011 and 2015.

Data from this survey will be used to understand why these mounds vary in space and time as various temporal and spatial scales. To do this, a systematic and therefore comparable survey is proposed to understand mound spatio-temporal variability. The data acquired on this survey feeds directly into a number of existing projects as well as proposed new projects. The data is part of Aaron Lim and the Marine Geology Research Groups research agenda's. Specific projects that these data will furnish are: the H2020 project "Integrated Assessment of Atlantic Marine Ecosystems in Space & Time" (iATLANTIC) and the SFI-, GSI- and MI-funded "Mapping, Modelling and Monitoring Key Processes and Controls on Cold Water Coral Habitats in Submarine Canyons" (MMMonKey_Pro) programme, Larissa Macedo's Irish Research Council Project, Marine Protected Areas Monitoring and Management MarPaMM and the Marine Institutes Post-Doctoral Research Fellowship Project 'Mop_uP'.

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Survey Objectives (and cruise track)

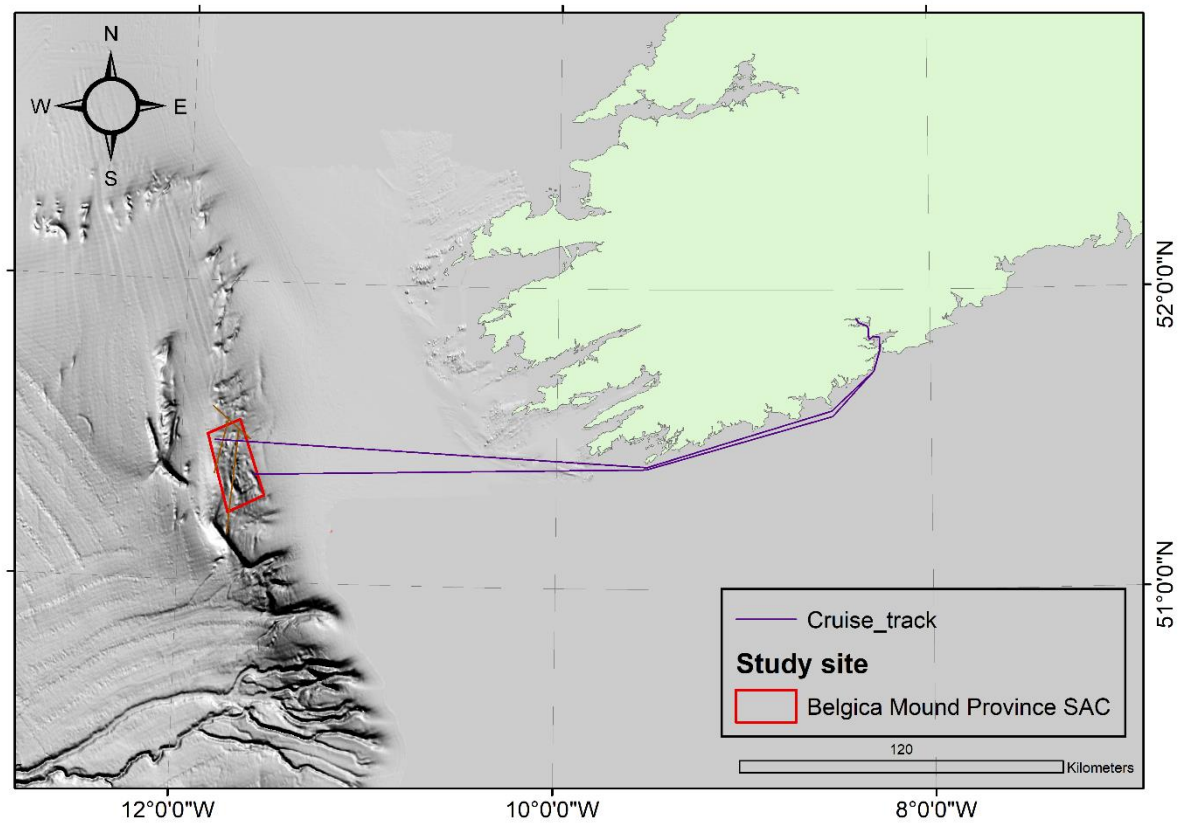


Figure 3. Map showing main cruise track

The SyMonS_MoM research cruise (CE20011) has 5 objectives:

Task 1.1 - ROV-mounted multibeam echosounder (Kongsberg EM2040)

An EM2040 was integrated with a sound velocity probe, interital navigation system and mounted on the Holland 1 ROV. The objective on the survey is to acquire mulitbeam data (400 kHz) at each of the study areas in order to identify suitable lander deployment sites. Furthermore, multibeam data (*.all and *.wcd) will be acquired at 200 kHz and 400 kHz within the Downslope area. These data will be used to examine the potential usefulness of multfrequency watercolumn data for particle flux characterisation.

Task 1.2 - ROV Photogrammetry

The Holland 1 ROV will be mounted with a downward-facing 1080i HD video camera. It will be equipped with a USBL beacon and inertial navigation system, laser scalers (10 cm) and lights. Data will be acquired in a 0.5 m gridded survey design, imagine a coral mound within each of the survey areas. Data acquisition will be managed within SIS, where the ROV will remain approx. 1 m above the seabed. This data will be used for: a) characterisation of the survey sites and; b) to complete a time series analysis of the Piddington Mound (2011; 2015; 2020).

Task 1.3 - Hull-mounted multibeam echsounder (Kongsberg EM302)

The vessel mounted Kongsberg EM302 will acquire data during ROV reconfiguration periods. The survey lines will be set up to acquire water column (*.wcd). Data acquisition will be managed within SIS. EM302 bathymetric and backscatter data will be used to characterise the survey areas, to compare against previously acquired data in the area (e.g. Beyer et al., 2003; INSS, 2005) and to contextualise ROV-mounted water column data.

Task 1.4 - ROV Lander systems

8 Lander frames, each equipped with an upward-facing Acoustic Doppler Current Profiler (ADCP) and Sediment Trap have been adapted specifically for deployment via the Holland 1 ROV. The landers have each been programmed to collect to trap particle flux binned into 14 day periods for approx. 1 year. Likewise, each ADCP was programmed to acquire 25 m current profiles for a period of 60 s every hour for 1 year. We aim to deploy 2 landers in each of the survey areas, 1 to the north of a coral mound and 1 to the south of the same coral mound. Deployment via ROV allowed to sample and image the area around the lander deployment site. Further, ROV pilots were able to exact the bottom position of the Lander to record on and around smaller seabed targets (small reefs, scour pits, mound summits and flanks, gullies etc.) in deep water. Landers will be retrieved on a follow up survey next year.

Task 1.5 - ROV Vibrocores

The Holland 1 ROV will be mounted with a vibro-core rig. The vibrocore rig will be used to acquire sediment cores from the survey areas. In particular, cores will be taken from coral mounds and adjacent areas. A maximum of 5 cores can be retrieved during a single ROV dive. On recovery to deck, all cores will be removed, labelled and stored within a refrigerated space.

Equipment

RV Celtic Explorer

The RV Celtic Explorer is a 65.5 m multi-purpose research vessel. 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. The aft deck has a 25 tonne "A-frame" with a 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.

The RV Celtic Explorer

Kongsberg EM302 Multibeam Echosounder – Hull Mounted

The Kongsberg EM302 multibeam echosounder is deep-water sonar which operates at 30 kHz achieving an 8,000 m water depth range. It is mounted at the hull of the RV Celtic Explorer (not on the drop keel). It is integrated with a sound velocity probe, C-Nav navigation, a motion reference unit and a dedicated processing unit. All planning and data acquisition is carried out in SIS.

Holland 1 ROV

The Holland 1 ROV is a remote operated vehicle (ROV) used for capturing underwater remotely sensed data. ROV records seabed data while transmitting these live to the scientists aboard the vessel. It is depth-rated to 3000 m and has 100 hp with a maximum speed of 3 knots. An EM2040 multi-beam echo sounder is mounted on the vehicle for high-resolution bathymetric mapping of the seabed. The EM2040 operates at 200 - 400 kHz and is effective to 600m. The ROV is equipped with eleven camera systems which include an HDTV camera (HD Insite mini-Zeus with HD SDI fibre output), two deep-sea power lasers spaced 10 cm, a pan-tilt colour zoom camera (Kongsberg OE 14-366), a digital stills camera (Kongsberg OE 14-208), two HD high inspection cameras (Kongsberg OE 14-502), a Pegasus colour camera, two aurora colour cameras (for night vision), one mini tooling camera with an integrated ring light and two navigation-specific low-resolution cameras (Near SIT and B/W). Positioning data were recorded with a Sonardyne Ranger 2 ultra-short baseline (USBL) beacon and Kongsberg inertial navigation system (INS). It is also fitted with a CTD and 2 robotic arms for sampling (1X7F and 1X5F) and an aspirator.

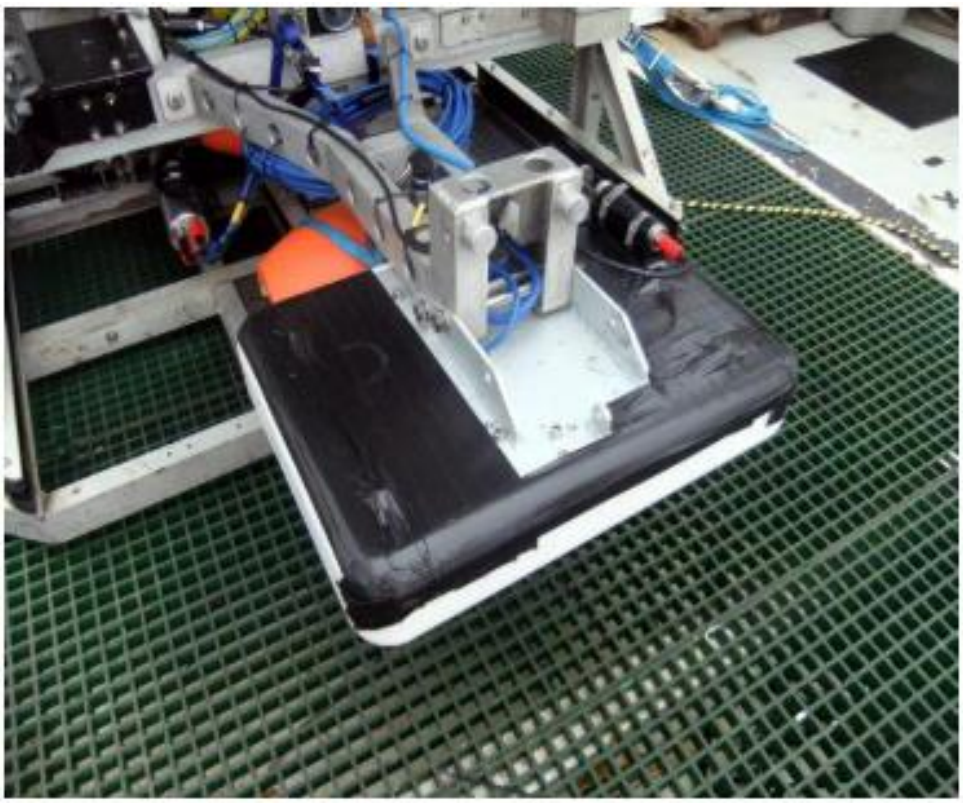
The Holland 1 ROV being prepared for launch (left) and its video and lighting rig (right).

ROV CTD

A Sea Bird Electronics SBE 911 plus CTD was used to measure variations in a variety of parameters in the water column. The CTD device was mounted on the Holland 1 ROV, and measurements were recorded during the descent, during and ascent of ROV dives. The CTD was fitted with the following sensors: SBE 35 Digital Thermometer, a SBE44plus conductivity sensor, a Digiquartz pressure sensor, a SBE 43 dissolved oxygen sensor, altimeter, fluorometer and a nitrogen saturation sensor.

Kongsberg EM2040 Multibeam Echosounder

The Kongsberg EM2040 multibeam echosounder is a high-resolution sonar with wide-band composite transducers which can operate at 3 frequencies (200 kHz 300 kHz, and 400 kHz), non-simultaneously. It is depth-rated to 6000 m. For this cruise, it is mounted on the Holland 1 ROV and integrated with a sound velocity probe, Sonardyne USBL, DVL and IXSea Inertial Navigation System. Acquisition is planned and managed via Kongsberg's Seafloor Information System (SIS) where it will be flown at approx. 100 m off the bottom at 200 kHz and at a survey speed of 0.4 knots.



Kongsberg EM2040 mounted on the Holland 1 ROV

ROV Vibrocore

The MBARI Vibrocorer is designed to retrieve core samples from water-saturated sediment from an ROV. This mean targets can be accurately positioned both by USBL and visual observation. The corer can be vibrated at a range of frequencies which allows it to penetrate soft sediment on the seabed with minimal disturbance. The vibrocorer was developed by MBARI and fixed to the front of the ROV. Up to 5 core barrels can be stored on the rig and are loaded by the ROV manipulator arms.

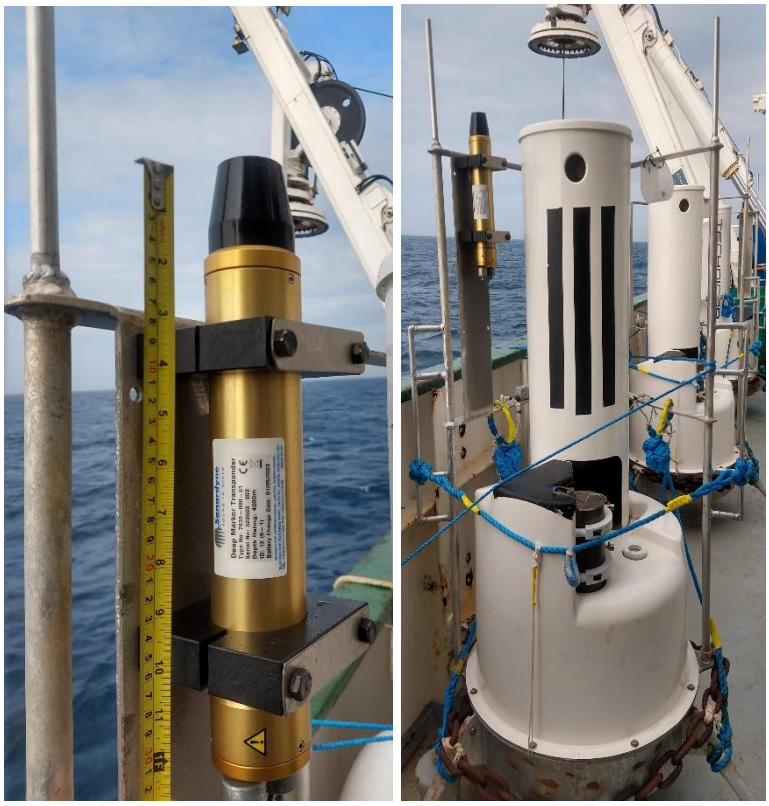
The Vibrocore rig mounted on the ROV

Deep Water Lander Systems

Eight monitoring stations, referred to as "Landers", have been designed specifically for this survey. Each Lander is equipped with an Acoustic Doppler Current Profiler (ADCP) and Sediment Trap. The ADCP is a 1 Hz Nortek Aquadopp, depth-rated to 3000 m water depth. It is powered by battery and can continually measure data from 0-25 m from the transducer for up to twleve months. The ADCP is mounted vertically, with sensors pointed upwards. All eight ADCPS were programmed to start data collection at the 02/10/2020 with one current speed measurement every 3600s (1 hour). Three landers were equipped with Sonardyne transponder beacons for positioning.

The sediment trap is a Technicap sediment trap, depth-rated to 6000 m water depth. It is made up of a streamline (teardrop-shaped) carbon fibre housing for minimal disturbance to the local hydrodynamic regime. The housing has a funnel which allows particles (e.g. sediment, POM, microplastics) to settle into the trap. The sediment is stored within 24 X 500 ml bottles, which were programmed to open at defined intervals to trap particulates during each period. The titanium motor is battery operated (12 volt AA alkaline batteries pack) and can continuously record for up to 18

months. The motor controls the rotation of the bottle carousel. For this survey, the sediment trap was programmed to start rotating on the 02/10/2020 at an interval of 1 bottle every 14 days.



Sonardyne beacon (left) and lander system ready for deployment (right)

Nylon strips

Landers were also equipped with 8 nylon strips. These will be used to collect biofouling material growing whilst the landers are underwater. One nylon strip was mounted on the frame of each lander. Each strip measures 25 x 6 cm.

Nylon strips (measuring tape as scale - right). Nylon strip mounted on lander frame (left)

Survey Log (UTC)

22/09/2020

1300 - Arrive at RV Celtic Explorer

1340 - COVID19 Medical examination

1430 - Survey Induction

1500 - Bridge meeting. Weather forecast shows unsuitable conditions for ROV work until the morning of the 26/09/20. The plan at the time of writing is to depart Galway at approx. 1000 on the 25/09/20. To accommodate for the reduction in survey time we have decided to not complete a calibration of the USBL system as a) the homer beacons that will be attached to the Landers for retrieval will be sufficient and b) the positioning for the USBL may not improve significantly after a calibration. In addition, the vessel technician says that each time the drop keel is moved, the system may need a recalibration anyway.

1800 - Dry lab set up

23/09/2020

0800 - Wet lab set up. Landers bottles prepared. Fresh seawater was unavailable so decided to wait until the start of the transit to obtain seawater for the lander bottles.

24/09/2020

0800 - Ruaihri trained in Sonardyne USBL operation and SVP calibration. Dry lab set up.

1230 - Luke gives lander workshop and developed a lander workflow protocol

1830 - Bridge meeting (Denis, Paddy and Aaron). Confirmed that the Pilot vessel is booked for 1030 on 25/09/2020. Due to Arrive on site on 26/09/2020.

25/09/2020

0800 - Wet lab set up (prepare bottles, tie down equipment).

0940 - Leave dock

1000 - Equip landers with bottles and ADCPs. Completed at 1300

26/09/2020

0300 - Arrive on site at the Piddington Mound. Waiting for weather to calm to deploy the ROV.

0428 - ROV in water (Dive 1). Troubleshooting ROV technical issues. ROV CTD cast recorded (station 1) on descent, converted to SVP and used to calibrate the EM2040 sound velocity profile.

0725 - ROV multibeam testing.

0854 - Commence ROV multibeam grid (station 2; 400 kHz) at the downslope area of the Moira Mounds.

1230 - Commence ROV multibeam grid (station 3; 200 kHz) at the downslope area of the Moira Mounds.

1600 - ROV multibeam mapping complete in the downslope area. ROV pilots noticed moisture in the bulk head and needed to assess/fix. Decided to do hull-mounted multibeam mapping as the contingent activity. Survey lines at 6 knots between survey areas (station 5).

27/09/2020

0410 - ROV issue rectified and stopped EM302 hull-mounted mapping. ROV in water for ROV-mounted EM2040 multibeam aping at the midslope area. To test positioning it was decided to collect the first main line of multibeam data over a large mound feature and then continue to map the survey area. Noticed that a 'striping' artefact gradually becomes clear throughout the data. Continued collected the data to pick a suitable target for lander deployment. Further, this ripple artefact may be rectified in post processing using the raw INS data.

1130 - Dive complete and ROV back on deck. Steam to next site (Macnas mounds).

1325 - Arrive at Macnas mounds. ROV deployed (Dive 3) and ROV multibeam survey (11) begins.

2000 - Dive complete and ROV on deck. Start hull-mounted EM302 mapping while ROV pilots demobilise the EM2040 and prepare for lander deployments.

28/09/2020

0430 - ROV in water and Lander 1 (A) deployed to the south of the Piddington mound (Dive 4). ROV circled around for local context and recovered to deck. Lander 1 has a transponder marker beacon.

0652 - ROV in water and Lander 2 (D) deployed to the north of the Piddington mound (Dive 5), approx. 125 m north of Lander 1. ROV circled around the lander for local context and recovered to deck.

1110 - ROV in water (Dive 6) and Lander 3 (E) deployed to the east (approx. 150 m), off-mound area of the Piddington Mound. ROV circled around the lander for local context and recovered back to deck. Transit to next Lander site.

1300 - ROV in water (Dive 7) and Lander 4 (B) deployed in the midslope Moira Mounds area. ROV circled around the lander for local context and recovered back to deck. Transit to next Lander site.

1640 - ROV in water (Dive 8) and Lander 5 (C) deployed in the Macnas mounds area. Lander deployed on the summit of a mound feature. ROV circled around the lander. Noticed that the features had no live coral and was mainly sediment covered. Decided to acquire some video footage from another mound to the NW (100 m) so confirm if the target was anomalous. ROV recovered to deck and transit back to the downslope area for lander deployment.

2100 - ROV in water (Dive 9) for Lander 6 (F) deployed in the downslope Moira Mounds area to the south of a mound feature.

29/09/2020

0046 - ROV in water (Dive 10) for Lander 7 (G) deployed in the downslope Moira Mounds area to the north of a mound feature.

0158 - Started acquiring bathymetric data with the hull-mounted EM302 while the ROV was configured for photogrammetric surveying with downward-facing HD camera.

0717 - ROV in water (Dive 11) for photogrammetric surveying of the Piddington Mound area. ROV recovery to deck at 1243.

1358 - Start hull-mounted EM302 mulitbeam mapping.

1510 - Review the impact of weather on the EM302 data quality. Try northerly line and to decide after.

1900 - EM302 data quality deteriorating so it was decided to heave to in position until sea state improves.

30/09/2020

0850 - Discussed with ROV Pilots and Captain the potential for continuing on the previous ROV dive. Decided to go to station and assess the suitability for the ROV to go back in.

1219 - ROV in water (Dive 12) to complete photogrammetric survey of the Piddington mound.

1756 - ROV back on deck and ROV mobilise for ROV vibrocoring.

1/10/2020

0017 - ROV in water (Dive 13) to acquire ROV-mounted vibro cores at the Piddington Mound (1 on-mound, 1 off-mound; VC 1 and VC 2; stations 54 and 55).

0500 - ROV in water (Dive 14) to acquire ROV-mounted vibro cores at the Macnas Mounds (1 on-mound, 1 off-mound; VC 3 and VC 4; stations 58 and 59).

0645 - ROV back on deck and start transit to Galway for demobilisation as weather conditions are not favourable and main objectives are complete.

Key Results Summary

Hull-mounted multibeam (EM302)

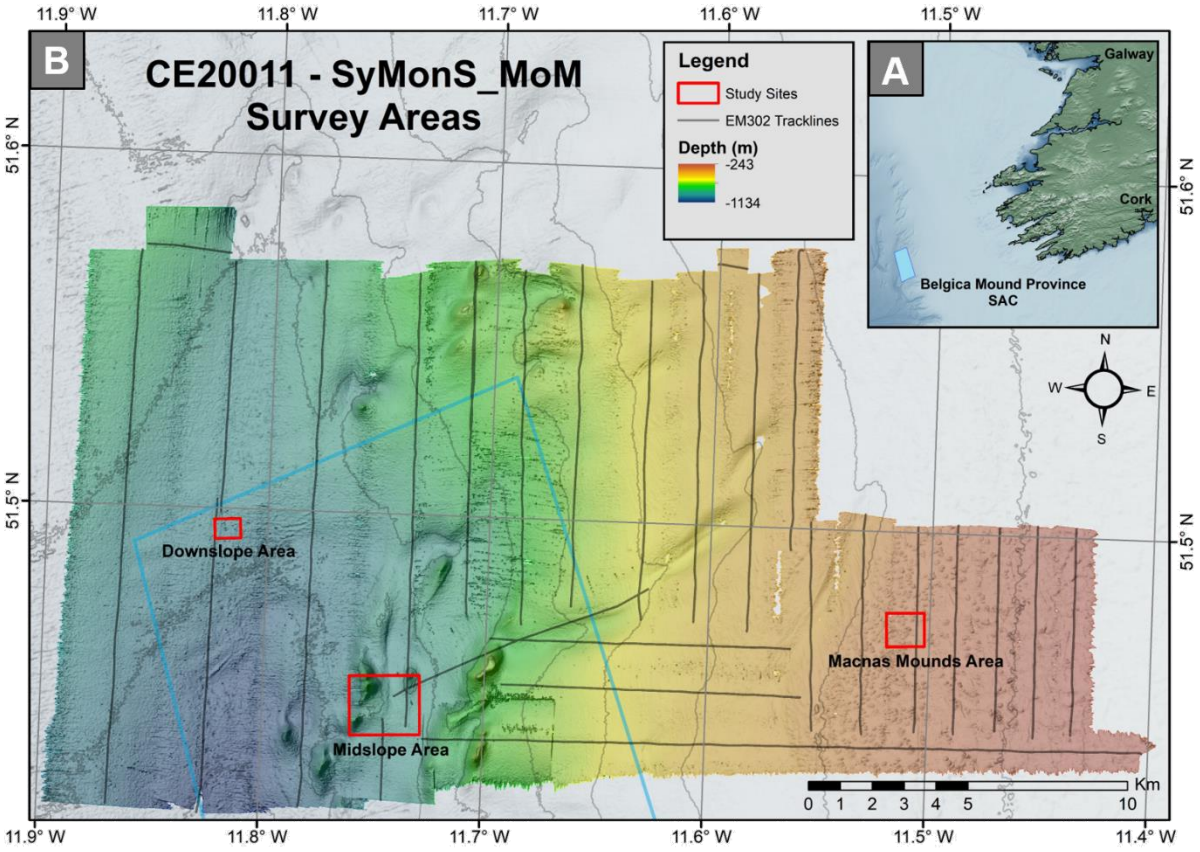
The hull mounted multibeam was collected via a Kongsberg EM302 echosounder at a speed 8 knots per hour. Line spacing was determined to ensure that 25 % overlap was achieved throughout the survey to compensate for the drop in data quality typically seen in the outer beams. An approximate total of 350 km2 has been mapped over the Macnus mounds, Moira Mounds, and the Belgic Mound Province (BMP).

Bathymetry

The raw .all files were collected from the EM302 and processed through QPS bathymetric processing software suite; Qimera. The raw data were then gridded at 10 m spatial resolution and exported as .asc files. The depth range for the area goes from minimum depth of -350 m to a maximum of -1160 m.

Backscatter

The backscatter for the hull mounted multibeam was processed via QPS's FMGT suite. This was gridded at 5 m resolution and had a data range of 5.7 - 53.3 dB. The BMP is clearly visible in the west of the area, the Macnas mounds to the east form ridge like features that trend in a North West - South East direction. The ridges have a darker side facing south ward and a lighter side facing



ROV-mounted multibeam (EM2040)

The ROV multibeam was collected via a Kongsberg EM2040 echosounder at a speed of 0.2 m/s. At ROV Dive 1 this data was collection was done initially at 400 kHz and repeated over the same area at 200 kHz. Here the ROV was flown at a height of 45 m prioritizing spatial resolution coverage of the mounds over total area mapped. Later during Dive 2 and Dive 3, the ROV was maintained at a height of 80 m and was collected at a frequency of 400 kHz. This height was maintained to ensure a greater surveyed area so that a target mound could be identified for the landers.

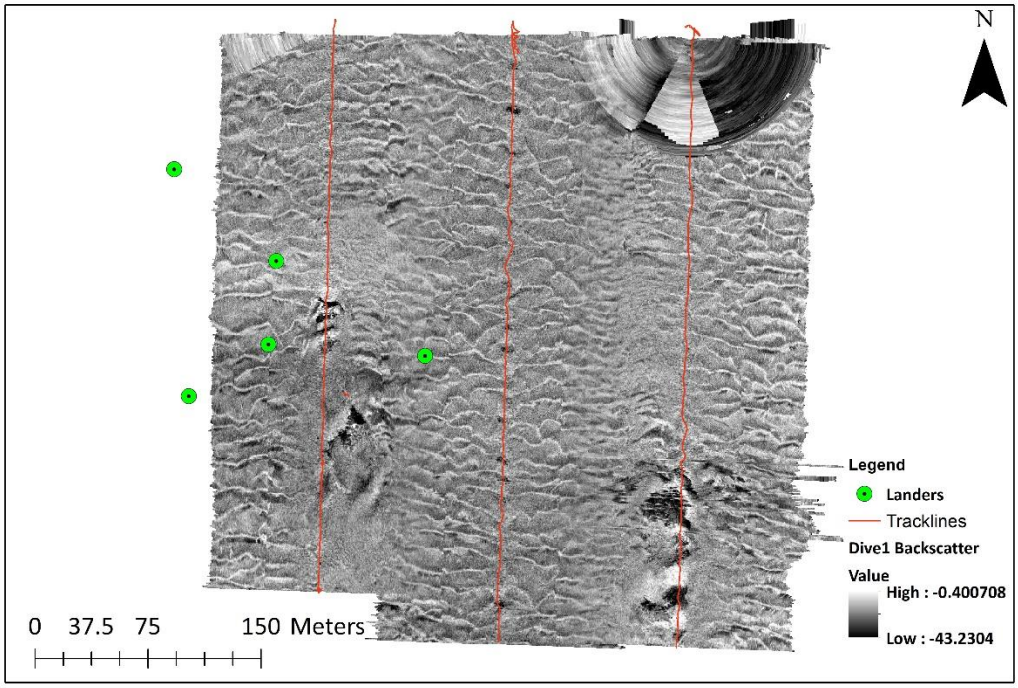
Bathymetry

Bathymetry for the ROV multibeam was processed using the same techniques as the EM302, with the exception that the ROV position was used as the vessel position within the processing parameters and that the data was gridded at 0.5 m spatial resolution. When the raw data for the ROV had been processed a DVL stripping had been imprinted on the data, this is planned to be resolved by using 2D Fast Fourier Analysis to remove the DVL artefact in post processing onshore. This data complements data that has been collected by the group in the Querci 1 survey and represents a potential for temporal analysis of the mounds and how they may have changed over the last 5 years.

Backscatter

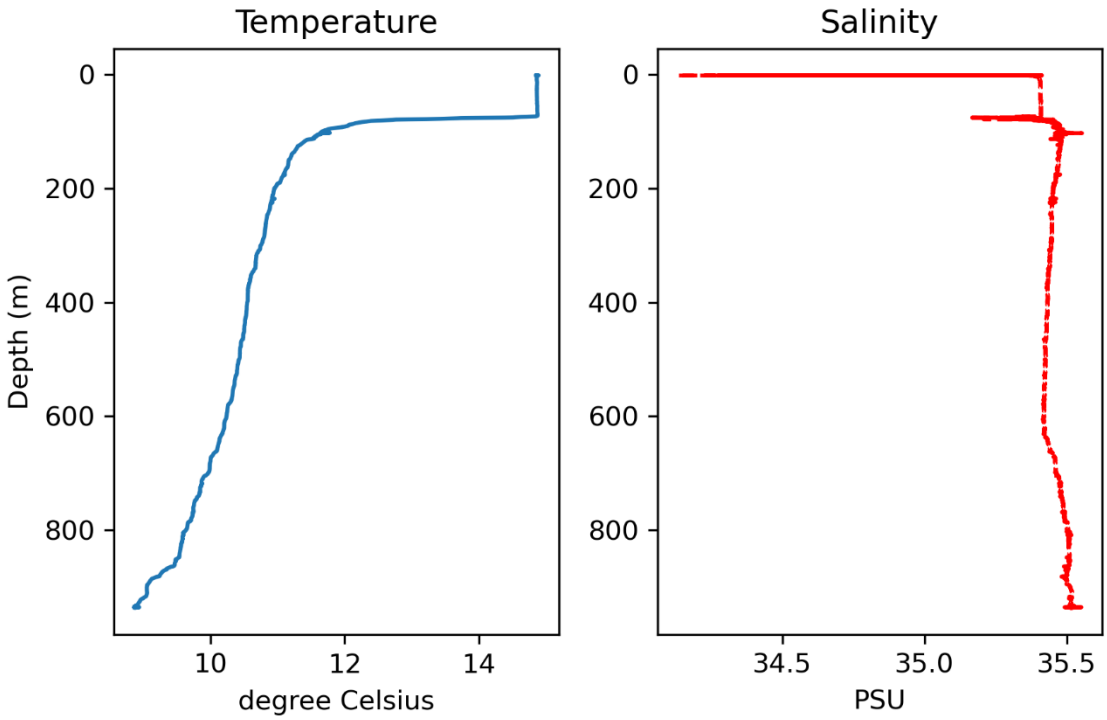
Backscatter data was processed in a similar method to the hull mounted backscatter, however the final image was gridded at a spatial resolution of 1 m. The artefact to the North East is data that was collected during a turn. A mound is visible in the South West of the Moira Mounds site with a scour pit on along its southern and western flanks, a series of sediment ripples surrounding the mound. The orientation of the ripples would indicate that the flow is going northwards.

Dive 1 ROV Backscatter and Landers

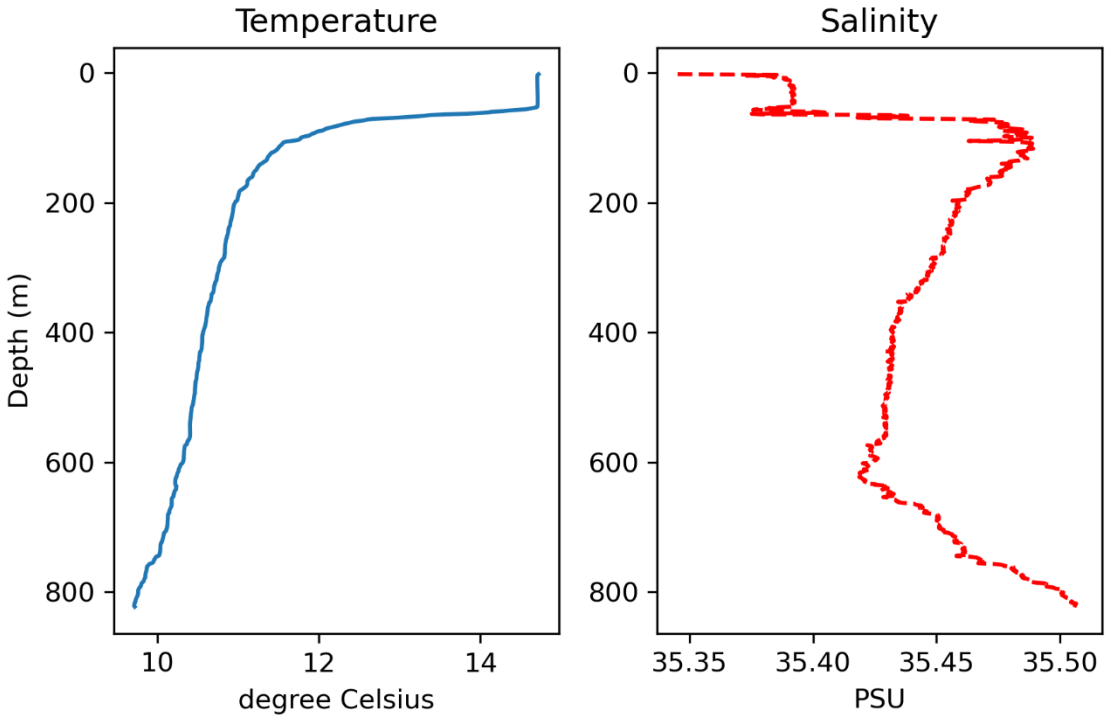


CTD Profiles

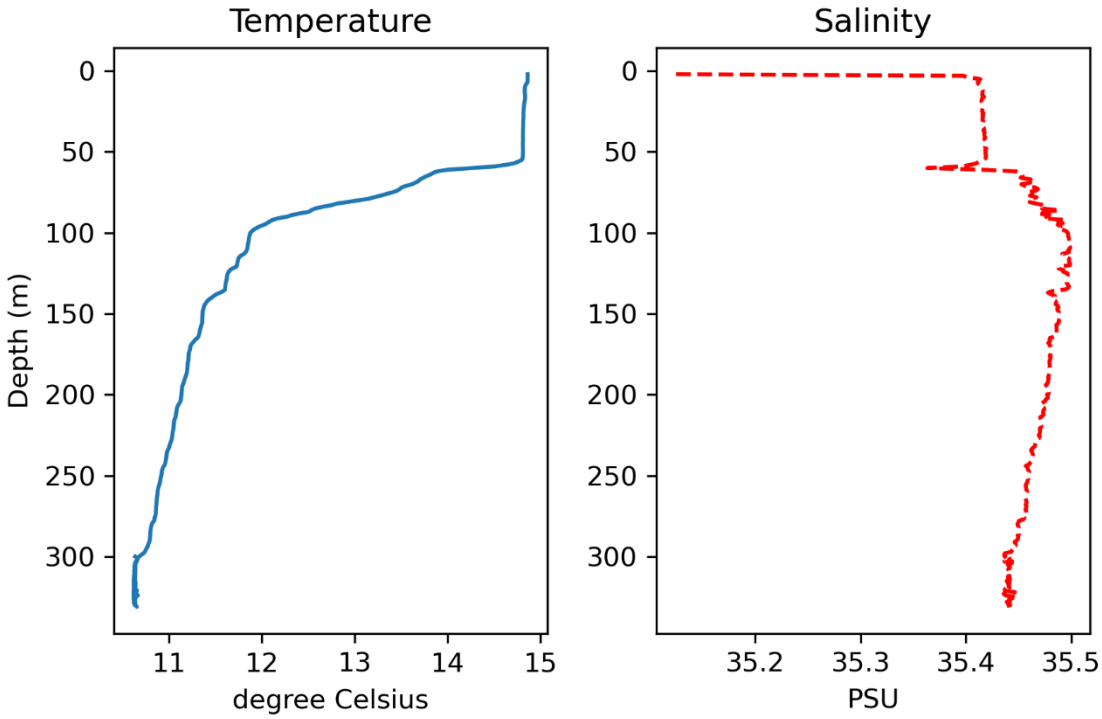
Downslope Moira Mounds



Midslope Moira Mounds

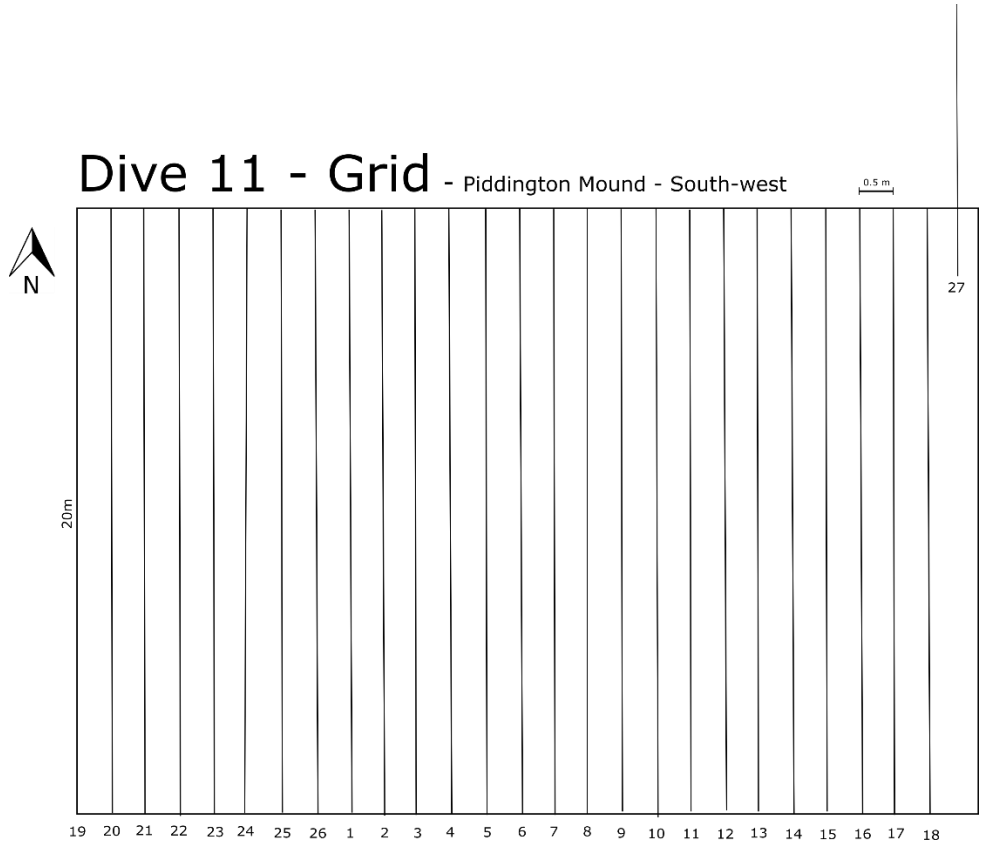


Macnas Mounds

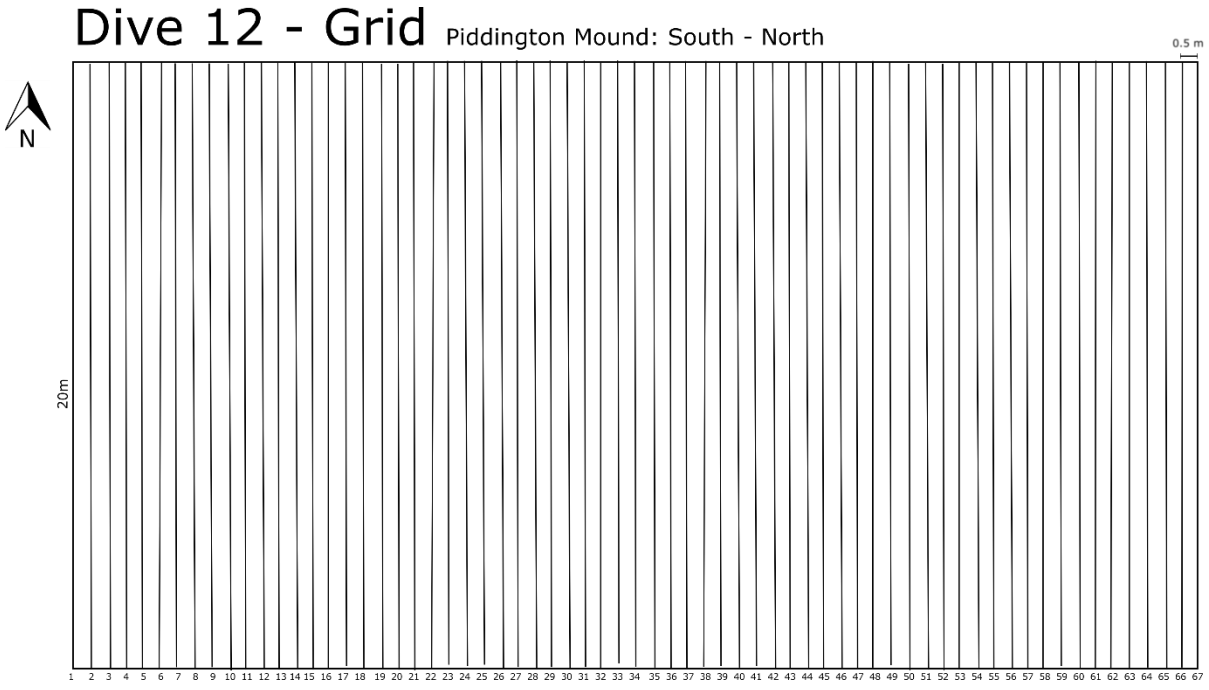


ROV Video/Photogrammetry

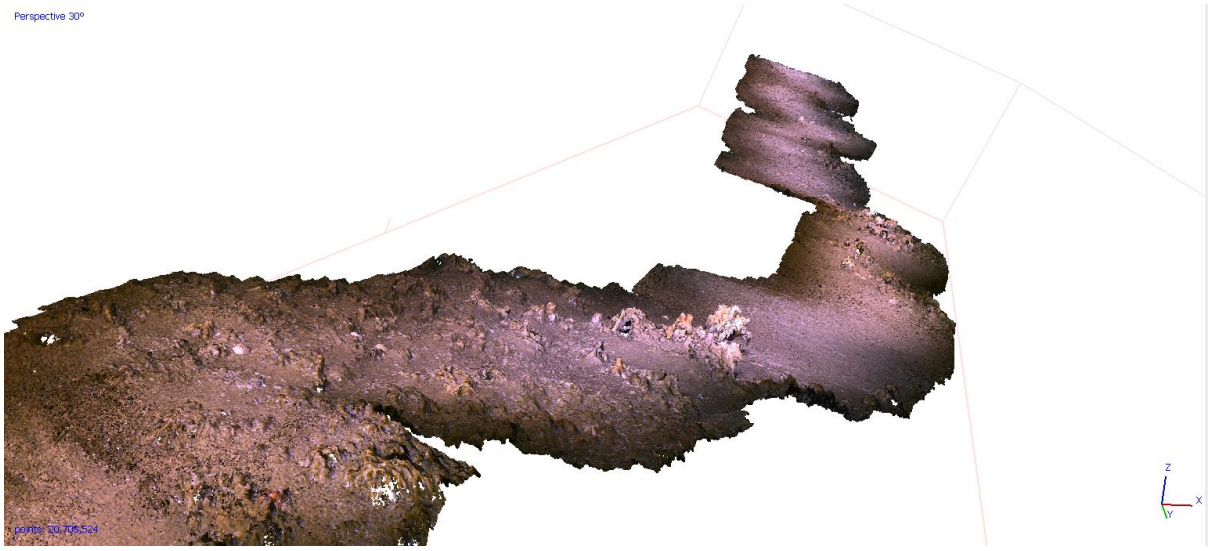
Two downward-facing ROV HD video survey grids were acquired during in the downslope Moira Mound area. Each grid is approx. 20 m X 20 m, with 50 cm spacing between lines. The ROV maintained an altitude of 1 m from the seabed using the altimeter. The survey speed was 0.1 knots. USBL navigation and INS attitude data were recorded during both dives. The first grid was acquired approx. 30 m to the south west of the Piddington Mound to ensure accurate reflection of the local off-mound setting which consisted of rippled sands, seabed scour, dropstone pavements and coral-colonised sediment waves. The second grid was acquired at the southern flank of the Piddington Mound. This grid will be used to compare against the findings of the 2011 and 2015 Piddington Mound datasets. Video data shows the mound consists of *lophelia* and *madrepora* (live and dead), glass sponges, squat lobsters, coral rubble and rippled sands. Coral density ranges from sparse near the flanks and edges to dense near the summit.



SW Piddington Mound photogrammetric survey design



Piddington Mound photogrammetric survey design



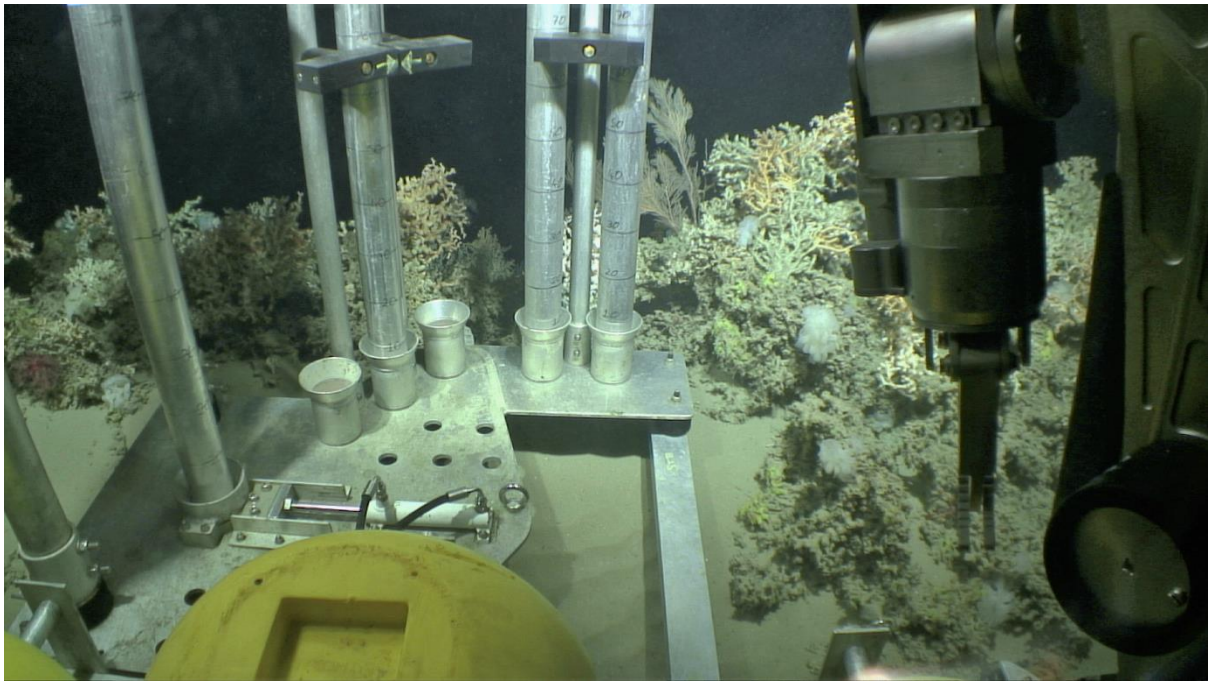
Test dense cloud reconstruction of the area to the SW of the Piddington Mound

Vibrocores

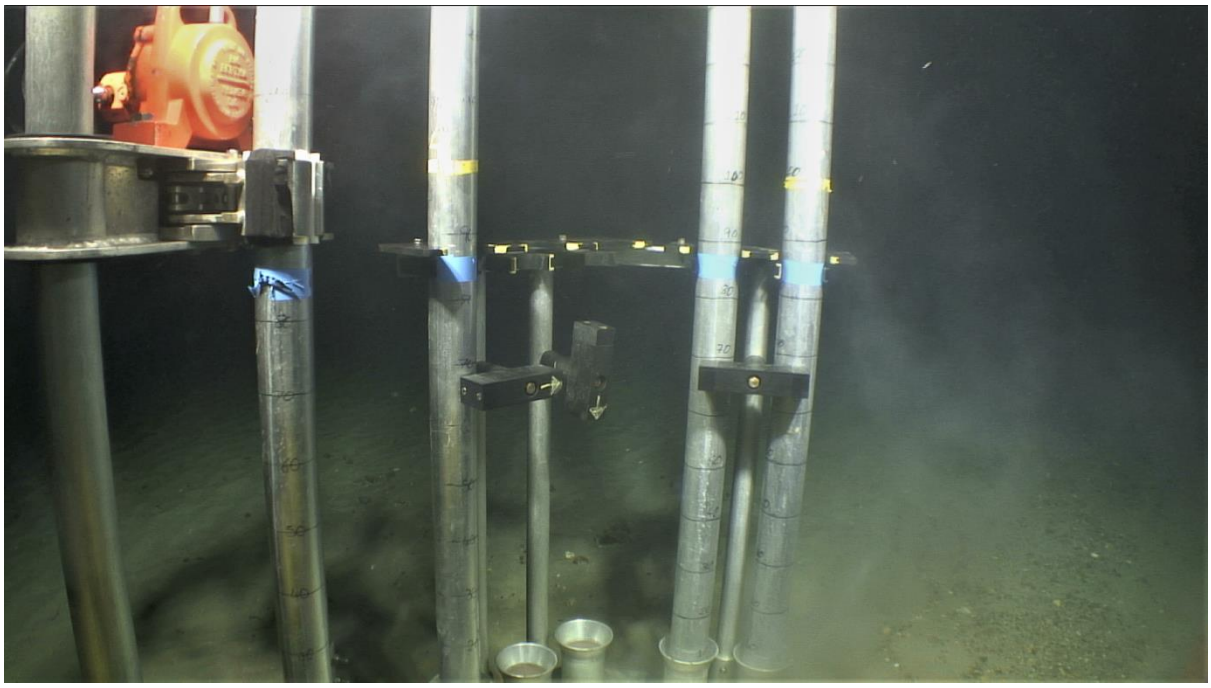
Core	Dive	Station	Lat	Long	Depth (m)	Apparent Penetration (m)	Retrieval (m)	Comments
VC1	13	54	51°29'42.336''N	11°49'08.567''W	956	0.60	0.25	Coral pieces present in top and bottom of core. Sands present throughout. Matrix sediment is browny green in colour. No smell was observed. Core catcher was bagged.
VC2	13	55	51°29'43.401''N	11°49'07.153''W	965	1.80	1.98	Grey silty muds at top and bottom of core, which contained a high clay content. Minor sand package evident from 20 - 28 cmbsf. Top few cms of core were disturbed from coring process and removing surface waters. Matrix sediment throughout is light brown in colour. Black mottling present up core liner from 100 - 190 cmbsf. No smell was observed.

VC3	14	56	51°28'22.774''N	11°30'32.277''W	348	1.90	1.18	Light brown sandy silts at top of core. At 27 cmbsf the sedimentary sequence has an erosional contact into olive green silts which dominate the matrix sediment to the base of the core.
VC4	14	57	51°28'20.749''N	11°30'33.712''W	351	1.80	1.40	Light brown sandy silts at top of core. At 52 cmbsf the sedimentary sequence has an erosional contact into olive green silts which dominate the matrix sediment to the base of the core.

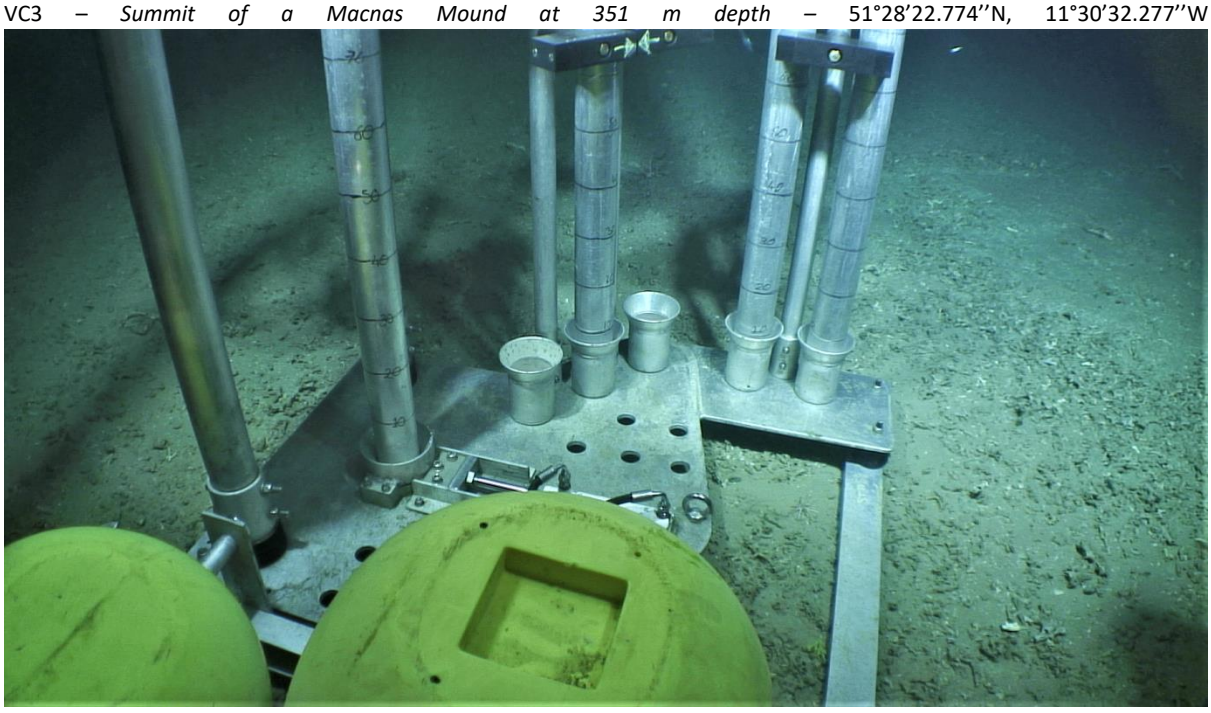
VC1 – *Summit of Piddington Mound at 956 m depth* – 51°29'42.336''N, 11°49'08.567''W



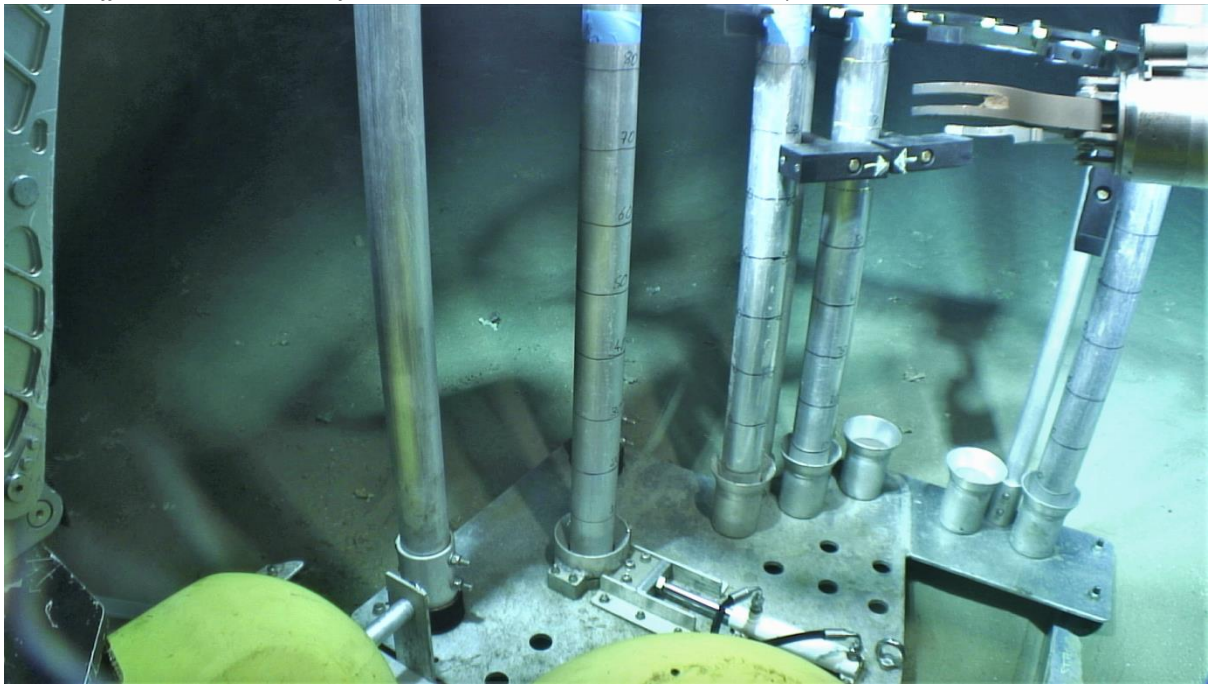
VC2 – *Off-mound core taken from Piddington Mound site at 965 m depth* – 51°29'43.401''N, 11°49'07.153''W



VC3 – *Summit of a Macnas Mound at 351 m depth* – 51°28'22.774''N, 11°30'32.277''W

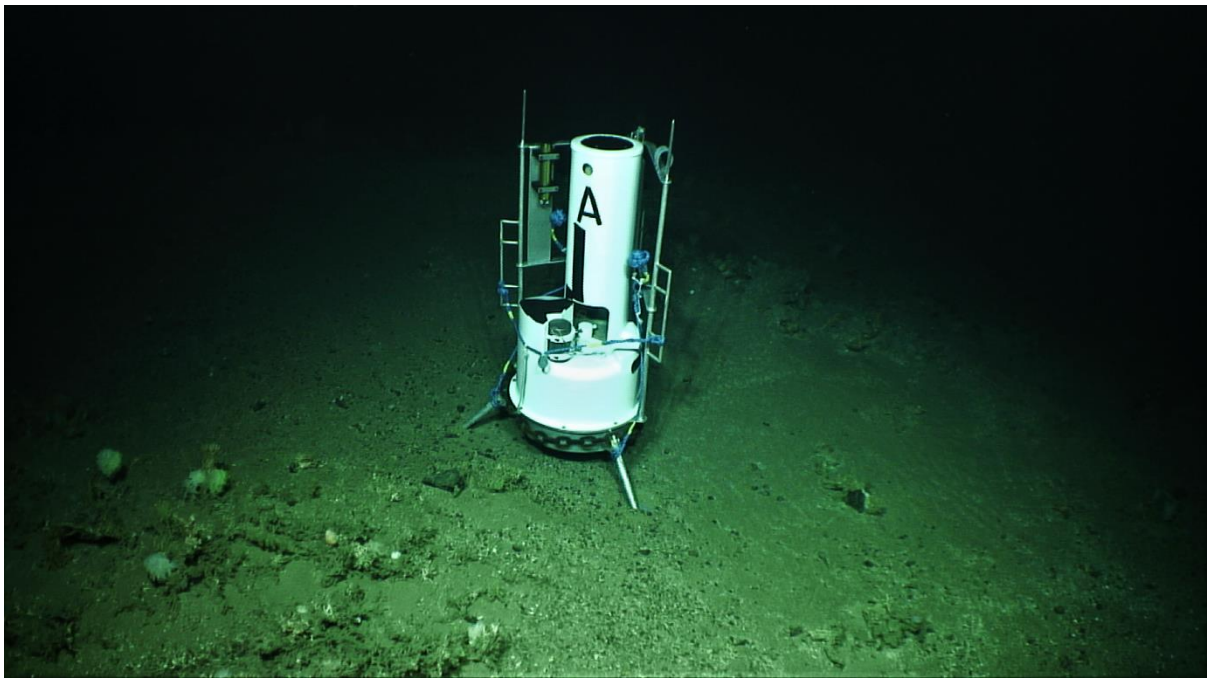


VC4 – *Off-mound core taken from Macnas Mound site at 965 m depth* – 51°28'20.749''N, 11°30'33.712''W

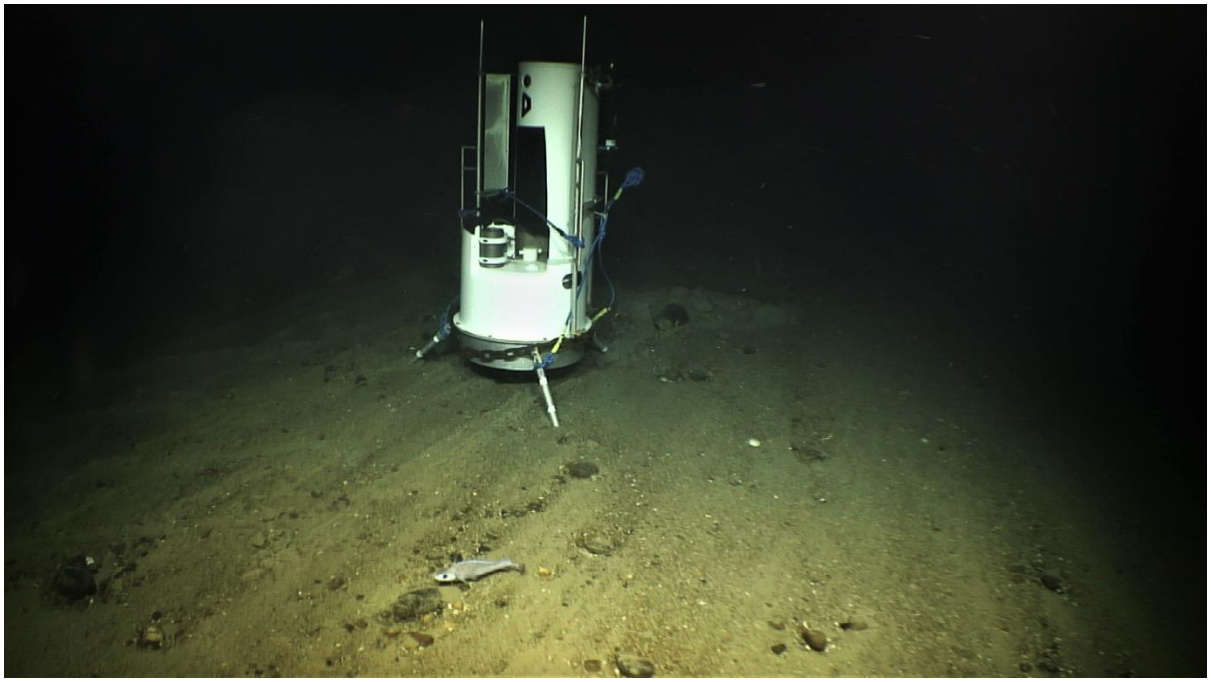


Landers

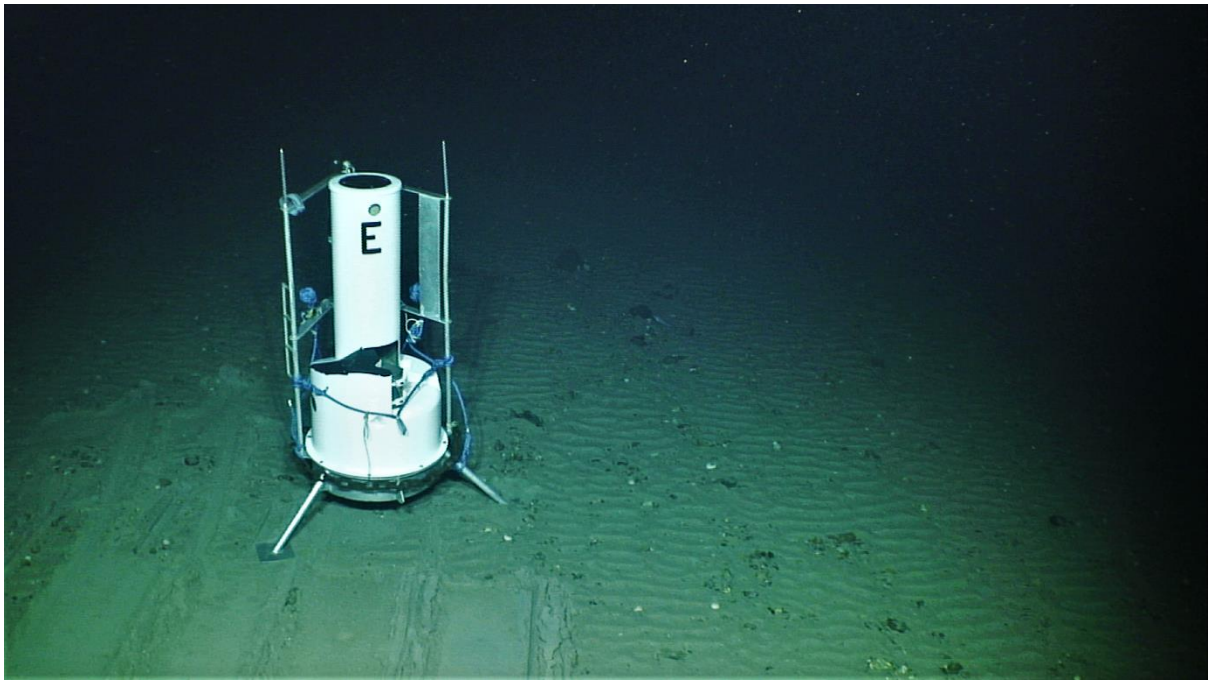
Lander 1 (A) – *South of Piddington Mound at 967 m depth* 51°29'39.00'' N, 11°49'08.00'' W



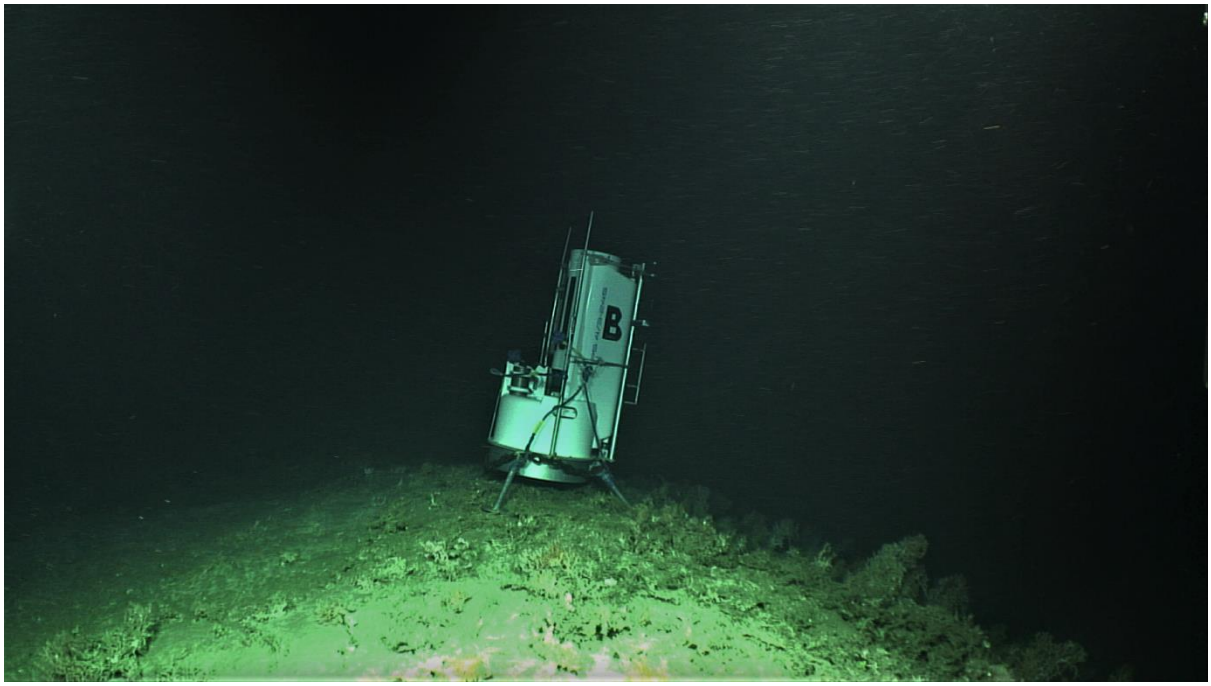
Lander 2 (D) – *North of Piddington at 965 m depth* 51°29'43.842'' N, 11°49'08.797'' W



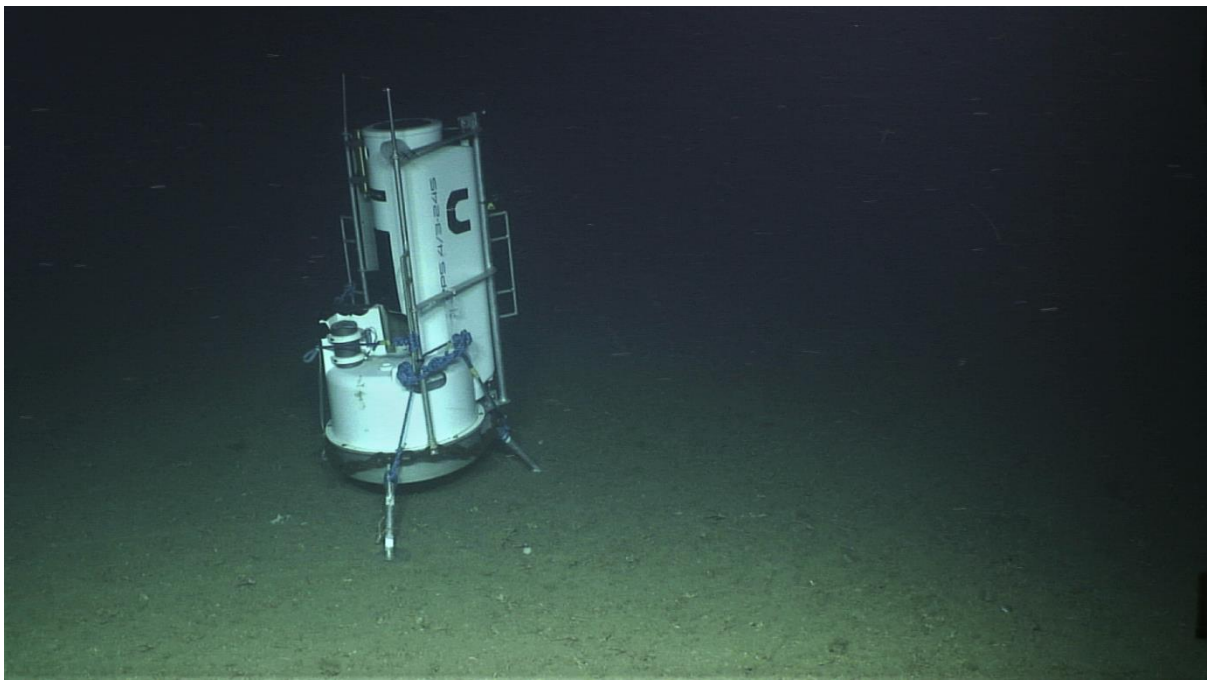
Lander 3 (E) – *East of Piddington Mound* 51°29'40.056'' N, 11°48'59.937'' W



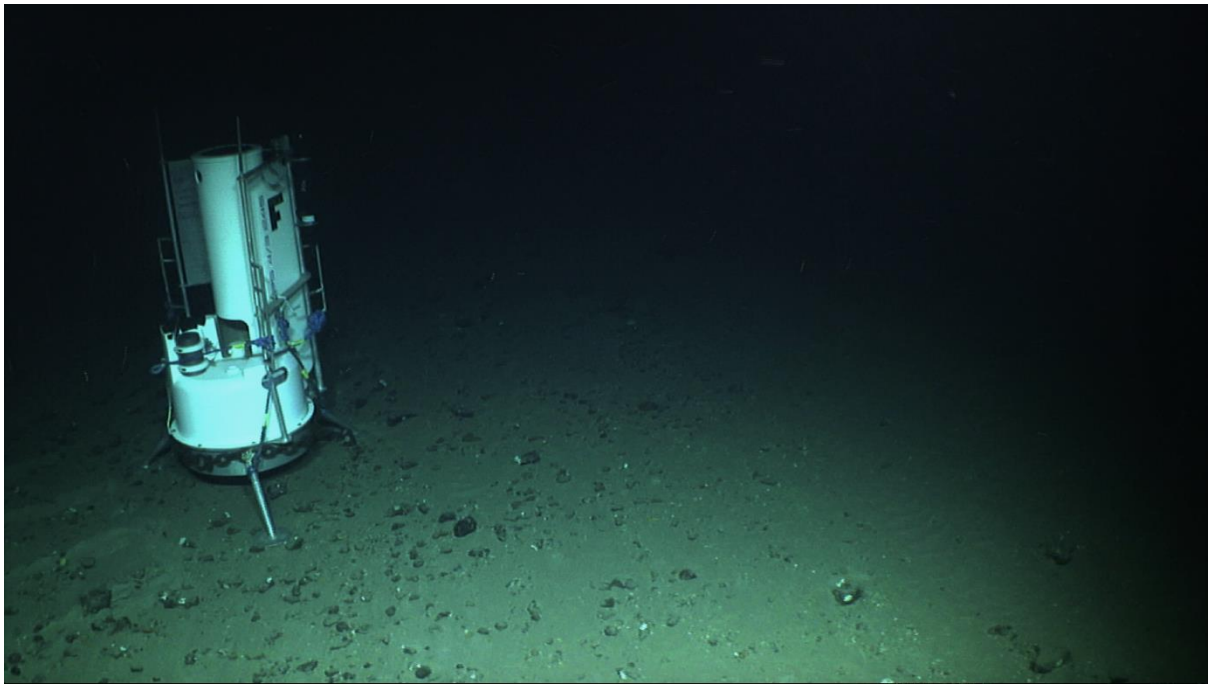
Lander 4 (B) – *Midslope Moira Mound on coral-colonised sediment wave at 911 m depth* 51°26'51.792'' N, 11°44'29.089'' W



Lander 5 (C) – *Summit of a Macnas Mound at 345 m depth* 51°28'22.684'' N, 11°30'32.359'' W



Lander 6 (F) – *South of downslope Moira Mound at 967 m depth* 51°29'40.171'' N, 11°49'05.334'' W



Lander 7 (G) – *North of downslope Moira Mound at 967 m depth* 51°29'41.964'' N, 11°49'05.174'' W

Appendices

Personnel

Scientific complement

Dr Aaron Lim	Chief Scientist
Mr Ger Summers	Day Watch Lead
Ms Larissa Oliveira	Marine Data Manager /Geoscientist
Mr Luke O'Reilly	Night Watch Lead
Mr Ruaihri Strachan	Marine Geoscientist

Holland 1 ROV pilots

Mr Paddy O' Driscoll	ROV Superintendent
Mr Karl Bredendieck	ROV Pilot
Mr Colin Ferguson	ROV Pilot
Mr Will Handley	ROV Pilot
Mr George Findlay	ROV Pilot
Mr Rob Carpenter	ROV Pilot

Officers and Crew of RV Celtic Explorer

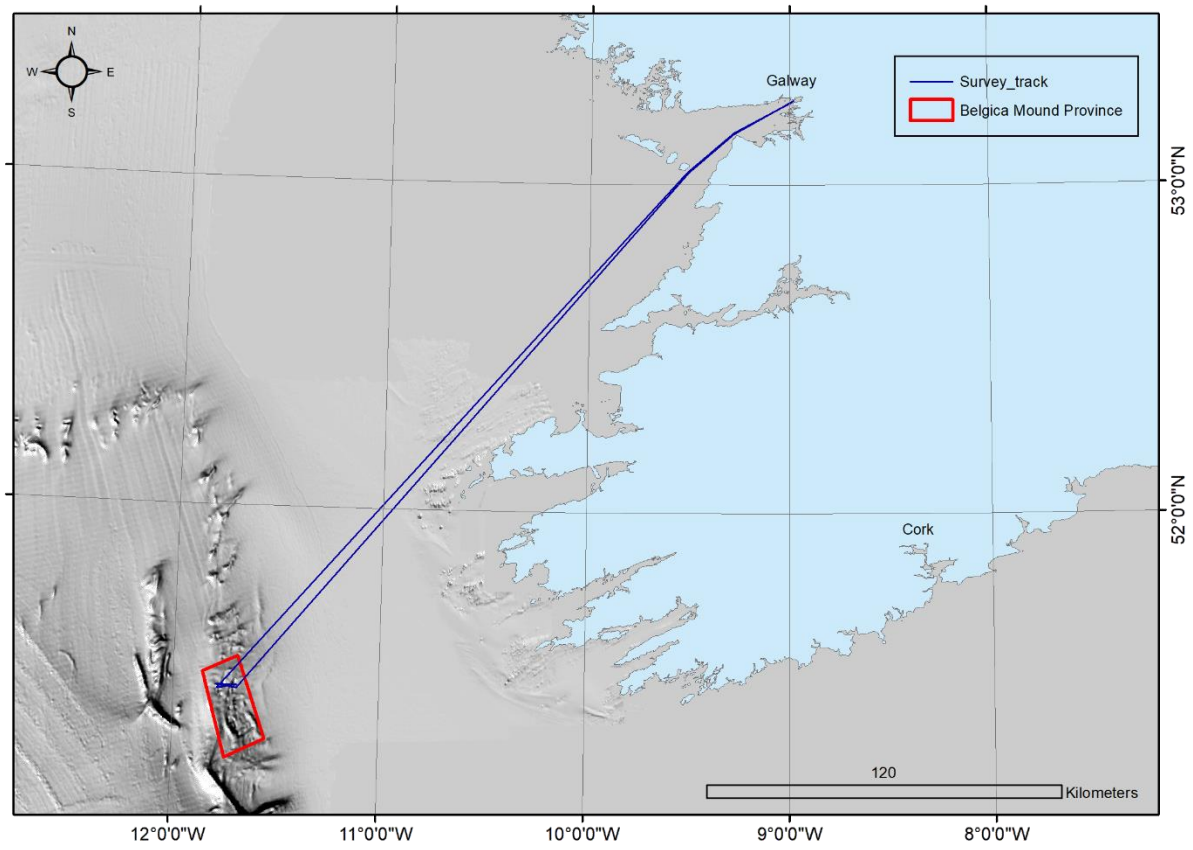
Captain Denis Rowan	Master
Mr Kenny Downing	Chief Officer
Mr Paddy Kenny	2nd Officer
Mr Garvan Meehan	Chief Engineer
Mr John Sammon	2nd Engineer
Mr Michael Slyne	ETO
Mr Frank Kenny	Bosun
Mr James Moran	Cook
Mr Tom Gilmartin	Bosuns Mate
Mr Tommy Grealy	AB Deckhands
Mr Noel O'Driscoll	AB Deckhands
Mr Marc O' Connor	Technician

Mr Martin Powell	AB Deckhand
Mr Peter Joyce	AB Deckhand
Mr Maurice Murphy	Asst. Cook

Left to right: Aaron Lim, Ruaihri Strachan, Luke O' Reilly, Gerard Summers and Larissa Macedo Oliveira

Stations (Logs and maps)

Cruise Track



Master Log Sheet

Master Log sheet			Time	dd	dd	Tick appropriate								
Station Number	Dive #	Date	(UTC)	Lat	Long	Depth (m)	CTD	ROV Video	Lander	ROV CTD	ROV MBES	Vibrocore	Hull MBES	Note
1	1	26/09/2020	02:55	51.49576	11.82245	0								Arrived at BMP downslope site - 25 knots
1	1	26/09/2020	04:34	51.49576	11.82245	0				x				ROV in water. CTD downcast started
1	1	26/09/2020	05:13	51.33058	11.443954	930								Technical set-up: Issue with INS in ROV
1	1	26/09/2020	06:36	51.33058	11.443954	930								Technical set-up: Issue with INS in ROV resolved
1	1	26/09/2020	07:35	51.33058	11.443954	930								Technical set-up: Issue with vessel dynamic positioning system.
1	1	26/09/2020	07:44	51.33058	11.443954	972.9								Technical set-up: Issue with vessel dynamic positioning resolved. Problems with PU on the ship. Restarting PU.
1	1	26/09/2020	08:27	51.49453	11.818835	972.9								Technical set-up: Issue with EM2040 (not recording water column data). Issue with SYS. Fabio loggin in to Team Viewer. ROV still in water. No data collection
	1	26/09/2020	08:42	51.49454	11.818835	972.9								Technical set-up: Issue with MBES solved
2	1	26/09/2020	08:54	51.49444	11.818835	974.2					x			EM2040 Start Grid Station 2 with Line 0014. Frequency 400kHz
3	1	26/09/2020	12:30	51.4929823	11.8194526	975					x			EM2040 Start Grid Station 3 with Line 0029. Change of frequency to 200kHz.
3	1	26/09/2020	15:20	51.4929232	11.8140573	979.8					x			EM2040 Finishing MBES grid station 3. ROV start recovery
4	1	26/09/2020	15:27	51.493005	11.8142113	948				x				CTD upcast (issue with file. Empty file upon convertion)
4	1	26/09/2020	16:01	51.494694	11.814485	0								ROV at surface
4	1	26/09/2020	16:08	51.496204	11.814877	0								ROV on deck
5	N/A	26/09/2020	17:09	51.4379	11.6805	0							x	EM302 Started with Line 248
5	N/A	26/09/2020	23:30	N/A	N/A	N/A								Technical set-up: Wobble corrected on ROV configuration (i.e. depth sensor offsets) New inputs x = 0.765, y = -0.140 and z = 0.005 for the EM2040
5	N/A	27/09/2020	00:25	N/A	N/A	N/A								Technical set-up: ROV fixed - steaming to the second site
5	N/A	27/09/2020	01:16	N/A	N/A	N/A								Arrived at site 2
5	N/A	27/09/2020	01:17	N/A	N/A	N/A								Technical set-up: Issue with ROV INS - will continue EM302 MBES survey moving westward from site 2 until further notice
5	N/A	27/09/2020	03:05	N/A	N/A	N/A								Technical set-up: Issue with INS update: 1PPS faulty. We will run a test run of the ROV over preexisting MBES
5	N/A	27/10/2020	04:47	51.467406	11.447368	0					x			EM 302 MBES finished at line 260. Arrived back on site 2 and entered DP for deployment
6	2	27/09/2020	05:10	51.467406	11.447368	0								ROV in water
6	2	27/09/2020	05:15	51.467406	11.447368	0				x				CTD downcast started
		27/09/2020	05:45	N/A	N/A	N/A								Technical set-up: Issue with CTD conversion - seabird software on CE comp not processing correctly. Please use ComaCop Laptop for this in future.
6	2	27/09/2020	06:30	N/A	N/A	N/A								Technical set-up: issue with MBES PU unit - had to restart SIS
7	2	27/09/2020	07:05	51.4467807	11.7448604	903.9					x			Start EM2040 with line 0039
7	2	27/09/2020	07:25	51.4481076	11.743165	913.9					x			EM2040 start with new line 0040 to confirm the positioning over feature. Comparison between EM302 and EM2040
8	2	27/09/2020	11:23	51.4408365	11.7469593	904.5				x				CTD During started. No data for CTD During prior to this point
9	2	27/09/2020	11:53	51.4408535	11.7495406	919.6				x				CTD upcast start
9	2	27/09/2020	12:35	51.4408565	11.7495506	0								ROV on deck
10	3	27/09/2020	13:40	51.472262	11.5111162	130				x				CTD Downcast started. CTD used for MBES2040 SVP
11	3	27/09/2020	13:57	51.4722806	11.5112665	349				x				CTD During started
12	3	27/09/2020	14:03	51.4723996	11.5108462	349.8					x			EM2040 Macnas mounds survey with start line 0057
13	3	27/09/2020	19:29	51.4705132	11.505825	348.8				x				CTD Upcast started
13	3	27/09/2020	19:54	51.4704785	11.50522785	0								Technical set-up: ROV on deck for recalibration to deploy landers
14	N/A	27/09/2020	20:20	51.4527	11.5594	436							x	Start EM302 started with line 260
14	4	28/09/2020	03:32	51.495815	11.490701	0								ROV in water
15	4	28/09/2020	03:39	51.495815	11.490701	0	x			x				CTD downcast started
16	4	28/09/2020	04:22	51.496635	11.491372	967				x				CTD during started
17	4	28/09/2020	04:30	51 29 39.00	11 49 08.00	967	x	x	x					Lander 1 (A) (South of mound)
18	4	28/09/2020	04:48	51.496581	11.491382	960				x				CTD upcast started
18	4	28/09/2020	05:40	51.496581	11.491382	0								ROV at surface
18	5	28/09/2020	06:25	51.496745	11.491374	0			x					ROV in water
19	5	28/09/2020	06:32	51.496028	11.492988	0				x				ROV CTD downcast
19	5	28/09/2020	07:17	51 29 41.352	11 49 8.117	971.5				x				ROV CTD downcast finished (Coords degrees min secs were used from this point onwards for lander deployment)
20	5	28/09/2020	07:20	51 29 40.907	11 49 8.154	971.1				x				CTD During started

Master Log sheet			Time	dd	dd	Tick appropriate								
Station Number	Dive #	Date	(UTC)	Lat	Long	Depth (m)	CTD	ROV Video	Lander	ROV CTD	ROV MBES	Vibrocore	Hull MBES	Note
21	5	28/09/2020	07:52	51 29 43.949	11 49 8.817	967.1		x						Lander 2 (D) deployment (North of mound). First attempt. It fell on its side. HD video recording
21	5	28/09/2020	08:20	51 29 43.842	11 49 8.797	965.5		x						Lander 2 (D)Successful second deployment of Lander 2
22	5	28/09/2020	08:38	51 29 43.411	11 49 6.922	827				x				CTD upcast started
22	5	28/09/2020	09:21	51 29 42.29	11 49 8.501	0								ROV on deck
22	5	28/09/2020	09:49	51 29 41.777	11 49 5.883	N/A								Technical set-up: Issue with DP software. Rebooting system
22	6	28/09/2020	10:20	51 29 38.987	11 49 0.498	0								ROV in water (vessel coords)
23	6	28/09/2020	10:21	51 29 38.960	11 49 0.362	0				x				CTD downcast started (vessel coords)
24	6	28/09/2020	11:05	51 29 38.523	11 49 1.065	970				x				CTD during started
25	6	28/09/2020	11:10	51 29 40.056	11 48 59.937	965			x					Lander 3 (E) deployed
26	6	28/09/2020	11:22	51 29 39.862	11 48 59.088	968				x				CTD upcast
26	6	28/09/2020	12:05	51 29 39.337	11 49 0.959	0								ROV on deck
27	7	28/09/2020	13:05	51 26 47.131	11 44 21.168	25				x				CTD downcast started
28	7	28/09/2020	13:52	51 26 51.768	11 44 28.778	907.5				x				ROV at bottom. CTD during started
29	7	28/09/2020	14:00	51 26 51.792	11 44 29.089	911			x					Lander 4 (B) deployed (with beacon) Midslope area
30	7	28/09/2020	14:41	51 26 51.439	11 44 27.562	751.8				x				CTD upcast started. ROV off bottom
30	7	28/09/2020	15:07	51 26 45.999	11 44 31.372	0								ROV at surface
31	8	28/09/2020	16:41	51 28 21.540	11 30 30. 535	44				x				CTD downcast started. Start of dive 8
32	8	28/09/2020	16:55	51 28 21.974	11 30 30.461	351.5				x				CTD during started. ROV on bottom
33	8	28/09/2020	17:16	51 28 22. 684	11 30 32.359	344.7		x	x					Lander 5 (C) deployed
34	8	28/09/2020	17:31	51 28 22.174	11 30 31.737	335				x				CTD upcast started. ROV off bottom
34	8	28/09/2020	17:54	51 28 19.857	11 30 32.336	0								ROV on deck
34	9	28/09/2020	19:45	51 29 36.116	11 49 05.095	0								ROV off deck
35	9	28/09/2020	19:56	51 29 37.789	11 49 02.715	80				x				CTD downcast started
35	9	28/09/2020	20:28	51 19 39.002	11 49 00.411	967								ROV on bottom
36	9	28/09/2020	20:29	51 19 39.002	11 49 00.411	967		x		x				CTD during started. HD video started
37	9	28/09/2020	21:07	51 29 40.171	11 49 05.334	967		x	x					Lander 6 (F) deployed
38	9	28/09/2020	21:21	51 29 40.171	11 49 05.334	967				x				CTD upcast started. ROV off bottom
39	9	28/09/2020	22:05	51 29 36.139	11 49 04.993	0								ROV on deck
39	10	28/09/2020	23:40	51 29 39.502	11 49 04.501	0								ROV off deck
40	10	28/09/2020	23:43	51 29 39.502	11 49 04.501	5				x				CTD downcast started
40	10	29/09/2020	00:17	51 29 40.690	11 49 03.603	968								ROV on bottom
41	10	29/09/2020	00:20	51 29 40.609	11 49 03.492	968				x				CTD during started. HD video started
42	10	29/09/2020	00:46	51 29 41.964	11 49 05.174	967		x	x					Lander 7 (G) deployed
43	10	29/09/2020	01:07	51 29 41.239	11 49 08.216	940				x				CTD upcast started, ROV off bottom
43	10	29/09/2020	01:48	51 29 42.149	11 49 04.441	0								ROV on deck
44	N/A	29/09/2020	01:58	51.51303	11.82058	N/A							x	EM302 start line 266
44	11	29/09/2020	05:10	51 29 36.624	11 49 07.180	969		x						Technical set-up: Onsite for ROV deployment
44	11	29/09/2020	05:25	51 29 36.522	11 49 07.180	0								ROV in water
45	11	29/09/2020	05:37	51 29 36.522	11 49 07.180	0				x				CTD downcast start
46	11	29/09/2020	06:13	51 29 38.150	11 49 07.750	966		x		x				ROV on bottom. CTD during started
47	11	29/09/2020	07:09	51 29 39.753	11 49 08.562	966		x						Technical set-up: Positioning the ROV to the start of the grid. Grid reallocated to the mound.
47	11	29/09/2020	07:16	51 29 39.718	11 49 10.087	N/A		x						ROV at start of grid.
47	11	29/09/2020	07:17	51 29 39.361	11. 49 09.996	970		x						HD video started on first line of grid
47	11	29/09/2020	07:44	51 29 40.055	11 49 01.024	970		x						HD video on 4th line of grid. current dragging ROV of by avg 1 m from line
47	11	29/09/2020	08:28	51 29 39.531	11 49 9.944	970		x						HD video on 8th line of grid. Strong current. Lines 8 and 9 repeated
47	11	29/09/2020	09:40	51 29 39.559	11 49 9.660	970		x						HD video change at end of line 13
47	N/A	N/A	N/A	N/A	N/A	N/A		x						Technical set-up: Change of grid line after line 18. Sonar detected a slight end slope to the right so Moved the remaining lines to the west to target the mound
48	11	29/09/2020	11:43	51 29 40.540	11 49 10.116	967		x		x				ROV video stopped and CTD upcast begun
49	NA	29/09/2020	13:58	51.5265552	11.7103753	761							x	EM302 mapping as weather contingent. Line start 271
49	N/A	30/09/2020	09:59	51.4933329	11.817723	0								Survey delayed due weather contigent. Approx. 12 h of contigency. Team worked on reports, maps and data backup
50	12	30/09/2020	10:20	51.4934376	11.8179994	0		x						ROV off deck
50	12	30/09/2020	10:29	51.4934376	11.8179994									ROV in water
50	12	30/09/202	10:31	51.493697	11.8178433	40.9				x				CTD downcast started. SVP used for Sonardyne
51	12	30/09/2020	11:09	51.4938744	11.8180155	968								ROV at bottom. CTD during started
51	12	30/09/2020	11:39	51.4943142	11.818477	972.2								ROV located Lander 1(A)
51	12	30/09/2020	11:58	51.4951076	11.818603									ROV located Piddington Mound
52	12	30/09/2020	12:19	51.4948432	11.8188587	953.5		x						ROV HD Video Start
52	12	30/09/2020	14:02	51.494853	11.8187818	965		x						ROV HD video change
52	12	30/09/2020	16:08	51.4948979	11.8186448	970		x						ROV HD video change
52	12	30/09/2020	16:11	51.4950008	11.8186499	965.7		x						HD end survey
52	12	30/09/2020	17:56	51.492018	11.8186459	0								ROV on deck
53	13	01/10/2020	00:17	51 29 39.473	11 49 08.030	0				x				ROV in water. CTD downcast started
54	13	01/10/2020	00:55	51 29 41.169	11 49 07.367	968								ROV on bottom
54	13	01/10/2020	01:01	51 29 42.336	11 49 08.567	956		x				x		Vibrocoring (CE20011_VC1)
55	13	01/10/2020	01:56	51 29 43.401	11 49 07.153	964		x				x		Vibrocoring (CE20011_VC2)
56	13	01/10/2020	02:27	51 29 43.582	11 49 08.319	963				x				ROV off bottom. CTD upcast started
56	13	01/10/2020	03:13	51 29 40.590	11 49 08.056	0								ROV on deck
57	14	01/10/2020	05:00	51 28 20.725	11 30 30.355	0								ROV in water
57	14	01/10/2020	05:08	51 28 20.655	11 30 30.475	20				x				CTD downcast started
57	14	01/10/2020	05:22	51 28 22.660	11 30 31.907	348								ROV on bottom
58	14	01/10/2020	05:28	51 28 22.774	11 30 32.277	348		x				x		Vibrocoring (CE20011_VC3)
59	14	01/10/2020	06:07	51 28 20.749	11 30 33.712	350		x				x		Vibrocoring (CE20011_VC4)
60	14	01/10/2020	06:30	51 28 20 706	11 30 35. 287	340				x				ROV off bottom. CTD upcast started
61	14	01/10/2020	06:45	51 28 19.258	11 30 32.780	0								ROV on deck. End of survey

Multibeam Log Sheet – EM302/EM2040

Station Log: Multibeam							
station #	**start line #**	**Time (UTC)**	**Date**	**Lat SOL**	**Long SOL**	**WCD? Y/N**	**note (302/2040)**
1	nan	08:27	26/09/2020	51.49453	11.818835		Technical set-up: Issue with MBES - Not recording water column data
1	nan	08:45	26/09/2020	51.49454	11.818835	n	Technical set-up: Issue solved. Survey starting with EM2040. Survey line start 0014 at frequency 400kHz
2	0014	08:53	26/09/2020	51.49444	11.818885	y	EM2040 Start line 0014. DVL stripping presence. North to South grid
2	nan	09:25	26/09/2020	51.492438	11.814938	y	EM2040 Start line 0018.
2	nan	09:59	26/09/2020	51.496434	11.614535	y	EM2040 Start line 0019
3	0029	12:30	26/09/2020	51.4929823	11.8194526	y	EM2040 Start Grid Station 3 with Line 0029. Change of frequency to 200kHz. Following same grid with reversed lines
3	nan	15:20	26/09/2020	51.4929232	11.8140573	y	End of grid. End line number 0038. ROV recovery to deck started
5	0248	17:09	26/09/2020	51.4379	11.6805	y	EM302 start with line 0248
7	0039	08:05	27/09/2020	51.4467807	11.7448604	y	EM2040 start with line 0039
12	0057	14:03	27/09/2020	51.4723996	11.5108462	y	EM2040 start with line 0057
12	nan	19:29	27/09/2020	51.4705132	11.505825	y	EM2040 end with line 0075
14	260	20:20	27/09/2020	51.4527	11.5594	y	EM302 started with line 260
44	266	01:58	29/09/2020	51.51303	11.82058	y	EM302 started with line 266
49	271	13:58	29/09/2020	51.5265552	11.7103753	y	EM302 start with line 0271
							CE20011 collected a total of 105 lines of MBES data. 30 lines of EM302 and 75 lines of EM2040

Video recording log sheet

time	time	y/n	# + time	# + time	# + time	# + time	time	Who and which HD?	
ROV IN	ROV ON BOTT	Lasers on	Video Recording	Lander deployed	VIBRO co	Video chang	Video stopped	Data backed up?	Observation/note
03:32	04:22	n		04:30				y/ HD 1 and HD2	
06:25	07:00	n		07:52				y/HD 1 and HD2	
10:20	11:10	n		11:10				y/ HD 1 and HD2	
13:05	13:52	n		14:00				y/ HD 1 and HD2	
16:41	16:55	n		17:16				y/ HD 1 and HD2	
05:25	06:13	y	07:17	N/A		09:40	12:00	y/ HD 1 and HD2	Second video changed at around 12pm
10:29	11:09		12:09	N/A		14:05:00/16:10	17:08	y/ HD 1 and HD2	Second video change at 16:10. At line 56

CTD / SVP log sheet

CTD/SVP log				DD	DD		
Station #	CTD #	ROV/ROSETTE	SVP? FILE NAME	Lat	Long	Time	Depth (m)
1	1	ROV	CE20011_Dive1_St1_SVP	51.49576	11.82245	04:34	0
4	2	ROV		51.493005	11.8142113	15:27	948
6	3	ROV	CE20011_Dive2_St6_SVP	51.467406	11.447368	05:10	0
8	4	ROV		51.44365	11.7469593	11:23	904.3
9	5	ROV		51.4408535	11.7495406	11:53	916.3
10	6	ROV	CE20011_Dive3_St9_SVP	51.472262	11.5111162	13:30	130
11	7	ROV		51.4722806	11.5112665	13:57	349
13	8	ROV		51.4705132	11.505825	19:29	348.8
15	9	ROV		51.495815	11.490701	03:39	967
16	10	ROV		51.496635	11.491372	04:22	967
18	11	ROV		51.496581	11.493375	04:48	0
19	12	ROV		51.496028	11.492988	06:32	0
20	13	ROV		51 29 40.907	11 49 8.154	07:20	971.1
22	14	ROV		51 29 43.411	11 49 6.922	08:38	827
23	15	ROV		51 29 38.960	11 49 0.362	10:21	0
24	16	ROV		51 29 38.523	11 49 1.065	11:05	970
26	17	ROV		51 29 39.862	11 48 59.088	11:22	968
27	18	ROV		51 26 47.131	11 44 21.168	13:05	25
28	19	ROV		51 26 51.768	11 44 28.778	13:52	907.5
30	20	ROV		51 26 51.439	11 44 27.562	14:41:00	751.8
31	21	ROV		51 28 21.540	11 30 30.535	16:41	44
32	22	ROV		51 28 21.974	11 30 30.461	16:55	351.5
34	23	ROV		51 28 22.174	11 30 31.737	17:31	335
35	24	ROV		51 29 37.789	11 49 2.715	19:56	80
36	25	ROV		51 19 39.002	11 49 00.411	20:29	967
38	26	ROV		51 29 40.171	11 49 05.334	21:21	967
40	27	ROV		51 29 39.502	11 49 04.501	23:43	2
41	28	ROV		51 29 40.609	11 49 03.492	00:20	968
43	29	ROV		51 29 41.239	11 49 08.216	01:07	940
45	30	ROV		51 29 36.522	11 49 07.180	05:37	
46	31	ROV		51 29 38.150	11 49 07.750	06:13	966
48	32	ROV		51 29 40.540	11 49 10.116	11:43	967
50	33	ROV	Different coords	51.493697	11.8178433	10:31	40.9
51	34	ROV	CTD during and upcast are recorded on the same file	51.4938744	11.8180155	11:09	968
53	35	ROV		51 29 39.473	11 49 08.030	00:17	0
56	36	ROV		51 29 43.582	11 49 08.319	02:27	963
57	37	ROV		51 28 20.655	11 30 30.475	05:08	20
58	38	ROV		51 28 20 706	11 30 35. 287	06:30	340

ROV Photogrammetry Log Sheet

		MBES 2040		ROV degress min sec			ROV camera	
Line #		Lat	Long	Lat	Long	Note	Lat	Long
1	07:17	51. 49 43836	11. 8194574	N/A	N/A	Start of grid. Grid designed with 43 lines of approx 20 m length and 0.5 metres spacing	51.296612	11.491675
2	N/A	N/A	N/A	N/A	N/A	No coord data for this line	N/A	N/A
3	N/A	N/A	N/A	N/A	N/A	No coord data for this line	N/A	N/A
4	07:44	51. 49 43276	11. 8194292	51 29 39.575	11 49 9.995		N/A	N/A
5	07:49	51. 4943227	11. 8194260	51 29 39.596	11 49 9.904		51.29660	11. 491655
6	08:01	51.4943071	11.8194191	N/A	N/A	Line six re done. First attempt with 2M off line and strong current	51.296585	11.491652
7	08:06	51. 4943232	11. 8194140	51 29 39.586	11 49 9.858	Line seven way off the line. Coming back. Line repeated	51.296585	11. 491653
8	08:15	51.494317	11 8194114	51 29 39.531	11 49 9.944	Line 8 restarted. Up top of mound. Third attempt. Strong current. Fourth attempt good	51.296597	11.491644
9	08:37	51.494386	11. 8194021	51 29 39.831	11 49 9.821	Line 9 - strong current. Line repeated three times	51.296638	11.491648
10	08:53	51.4943254	11.8193905	51 29 39.588	11 49 9.792		51.2966	11.491633

		MBES 2040		ROV degress min sec			ROV camera	
Line #		Lat	Long	Lat	Long	Note	Lat	Long
11	09:08	51.4943474	11.8193778	51 29 39.669	11 49 9.746	Line 11 ROV off by 2-3 m. Line repeated	51.296616	11.491626
12	09:33	51.4943151	11.8193640	51 29 29.525	11 49 9.979		51.296581	11.491617
13	N/A	N/A	N/A	N/A	N/A	Video cartrigde changed at end of line 13	N/A	N/A
14	09:44	51.4943585	11.8193660	51 29 39.671	11 49 9. 969		51.296618	11.491618
15	09:50	51.4943771	11.8193566	51 29 39. 169	11 49 8. 524		51.296631	11.491614
16	09:59	51 .4943800	11.8193547	51 29 39.828	11. 49 9. 590		51.296635	11.491619
17	10:07	51 4944084	11.8193471	51 29 39.860	11 49 9. 812	Video showing sand ripples and dropstones. More offmound features so question on moving the lines of grid to the west	51.29665	11.49161
18	10:17	51.494329	11.8193337	51 29 39.614	11 49 9. 547	After line 18 we moved what was left of the grid to the west of the lines 1 to 18	51.2966	11.491601
19	10:20	51.4943254	11.8196181	51 29 39.609	11 49 10. 534	Line 19 repeated. Strong current	51.296597	11.491773
20	10:39	51.4943122	11.8196130	51 29 39.528	11 49 10. 563		51.296585	11.491769
21	10:53	51.4943304	11.8196125	51 29 39. 565	11 49 19. 704		N/A	N/A
22	11:03	51.4943192	11.8195900	51 29 39. 586	11 49 10. 439	Line recorded twice. No coord data collected for this line	N/A	N/A
23	N/A	N/A	N/A	N/A	N/A	Line recorded twice. No coord data collected for this line	N/A	N/A
24	11:15	51.4943136	11.8194550	51 29 39.144	11 49 9. 928	changed survey line to the middle of the grid. Instead of going outwards to the center. We are going from centre to outwards. Line 24 repeated. This would be line 40 on the originial grid	N/A	N/A
25	11:23	51.4944167	11.8194748	51 29 39. 933	11 49 10. 983	Line 41 of the original grid. Line 25 on the recording sequence	N/A	N/A
26	11:28	51.4943129	11.8194692	51 29 39.502	11 49 10. 176	Line 41 of the original grid	51.2985	11.491684
27	11:37	51.494445	11.8193510	51 29 39. 963	11 49 9. 566	Line 27 was designed out of grid. Longer line to the north. Attempt to record further up the mound	N/A	N/A
28	11:25	51.4949149	11.8188803	51 29 41.672	11 49 7.911	Start of new grid at Piddington mound with line 28. Start grid from west to east. Line 28 repeated four times.	51.296963	11.491317
28	11:43	51.4948622	11.8188388	51 29 41.466	11 49 7.831	Technical set-up: Navigation is having issues. Nav not showing the real position of ROV. Still in line 28	N/A	N/A
29	11:58	51.4948446	11.8188438	51 29 39.447	11 49 9.053	Navigation is approx 10 m off line. Line repeated twice. Camera is trembling.	51.296909	11.491306
30	12:00	51.4948461	11.8188300	51 29 41.461	11 49 7.829		51.2969	11.491285
31	12:14	51.4948452	11.8188426	51 29 41.455	11 49 7.942	Navigation is not accurate (INS)	51.296913	11.4913
32	13:20	51.494851	11.8188266	51 29 41.491	11 49 7.807		51.296917	11.491294
33	N/A	N/A	N/A	N/A	N/A	No coord data for this line	N/A	
34	13:30	51.4948501	11.8188233	51 29 41.438	11 49 7.791		51.296913	11.491282
35	13:38	51.4948356	11.8188172	51 29 41.302	11 49 7.831		51.296902	11.491294
36	13:45	51.4948604	11.8187884	51 29 41.509	11 49 7.694		51.296928	11.491282
37	13:53	51.4948491	11.8187882	51 29 41.430	11 49 7.611	INS issue resolved. Navigation is better	51.296909	11.491269
38	14:02	51.494853	11.8187818	51 29 41.468	11 49 7.676	Cartridge change for line 39 onwards	51. 296921	11.491269
39	14:10	51.4948427	11.8187742	51 29 41 456	11 49 7.608		51.296902	11.491268
40	14:19	51.4948537	11.8187654	51 29 41.420	11 49 7.540		51.296921	11.49126
41	14:25	51.4948531	11.8187584	51 29 41.471	11 49 7. 526		51.296917	11.491256
42	14:31	51.4948633	11.8187559	51 29 41.512	11 49 7.673		51.296928	11.491254
43	14:38	51.4949875	11.8187579	51 29 41.567	11 49 7.552		51.297001	11.491254
44	14:42	51.4948628	11.8187331	51 29 41.460	11 49 7.269		51.296928	11.491246
45	14:47	51.4948479	11.8187351	51 29 41.460	11 49 7.636		51.296917	11.491239
46	14:53	51.4948772	11.8187252	51 29 41.483	11 49 7.492		51.296921	11.491235
47	14:57	51.4948642	11.8187183	51 29 41.460	11 49 7.486		51.236944	11.4912138
48	15:01	51.4948489	11.8187051	51 29 41 453	11 49 7.237		51.296917	11.491225
49	15:12	51.4948478	11.8186931	51 29 41.463	11 49 7.372		51.296928	11.491217
50	15:25	51.494858	11.8186793	51 29 41.525	11 49 7.251		51.296921	11.491207

		MBES 2040		ROV degress min sec			ROV camera	
Line #		Lat	Long	Lat	Long	Note	Lat	Long
51	15:32	51.4949013	11.8186765	51 29 41.621	11 49 7.183		51.296947	11.491203
52	15:39	51.494896	11.8186682	51 29 41.648	11 49 7.218		51.296944	11.491202
53	15:46	51.4949184	11.8186590	51 29 41.734	11 49 7.010		51.296955	11.491196
54	15:53	51.4948657	11.8186526	51 29 41.514	11 49 7.243		51.296928	11.49119
55	15:58	51.4949901	11.8186518	51 29 41.956	11 49 7.147		51.296986	11.491191
56	16:11	51.4950008	11.8186499	51 29 41.977	11 49 7.186		51.297012	11.491191
57	16:14	51.4948795	11.8186309	51 29 41.523	11 49 7.174		51.296928	11.49118
58	16:18	51.4948491	11.8186278	51 29 41.416	11 49 7.228		51.296913	11.491172
59	16:24	51.4949487	11.8186184	51 29 41.812	11 49 6.985		51.29697	11.49117
60	16:28	51.4948478	11.8186045	51 29 41.392	11 49 6.923		51.296913	11.491167
61	16:34	51.4949498	11.8186063	51 29 41.777	11 49 7.034		51.296997	11.491164
62	16:39	51.494851	11.8185948	51 29 41.423	11 49 7.025		51.296913	11.491155
63	16:45	51.494872	11.8185868	51 29 41.603	11 49 6.951		51.296917	11.491152
64	16:53	51.4948549	11.8185787	51 29 41.481	11 49 7.010		51.296917	11.491147
65	16:58	51.4948854	11.8185689	51 29 41.559	11 49 8.976		51.296955	11.491146
66	17:04	51.4948671	11.8185634	51 29 41 468	11 49 6.819		51.296951	11.491142
67	17:08	51.4948543	1.8185603	51 29 41.499	11 49 6.836	End of grid	N/A	N/A

ROV Vibrocore log sheet

Core	Dive	Station	Lat	Long	Depth (m)	Apparent Penetration (m)	Retrieval (m)	Comments
VC1	13	54	51°29'42.336''N	11°49'08.567''W	956	0.60	0.25	Coral pieces present in top and bottom of core. Sands present throughout. Matrix sediment is browny green in colour. No smell was observed. Core catcher was bagged.
VC2	13	55	51°29'43.401''N	11°49'07.153''W	965	1.80	1.98	Grey silty muds at top and bottom of core, which contained a high clay content. Minor sand package evident from 20 - 28 cmbsf. Top few cms of core were disturbed from coring process and removing surface waters. Matrix sediment throughout is light brown in colour. Black mottling present up core liner from 100 - 190 cmbsf. No smell was observed.

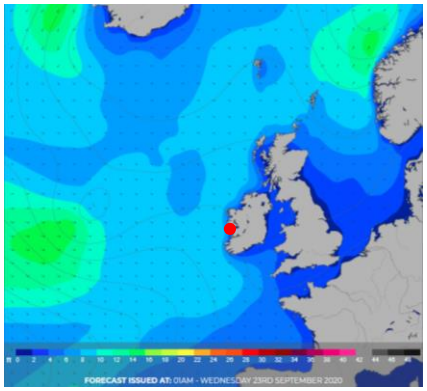
VC3	14	56	51°28'22.774''N	11°30'32.277''W	348	1.90	1.18	Light brown sandy silts at top of core. At 27 cmbsf the sedimentary sequence has an erosional contact into olive green silts which dominate the matrix sediment to the base of the core.
VC4	14	57	51°28'20.749''N	11°30'33.712''W	351	1.80	1.40	Light brown sandy silts at top of core. At 52 cmbsf the sedimentary sequence has an erosional contact into olive green silts which dominate the matrix sediment to the base of the core.

Lander Log sheet

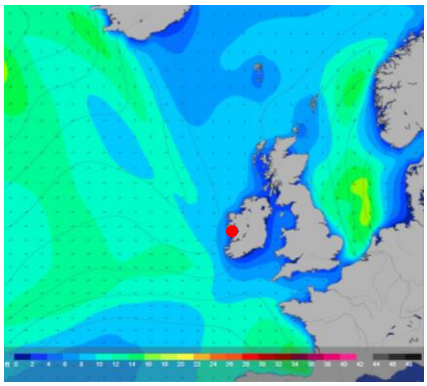
Lander	ADCP	Motor	Beacon (y/n)	Nylon Strip	ROV Lat	ROV Long	Depth	Vessel Lat	Vessel Long	Area	Note
1	707	301	y	A	51 29 39. 000	11 49 08. 000	968	51 21. 38	11 49. 06	South of mound	Referred as lander 1(A) in Master log
2	708	302	y	B	51 26 51.792	11 44 29.089	903.7	51 26 25.949	11 44 31.472	Midslope area	Referred as Lander 4(B) in Master log
3	703	303	y	C	51 28 22. 684	11 30 32. 359	344.7	51 28 19. 869	11 30 32. 400	Macnas Mounds	Referred as Lander 5 (C) in master log
4	704	304	n	D	51 29 43.842	11 49 8.797	965.5	51 29 42.196	11 49 8.511	North of Mound	Lander fell on its side on first attempt. Second deployment succesful. Referred as Lander 2 (D) in Master log
5	705	305	n	E	51 29 40.056	11 48 59.937	970.5	51 29 38.513	11 49 1.104	160 m East of Lander 1 (off mound)	Referred as Lander 3 (E) in Master Log
6	706	306	n	F	51 29 40.171	11 49 05.334	967	51 29 36.129	11 49 04.965	South of mound	Referred as Lander 8(F) in Master log
7	709	299	n	G	51 29 41.964	11 49 05.174	967	51 29 40.027	11 49 04.546	35 m North of Lander 6	Referred as Lander 9(G) in Master Log
8	710	300	n	H	N/A	N/A	N/A	N/A	N/A	N/A	Not deployed. This lander will be kept for future surveys

Weather Report (UTC +1)

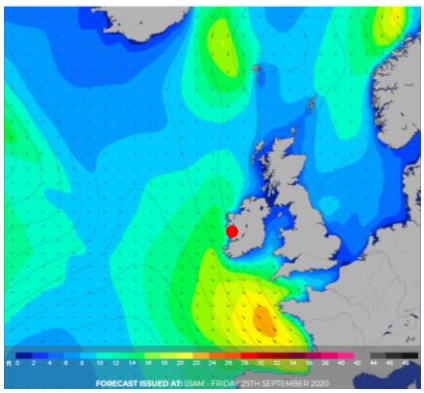
23.09.2020 – 3 am



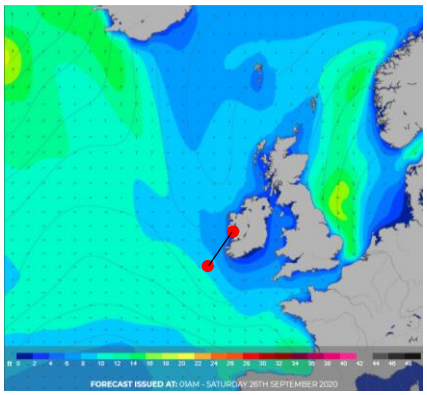
24.09.2020 – 3am



25.09.2020 – 3am



26.09.2020 - BMP



0400

Wind Speed: 20 knots (Beaufort 5)

Wind direction: 100

Swell: 2 m

Light Rain

0800

Wind Speed: 20 knots (Beaufort 5)

Wind direction: 110

Swell: 2 m

Light Rain

1600

Wind Speed: 11 knots (Beaufort 4)

Wind direction: 100

Swell: 2 m

Light Rain

2000

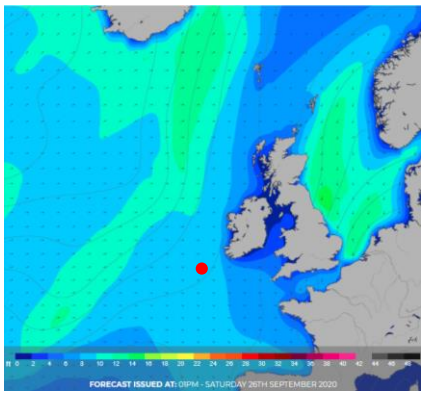
Wind Speed: 10 knots (Beaufort 3)

Wind direction: 120

Swell: 2 m

Light Rain

27.09.2020 – 3am at the BMP



0400

Wind Speed: 11 knots (Beaufort 4)

Wind direction: 150

Swell: 2 m

Light Rain

0800

Wind Speed: 12 knots (Beaufort 4

Wind direction: 140

Swell: 1.5 m

Light Rain

1600

Wind Speed: 16 knots (Beaufort 5)

Wind direction: 130

Swell: 1.5 m

Light Rain

2000

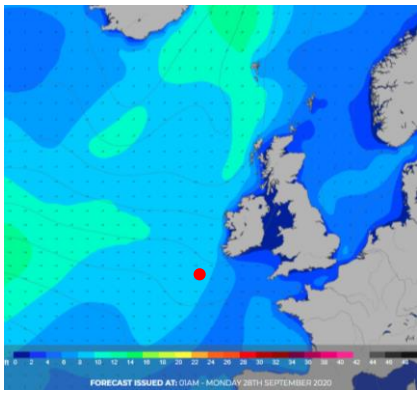
Wind Speed: 16 knots (Beaufort 5)

Wind direction: 140

Swell: 1.5 m

Light Rain

28.09.2020 – 3am at the BMP



0400

Wind Speed: 16 knots (Beaufort 5)

Wind direction: 220

Swell: 2 m

Light Rain

0800

Wind Speed: 13 knots (Beaufort 4)

Wind direction: 210

Swell: 2 m

Light Rain

1600

Wind Speed: 14 knots (Beaufort 4)

Wind direction: 170

Swell: 1.5 m

Light Rain

2000

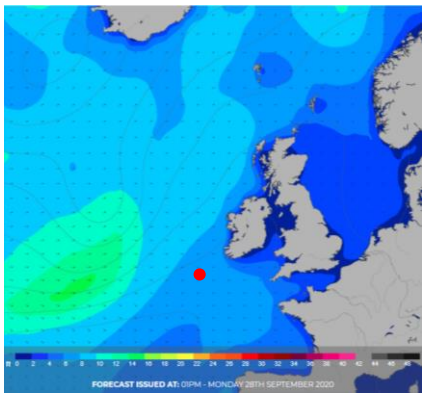
Wind Speed: 10 knots (Beaufort 3)

Wind direction: 180

Swell: 1.5 m

Light Rain

29.09.2020 – 3am at the BMP



0400

Wind Speed: 12 knots (Beaufort 4)

Wind direction: 240

Swell: 1.5 m

Light Rain and Fog

0800

Wind Speed: 16 knots (Beaufort 5)

Wind direction: 250

Swell: 1.5 m

Light Rain

1600

Wind Speed: 29 knots (Beaufort 7)

Wind direction: 240

Swell: 3 m

Light Rain

2000

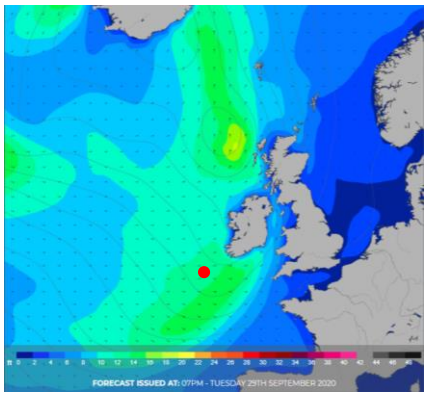
Wind Speed: 42 knots (Beaufort 9)

Wind direction: 300

Swell: 5.5 m

Light Rain

30.09.2020 – 3 am at BMP



0400

Wind Speed: 20 knots (Beaufort 5)

Wind direction: 300

Swell: 4 m

Light Rain

0800

Wind Speed: 20 knots (Beaufort 5)

Wind direction: 310

Swell: 3 m

Clear

1600

Wind Speed: 17 knots (Beaufort 4)

Wind direction: 260

Swell: 2.5 m

Clear

2000

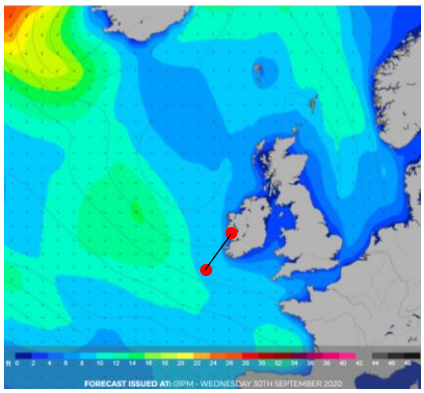
Wind Speed: 16 knots (Beaufort 4)

Wind direction: 270

Swell: 2 m

Clear

01.10.2020 – 3 am at BMP



0400

Wind Speed: 17 knots (Beaufort 4)

Wind direction: 260

Swell: 1.5 m

Clear

0800

Wind Speed: 22 knots (Beaufort 5)

Wind direction: 250

Swell: 1.5 m

Heavy Rain

UCC Marine Geology

Research Group

Acknowledgements

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"The Creamy Dreamers"