

National Research Vessels

SHIP-TIME PROGRAMME

RESEARCH SURVEY REPORT

Survey Code:	Survey Name:	Chief Scientist/ Institution
CE14011	Slope Collapses on Rockall Bank and Escarpment Habitats	Aggeliki Georgiopoulou University College Dublin

Section A: Award Summary

Title of Research Survey and Survey Code:	CE14011 Slope Collapses on Rockall Bank and Escarpment Habitats	
Co-Ordinator/ Chief Scientist:	Aggeliki Georgiopoulou	
Vessel used for ship-time:	RV Celtic Voyager <input type="checkbox"/> RV Celtic Explorer <input checked="" type="checkbox"/>	
Total number of days at sea:	11	
Total number of grant-aided ship-time days awarded:	14	
Dates of survey:	14/07/2014-27/07/2014	
Mobilisation/Demobilisation Ports	Galway / Galway	
Survey Personnel:	<i>No. of Scientists</i> 5	<i>No. of Students</i> 8
Final Report Completed by:	A Georgiopoulou (with contributions from V. Huvenne and RB Wynn)	Date:

Section B: Description of the Research Survey

B1 Overview of survey personnel

<i>Names</i>	<i>Institute/ Department/ Course</i>	<i>Position (undergraduate/ post graduate etc)</i>	<i>Number of Days</i>
Scientists			
Aggeliki Georgiopoulou	UCD	Lecturer	14
Veerle Huvenne	NOC	Senior Research Fellow	14
Russell Wynn	NOC	Chief Scientist for Marine Autonomous and Robotics Systems	13
Claudio Lo Iacono	NOC	Postdoctoral Researcher	13
Aoife Braidon	UCD	Research Manager of UCD Geophysics Group	13
Students			
Katleen Robert	NOC	Postgraduate student	13
Cormac Reale	UCD	Postgraduate student	13
Laurence De Clipelle	Heriot-Watt University	Postgraduate student	13
Dimitra Salmanidou	UCD	Postgraduate student	13
Lissette Victorero-Gonzalez	NOC	Research Assistant	13
Ioannis Tsiantis	UCD	Postgraduate student	13
Leo Chaumillon	IntechMer, France (via NOC)	Graduate student	13
Ian Hamilton	UCD	Postgraduate student	13

B2 Objectives

Briefly outline the overall objectives of the research survey.

Please state if objectives have changed from the original proposal. If survey included a training element please outline clearly.

Originally there had been three objectives for SORBEH;

- 1) Lithological characterisation of the Eastern Rockall Bank by sampling areas in and around the Rockall Bank Slide Complex.
- 2) Habitat investigation of steep escarpments and seabed pinnacles using the Holland I ROV.
- 3) Make measurements of wave-induced seafloor microseisms using a bespoke sensor array deployed on the way out and retrieved on the way in after 10 days.

The third objective had to be abandoned as there were delays with the development and delivery of the sensors array relative to the timing of the cruise.

A total of 12 core sites had been planned with two cores intended to be collected from every location. Six ROV dive sites had been targeted for video imaging and five of them for multibeam mapping.

The cruise was also planned to be a training opportunity for postgraduate students and therefore preference was given to offering berths to early career scientists.

B3 Overview of research survey

*Provide a narrative overview of the research survey including survey timelines
The information provided in this section should not exceed 5 pages (excluding tables and maps)*

14 July 2014

12:00 noon arrival of chief scientists, AG and VH to the ship to oversee and assist with mobilisation.

15 July 2014

At 11:00 am the ship turned starboard to port to wet test the ROV and the corer. By 15:45 scientists party had arrived. Safety meeting and tour of the ship was done in two groups, one at 16:00 and the other at 17:00. The ship sailed as scheduled at 19:00. On the way out of Galway Bay the ROV was launched in 50 m water depth. There were some problems with the software licenses with the rented Reson 7125 multibeam echosounder, which were taking time to resolve. Originally it was recommended to stay in Galway Bay, within telephone range to resolve the issue but eventually it was decided to start the transit to Rockall Bank and continue communications through email and ship's telephone.

16 July 2014

01:00 on our way to WP1 on southeastern Rockall Bank. Transit took more than 24 hrs. The first scientific meeting was held where all participants were informed of the objectives, background and techniques. The scientific party was divided in two 12hr shifts, 4 am – 4 pm and 4 pm – 4 am.

17 July 2014

Ship arrived on station at 04:09 and CTD 1 (**Station 001**) was deployed at 04:18. The CTD frame also carried 2 USBL beacons for testing. CTD near bottom (700 m WD) at 04:44. CTD recovered at 05:02.

ROV dive 1 (**Station 002**) in water at 05:35. ROV at seabed at 06:08 (724 m WD). Deployment of USBL beacon for later system calibration. First transect running SE-NW and crossing small intra-landslide scarp. No significant seafloor expression of scarp, and seafloor in region looked to be composed of muddy sand or sand (confirmed with ROV push cores). ROV transect ended at 12:00 at 656 m WD. ROV on deck at 12:40.

Transit to first coring site (**Station 003**) below intra-landslide scarp, for 3 m GC deployment. Arrival on station at 12:56. Corer in water at 13:05. Corer on seabed at 13:24 (689 m WD). Pullout 1.0 tonnes. Note that wire-out reading at seabed (525 m) is incorrect due to lack of suitable calibration, so potential risk of re-penetration on this deployment. Also, no USBL deployed on corer, as not working correctly. Corer on deck at 13:40. Core contained ~0.8 m of muddy sand, although core catcher fingers were inverted with dark stiff mud in core catcher. A repeat core was not attempted at this site as it was deemed difficult to penetrate.

Transit to ROV dive 1 deployment location, to undertake calibration using USBL previously positioned on seabed by ROV. On station at 14:32 (724 m WD). Calibration involves making a loop with the ship at approximately 1000 m radius around the position of the

USBL on the seafloor. The outcome of the calibration was very positive, the USBL navigation seems reliable and no further calibrations or corrections needed to be done. Transit to **Station 004** to start ROV dive 02. Arrival on station at 18:55. The target at this location was a steep slide wall in the northern scar. The ROV was deployed at 19:12 and was at the seabed at 19:52 (56°39.672N / 130°53.975W; 710 m WD).

18 July 2014

The ROV was brought back on deck at 02:45. Ship on station for ROV dive 3 (**Station 005**) at 03:00. Preparing for dive at 03:30. ROV in water at 03:37. Target on ROV dive 3 is steep wall in landslide scar, adjacent to steep wall targeted on ROV dive 2. ROV at seabed at 04:10 (56°40.047N / 13°53.980W; 677 m WD). Delayed start of transect due to problems with USBL feed from ROV into OFOP. Transect for ROV dive 3 starting at 04:35 (56°40.043N / 13°53.987W; 677 m WD; SS3). First ROV push core in slide scar recovered sandy sediments that mostly washed out on recovery (04:50; tube 12 in front left chamber). Second ROV push core taken in small channel-like feature in slide scar. Core tube 11 failed to recover any sediment due to sandy non-cohesive nature of sediments. Higher incidence of holothurians and rabbitfish noted in channel area. Two small rocks sampled from slide scar while disks being changed, in area characterised by abundant scattered rocks and sand/gravel substrate. A third ROV push core site was reached ~100 m from the foot of the large scarp, in area of sand/gravel substrate. The corer penetrated seabed to ~30 cm but appeared to hit a subsurface obstruction, and non-cohesive sandy sediment in the core meant that only a small sample was recovered (core tube 7 in back right chamber). Note that the core tube in the front right chamber was damaged and not used for coring.

The foot of the major slide scar was reached at ~07:18, and a small sample of bio-eroded semi-lithified sedimentary outcrop recovered. The scarp appeared terraced, with coral growth limited to small gullies and larger dropstones. A small white coral was sampled, as well as some additional geological samples. The top of the slide scar was reached at ~10:15, and a final ROV push core attempted in rippled sands/gravels on the open slope (but no recovery due to non-cohesive sandy sediments). The dive was completed and the ROV left the seabed at 10:42 (56°40.812N / 13°54.151W; 487 m WD).

The ship then transferred to a coring location below the major scarp surveyed during ROV dives 1 and 2 (**Station 006**), in an attempt to sample the glide plane. The ship arrived on station at ~11:45, at the location where ROV dive 2 started. A 3 m gravity corer was deployed at 11:48. The corer hit seabed at 12:08 (56°39.684N / 13°54.031W; 702 m), with a pullout of 0.9 tonne and a wire-out reading of 540 m. The corer returned on deck at 12:24 but no sediment was recovered. A second attempt was made nearby (**Station 007**), with the corer in the water at 12:37. The corer reached the seabed at 12:57 (56°40.049 / 13°53.99W; 677 m). The pullout was again 0.9 tonnes. The corer was on deck at 13:12. However, there was again no recovery.

The ship moved a short distance to another coring location below the major scarp, at the location where ROV dive 3 started. The ship arrived on station at ~13:36 (**Station 008**). A 3 m gravity core was deployed at 13:49. The corer was in the seabed at 14:07 (56°40.053N / 13°53.985W; 678 m). The pullout was 0.8 tonnes. The corer returned on deck at 14:24, but was again empty with no indication of penetration.

The ship again moved a short distance to a coring location near the foot of the slide scar (**Station 009**; second push core location on ROV dive 2). The ship arrived on station at ~14:50, and a 3 m gravity core deployed at 15:00 (56°39.418N / 13°54.615W; 705 m WD; SS3). The pullout was again 0.8 tonnes. The corer returned on deck at 15:36, but was again empty with no indication of penetration. Moved to **Station 010** and repeated again. The corer was deployed at 16:18 and hit the seabed at 16:39 (56°38.368N / 130°57.089W; 570 m WD) but again retrieved no sediments. The ship then moved to the next diving site, dive 4, which was in the area of the Northern headwall scar (**Station 011**). The ROV was deployed at 18:10 and reached the seabed at 18:16 (56°40.489N / 13°55.131W; 599 m WD).

19 July 2014

Dive 4 finished at 00:26 (56°40.888 / 130°55.533W; 440 m WD) and was retrieved on deck at 00:50. The ship then moved to **Station 012** for ROV dive 5, to recover the USBL beacon at seabed used for calibration during ROV dive 1. Dive 5 saw the ROV in the water at 03:27. The ROV reached the seabed at 03:59 (56°30.148N / 14°06.726W; 725 m WD). The USBL beacon was quickly located and the ROV left the seabed at 04:58. Recovery was

delayed while problems with the ROV MBES set-up were addressed. The ROV was on deck at 06:33.

The ship then moved a short distance to the first coring station in order to attempt a repeat, with the aim of re-sampling potential glide plane material beneath the Holocene sand drape. The ship arrived on **Station 013** at 06:59, and a 3 m gravity corer was in the water at 07:21. The corer reached the seabed at 07:42 (56°30.637N / 14°07.212W; 690 m WD) with a pullout of 0.9 tonnes. The corer was on deck at 8:00. A core of ~0.8 m length was recovered with Holocene overlying dark mud, similar to the first attempt at this location.

The ship then moved to a nearby spur separating two arcuate slide scars, for a further coring attempt. The ship arrived on **Station 014** at 08:35 and a 3 m gravity corer was deployed at 08:49. The corer was in the seabed 09:10 (56°28.853N / 14°06.898W; 761 m), with a pullout of 0.8 tones. The corer returned on deck at 09:29, and contained 1.05 m of muddy contourite sand.

A repeat core was taken at the same location (**Station 015**). A 3 m gravity core was deployed at 09:51. The corer reached the seabed at 10:13 (56°28.848N / 14°06.885W; 762 m WD) with a pullout of 0.8 tonnes, and returned on deck at 10:30. Recovery was much lower on this occasion, with only ~10 cm of sediment recovered from the base.

The ship moved a short distance to the south, into an adjacent slide scar. **Station 016** was reached at ~11:53, and a 3 m gravity corer deployed at 11:55. The corer reached the seabed at 11:18 (56°28.447N / 14°07.457W; 772 m WD), with a pullout of 0.8 tonnes. The corer was back on deck at 11:40, but only contained ~10 cm of muddy sand sediments.

The ship then moved back north to undertake a ROV MBES survey of the slide scar surveyed on previous dives. The ship arrived on station at 13:17 (**Station 017**). ROV dive 6 was in the water at 13:37. Upon arrival at the seabed, it was quickly noticed that the Reson MBES system was experiencing interference with the Doppler navigation. In the end it was decided to switch the Doppler off and work with the USBL navigation only. This resulted in less accurate track & ping positioning, and in significant striping in the data.

20 July 2014

ROV MBES dive 6 finished just after midnight and the ROV was on deck at 00:12. The ship was on transit to the isolated pinnacle at 03:00, and arrived at the first waypoint at 03:49 (**Station 018**). The ROV was in the water at 04:10. The ROV reached the seabed at 04:57 (56°14.408N / 14°16.451W; 1072 m WD). A push core was taken, into what appeared to be a quite resistant muddy sand substrate. The ROV dive then followed a transect up onto the ridge of a volcanic mount. The ROV left the seabed at the end of transect at 12:20 (56°14.137N / 14°17.466W; 850 m WD). The ROV returned on deck at 13:05.

The ship then undertook a transit to a coring site within a shallow slide scar (adjacent to those cored the previous day) in the central upper slope area, and arrived at **Station 019** at 14:36. A 3 m gravity core was deployed at 14:52. The corer reached the seabed at 15:05 (56°27.06 / 14°12.29W; 668 m WD). The pullout was very low, only 0.7 tonnes. The corer was recovered at 15:26 and was recovered empty and with no apparent penetration. Another attempt was made at the same site only a short distance away (**Station 020**) (56°27.06N/14°12.305W; 668 m WD) but reduced the entry (winch payout) velocity. The corer was retrieved at 16:08 and it was empty, but some fine to medium "clean" sand had stuck on the cutting shoe (greased).

The ship then moved a short distance south for another coring attempt on a spit of remnant seafloor between scars (**Station 021**). The 3 m gravity corer was deployed at 17:31 and reached the seabed (56°24.591N/ 14°14.163W; 692 m WD) at 17:43. The pullout was only 0.8 tonnes and a few centimeters of sand and sandy mud were captured in the core cutter which were bagged (CE14011_05).

The ship then transitted to **Station 022** for dive 08 on the southern flank of the pinnacle. The ROV was deployed at 19:50 and reached the seabed at 2037 (56°13.976 / 14°17.976W; 1028 m WD). Dive 08 started SW of the pinnacle and moved NE towards the top of the pinnacle ridge.

21 July 2014

The ship undertook a mid-water transit during **Station 022** following the pinnacle ridge to the base of the isolated pinnacle, in order to complete a second transect up the southeast ridge (which appeared to be steeper than the areas previously mapped) along a lava outcrop to the top of the lava flow. The ROV reached the seabed at 03:38 and left the seabed at 5:49 (56°13.917N / 14°16.730W; 994 m WD), and was on deck at 06:36. The

ship then began a transit to a series of coring sites in a slide scar to the east at ~1600 m WD.

The first target was the deepest part of the slide scar. The ship arrived at **Station 023** at 07:30 and a 3 m gravity core was deployed at 07:40. The corer reached the seabed at 08:32 (56°10.816N / 14°08.357W; 1735 m WD) with a pullout of 2.6 tonnes (note that a different winch was used to the previous core deployments due to deeper water depth). The corer returned on deck at 09:19. Recovery was ~2.0 m of muddy greyish sediment.

A repeat core was undertaken at the same site (**Station 024**), and a 3 m gravity core was again deployed. The corer was in the water at 09:42. The corer reached the seabed at 10:16 (56°10.814N / 14°08.365W; 1736 m WD) and the pullout was 2.0 tonnes. The corer returned on deck at 10:57, and contained ~1.8 m of sediment with stiff silt at the base.

The next target was a terrace within the same slide scar, and **Station 025** was reached at ~11:35. A 3 m gravity core was deployed at 11:43 and reached the seabed at 12:17 (56°09.692N / 14°10.062W; 1695 m WD). The pullout was 2.0 tonnes. The corer was on deck at 12:57, and ~1.6 m of sediment was recovered.

A repeat core at the same site (**Station 026**) saw a 3 m gravity core deployed at 13:21. The corer reached seabed at 13:52 (56°09.695N / 14°10.076W; 1695 m WD), with a pullout of 2.4 tonnes. The corer was on deck at 14:39, and contained ~1.0 m of sediment (despite apparently penetrating over 2.5 m into the sediment).

The ship then transitted to a third coring site (**Station 027**) immediately southwest of the slide scar on the apparently undisturbed seafloor. The 3 m corer was deployed at 15:15. The corer reached the seabed at 15:40 (56°08.055N / 14°12.196W; 1679 m WD). Pullout was 1.7 tonnes. The corer was on deck at 16:19 and had retrieved 1.68 m (CE14011_08A). Because of the good recovery it was decided to use the 6 m corer and try again in the same location (**Station 028**). The corer was deployed at 17:00 and reached the seabed at 17:35 (56°08.058N / 14°12.204W; 1668 m WD). Pullout was 2.4 tonnes. The corer was on deck at 18:09 and had recovered 2.45 m having apparently penetrated ~4.5 m below the seafloor.

The ship then began transitting to **Station 029** to begin dive 09 to traverse a shallow and relatively wide alongslope ridge-and-moat at the northern reach of the southern scar. The ROV was deployed and reached the seabed at 20:55 (56°03.9N / 14°33.92W; 945 m WD).

22 July 2014

The ROV transferred in mid-water to another transect as part of **Station 029**, to run up the southern scarp at a different location. The ROV reached the seabed at 03:29 (56°04.859N / 14°34.345W; 859 m WD) and completed the transect up the ridge before leaving seabed at 05:35 (56°05.139N / 14°34.807W; 740 m WD; SS3). The ROV was on deck at 06:10, and delivered a deep-sea shark and a large squid (both of which had got caught in the ROV by accident).

The ship then moved a short distance to **Station 030**, in order to take a couple of gravity cores in the muddy sand seabed adjacent to the exposed scarps. The ship arrived on station at 06:22, and a 3 m gravity core was deployed. The corer reached the seabed at 06:38 (56°05.114N / 14°34.761W; 745 m WD), with a pullout of just 0.8 tonnes. The corer returned on deck at 06:55, but contained no sediment.

The ship transferred to nearby **Station 031** for a further coring attempt, arriving on station at 07:07. A 3 m gravity core was deployed at 07:10. The corer reached seabed at 07:22 (56°04.418N / 14°34.574W; 863 m WD), with a pullout of 0.8 tonnes. The corer returned on deck at 07:47, but was also washed out with no sediment recovery.

The final coring site (**Station 032**) was reached at 07:56 and a 3 m gravity core was deployed at 08:02. The corer reached the seabed at 08:20 (56°03.926N / 14°34.012W; 936 m WD) and the pullout was 0.8 tonnes. The corer returned on deck at 08:38, but was again empty.

The ship then moved east to an isolated pinnacle within a slope-parallel moat, downslope of the slide scarps / rock outcrops. The ship arrived on **Station 033** at 09:35 and a CTD was deployed at 09:37 (55°58.996N / 14°26.824W; 1528 m WD; SS3). The CTD returned on deck at 10:57.

The next ROV dive (ROV dive 010) was targeting the isolated pinnacle, and an adjacent small slide scar on its southwest margin. **Station 034** was reached at 11:45 and the ROV was deployed at 12:08. The ROV reached the seabed at 13:17 (55°58.554N / 14°29.000W; 1545 m WD). The ROV left the seabed at 21:46 (55°59.945N / 14°27.974W; 1101 m WD) and the ship transitted to a short distance away with the ROV mid-water, which reached the seabed again at 23:54 (55°58.879N / 14°29.391W; 1518 m WD).

23 July 2014

At 02:34 the ROV was again lifted to mid-water (55°58.967N/ 14°29.618W; 1381 m WD) and the ship transitted to a third vertical transect up the slide scar adjacent to the southwest pinnacle; this transect was located on the southwest margin of the slide scar. The ROV reached seabed at 03:42 (55°58.567N / 14°29.461W; 1398 m WD; SS3). After the transect was completed, the ROV left the seabed at 05:38 (55°58.481N / 14°29.664W; 1368 m WD m WD) and returned on deck at 06:33.

The ship then moved into deeper water in order to target a slide scar on the mid-slope at ~2000 m WD. The ship arrived at **Station 035** at 07:45 and a 6 m gravity corer was deployed at 08:06. The corer was at the seabed at 08:44 (55°50.593N / 14°23.832W; 1981 m WD), with a pullout of 2.3 tonnes. The corer returned on deck at 09:19 and contained ~2.75 m of sediment (although penetration was ~6 m).

A repeat 6 m gravity core was then taken at the same site (**Station 036**). The corer was in the water at 09:50. The corer reached the seabed at 10:34 (55°50.605N / 14°23.825W; 1984 m WD), with a pullout of 2.4 tonnes (note that the corer went in at 40 m/s, compared to 60 m/s on the previous deployment, to try and increase recovery). The corer returned on deck at 11:05, but this time only contained about ~1.0 m of sediment.

The ship then moved to the next coring site (**Station 037**), and a 6 m gravity core was deployed at 11:44. The corer reached the seabed at 12:32 (55°51.247N / 14°23.028W; 1959 m WD), with a pullout of 2.7 tonnes. The corer returned on deck at 13:08, and again only recovered 1.25 m of sediment despite apparently penetrating ~6 m into the seabed.

The repeat attempt at this site saw the ship move ~200 m away. A 6 m gravity core was deployed at **Station 038** at 13:43, and the corer reached the seabed at 14:24 (55°51.194N / 14°22.931W; 1963 m WD). The pullout was 2.9 tonnes. The corer returned on deck at 15:02 and had recovered 2.62 m of sediment.

The ship then moved to **Station 039** to deploy the ROV for a MBES forward-mapping survey (dive 11) along the northeast wall of the slide scar, where abundant corals had been imaged two days previously. It was decided to use the high-frequency (short-range) Doppler system for this dive, to avoid interference with the MBES while still maintaining good navigation up to 25m above the seabed. The ROV went in the water at 16:32 (55°58.852N/ 14°28.830W; 1425 m WD) and was surveying until 21:16 when an oil leak occurred and the dive had to be interrupted. The ROV was on deck at 22:08.

25 July 2014

At 1:09 the problem had been fixed and the ROV was back in the water for dive 12 (**Station 040**). The dive was completed by 10:37 (55°58.817N/14°28.812W; 1550 m WD). Upon retrieving it and when the ROV was at the sea surface the ROV cable jumped out of the sheave generating sparks. The recovery could not be continued using the ROV LARS so the MoB boat had to be launched in order to attach to the ROV the hooks of ship's cranes to complete the ROV recovery. While the ROV cable was being mended the ship moved to the next coring site (**Station 041**). A 6 m gravity corer was deployed at 14:15 and reached the seafloor at 14:52 (56°07.203N/ 14°08.222W; 1845 m WD). The recovery was again low, 1.89 m (CE14011_12) with apparent penetration ~6 m into the seabed.

The ship then moved to **Station 042** for another 6 m gravity core, which was deployed at 16:19 and reached the seabed at 16:48 (56°09.58N/ 14°12.212W; 1604 m). The corer returned on deck at 17:23 and had recovered 1.4 m of sediment, having apparently only penetrated ~3 m. A second coring attempt was made at the same location (**Station 043**) with the corer being deployed at 17:56 and hitting the seabed at 18:15 (56°09.851N/ 14°12.128W; 1604 m) and brought back on deck at 18:50. The recovery was similar, 1.38 m but apparently having penetrated a little more than 3 m.

26 July 2014

Overnight the ship slowly transitted to **Station 044** while the ROV was still being mended. It was ready for the final dive and in the water at 05:33. The ROV arrived at the seabed at 06:01 (56°0.249N/ 14°46.11; 640 m WD). The ROV finished the dive and left the seabed at 07:53 (56°02.36N/ 14°46.499W; 529.5 m WD) and was back on deck at 08:16. The ship then left the Rockall Bank and started transitting back to Galway. One last coring station was added along the transit to supplement the datasets of previous cruises (**Station 045**). The 6 m gravity corer was deployed at 16:36, arrived at the seabed at 17:32 (56°18.8N/ 12°48.214; 2858 m WD). The retrieval was 1.89 m having apparently penetrated ~4.5 m into the seabed. By 18:38 we were back en route to Galway.

27th July 2014

We arrived in Galway Bay in the morning but we had to wait for the afternoon gate opening and the ship was taken in at 5 pm.

B4 Benefits, impact and contribution of the outputs to marine research and the marine sector in general.

Outline clearly the specific outcomes and benefits of the research survey.

The information provided in this section should not exceed 1/2 page (excluding tables and maps)

CE14011 was a highly a successful cruise with a wealth of data acquired (Section B5), which will lead to several publications. Its success depended largely on the weather conditions which was particularly favourable. It also depended on good planning which proved to be well structured and demonstrated an effective and fruitful collaboration between UCD and NOC, which is now well-established and will be maintained in future projects.

Undergraduate and postgraduate students benefitted greatly by the experience of sea-based research and onboard research planning and data analysis, while some of them will be using data acquired during the cruise for their individual projects (namely Leo Chaumillon and Laurence De Clipelle). Kat Roberts and Cormac Reale will be using data as part of their post-doctoral research.

The pairing of ROV surveying and gravity coring used the shiptime quite efficiently and will be used again in the future.

It was the first time that Holland I was fitted with a forward-looking MBES system and this survey proved that it can be done successfully. We also used the ROV to study a fairly inaccessible and difficult terrain and obtain data for submarine slides that we hadn't attempted before (push cores and rock samples). This procedure also gave us ideas to develop new sampling techniques for Holland I which we will be discussing with the ROV technicians. This will lead to further uses of Holland I and more expeditions.

Finally our habitat surveying has revealed reef communities in areas that had not been known before but that lie on the periphery of a candidate SAC. We intend to recommend that the borders of the cSAC include our discovered sites.

B5 Data

Provide a description of the data collected from the research survey, the usage of the data and how it will be stored.

The information provided in this section should not exceed 1/2 page (excluding tables and maps)

The data collected during SORBEH are shown in the following maps and tables.

Out of the 30 gravity coring attempts, 20 were successful in retrieving sediment (Tables 1 and 2). However even those were not very effective in retrieving as much as the corer apparently had penetrated into the seafloor. Most of the successful attempts returned the core barrel with smeared sediment down the whole length of it, some times even up to the weight but on average retrieval was approximately 30% (Table 1). Several different approaches were tried, such as altering the winch pay out speed, waiting 20 m off the seafloor before paying out fast, changing the height at which the corer waited above the seafloor and was dropped from, not waiting above the seafloor at all, but these seem to make little difference.

Holland I performed 13 dives, out of which three were forward-looking multibeam mapping surveys of near-vertical walls. The longest dive lasted 16.5 hours, but as the ROV was lifted off the seabed twice and the ship transitted to nearby locations with the ROV mid-water, 13 hours of that contain real data. In total, 67 hours of video footage, more than 4500 still photographs, 21 hours of multibeam mapping, 61 biological samples, 22 push cores and 35 rock samples were collected with the ROV (Tables 3- 6).

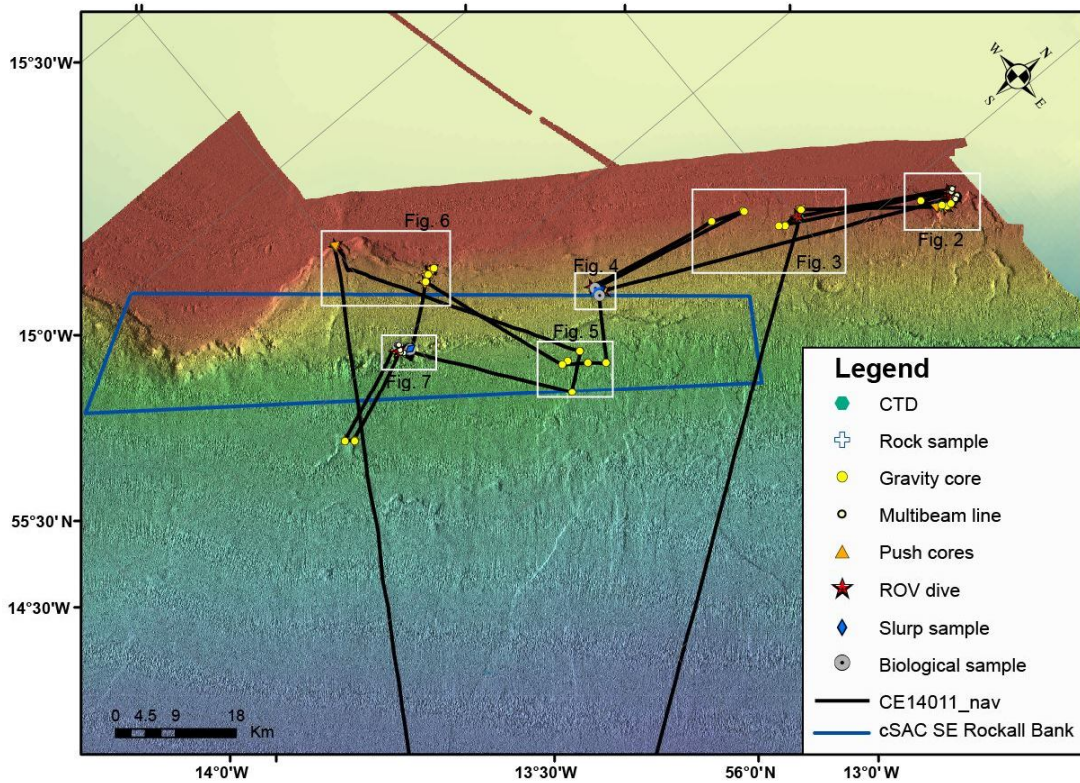


Figure 1 Map of the general study area that shows the track of the ship and data collected. Each of the targeted areas are zoomed in and shown in figures 2 to 7.

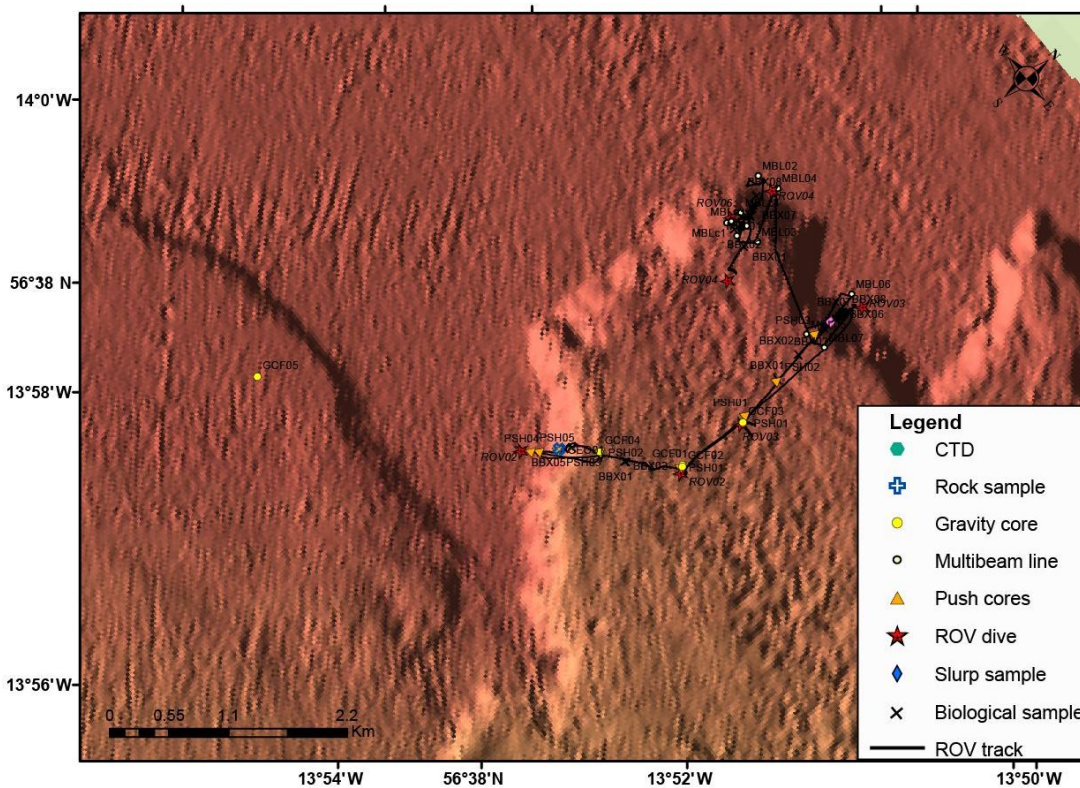


Figure 2 Close up to the northern scars. GCF indicates the location of failed gravity cores, i.e. that retrieved no sediments. Dives 02, 03 and 04. See figure 1 for wider location.

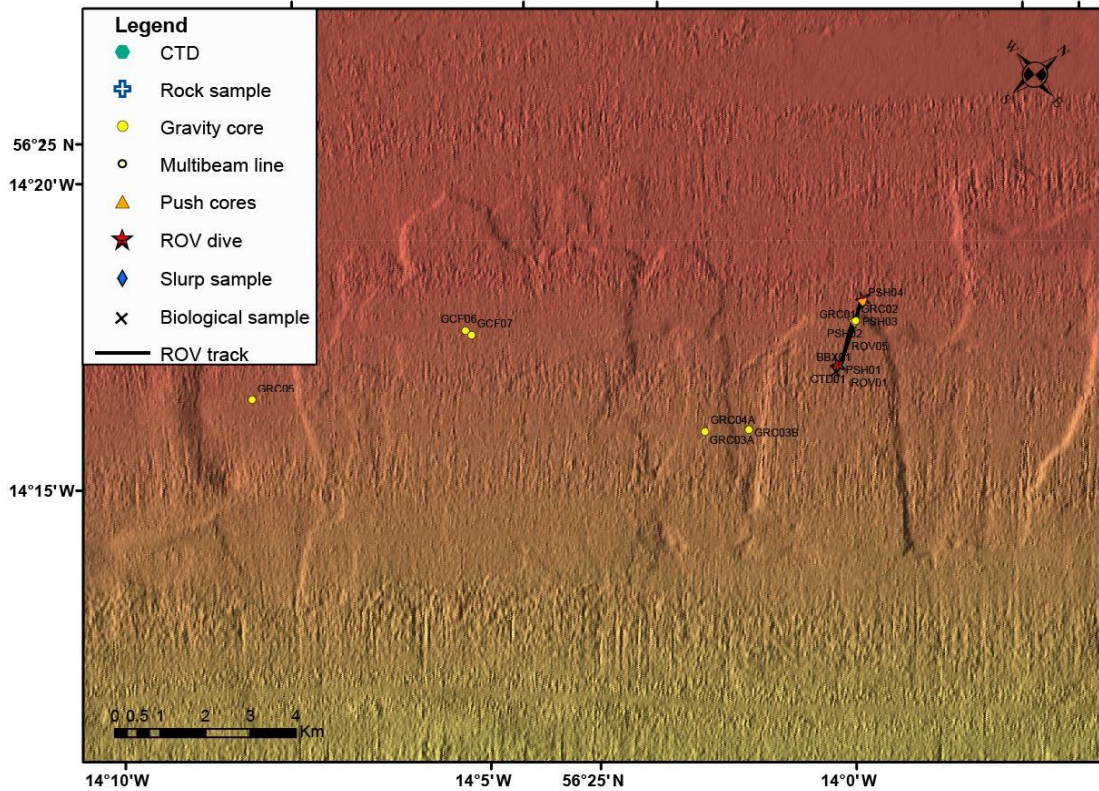


Figure 3 Central Upper slope area. GCF indicates the location of failed gravity cores. ROV dives 01 and 05 (deployment and retrieval of USBL beacon). See figure 1 for wider location.

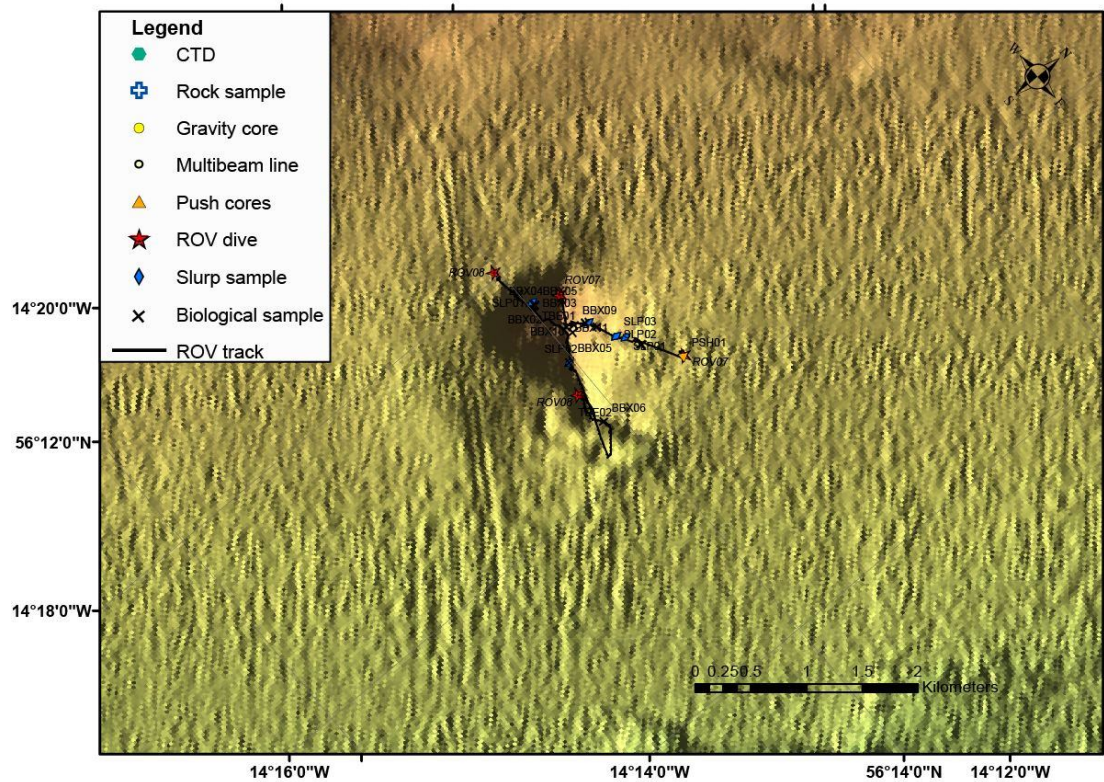


Figure 4 Isolated pinnacle in the central upper slope. This pinnacle lies adjacent to the limits of the cSAC (shown in blue in Fig 1). We found a thriving reef on this pinnacle (Figs 10-12) and we intend to recommend its inclusion in the cSAC. ROV dives 07 and 08. See figure 1 for wider location.

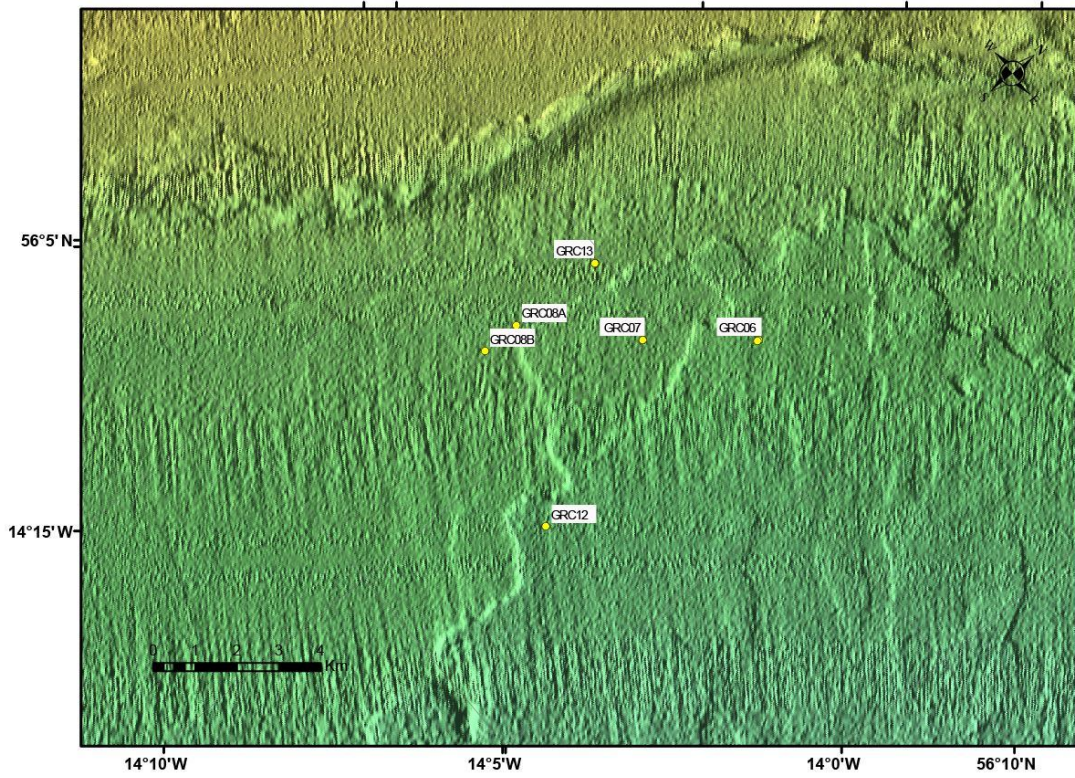


Figure 5 Gravity core locations from the deeper water area. See figure 1 for wider location.

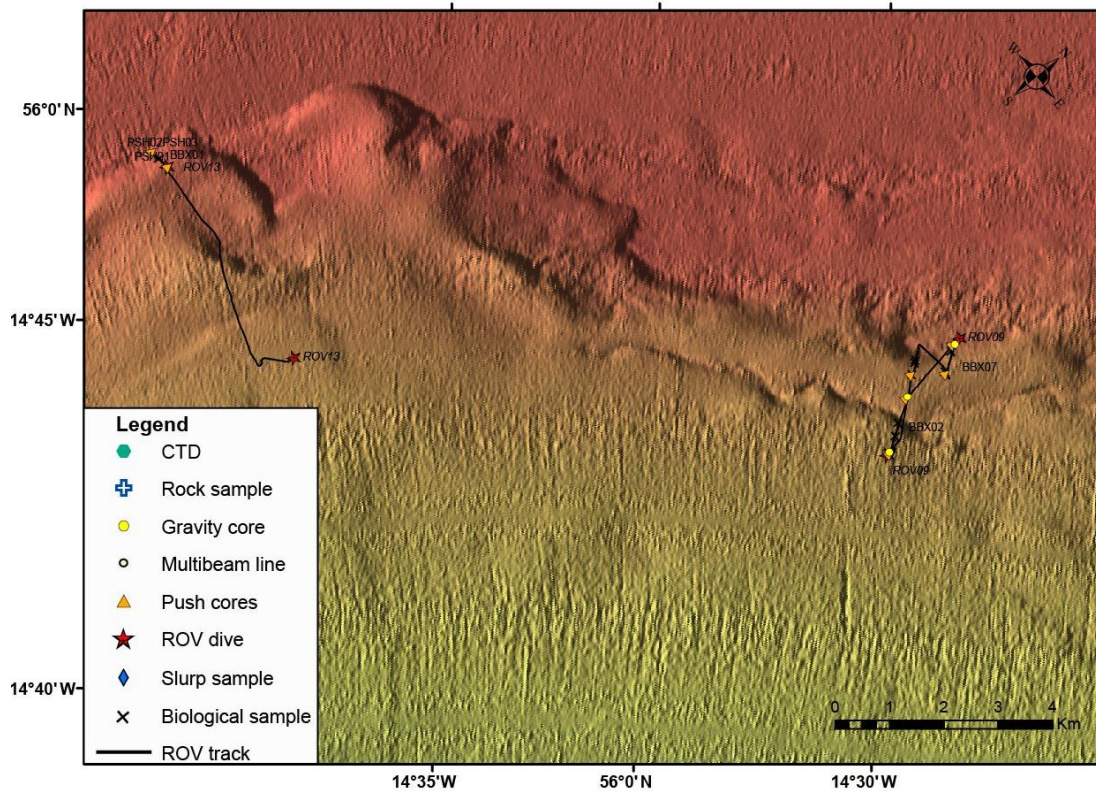


Figure 6 Southern study area. ROV dives 9 (right) and 13 (left). See figure 1 for wider location.

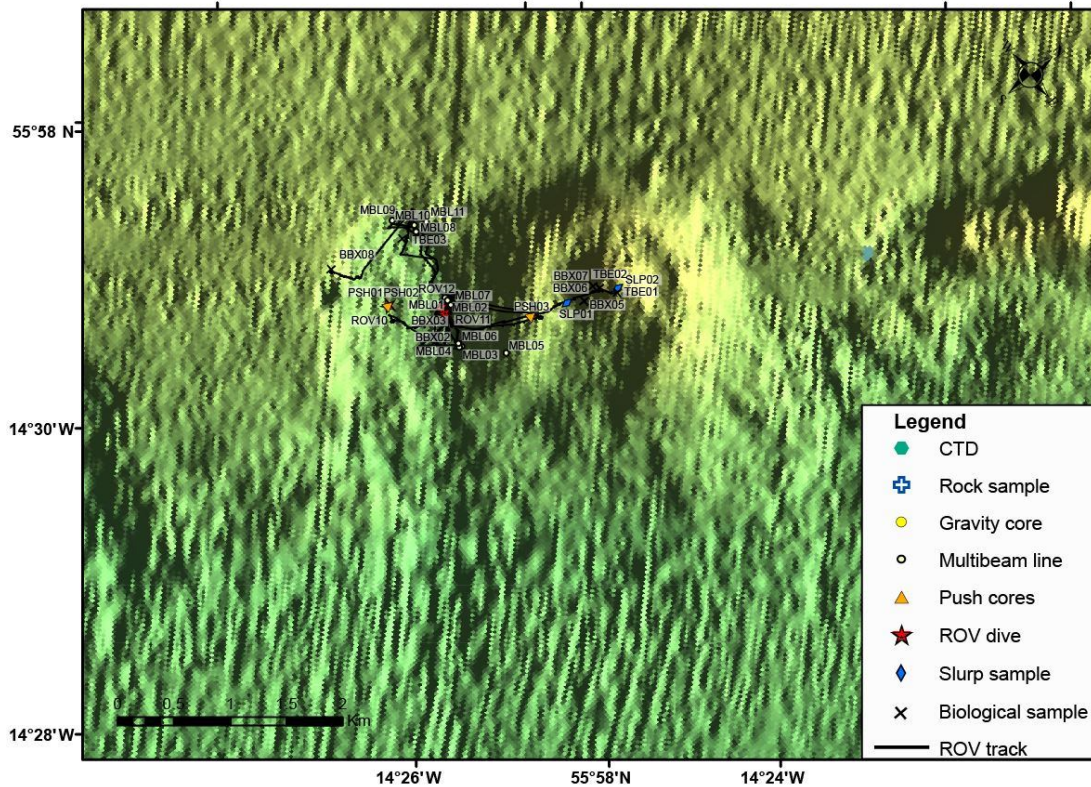


Figure 7 Mound (pinnacle) in alongslope moat, near the base of slope. ROV dives 10, 11 and 12. For wider location see figure 1.

The following tables list all the data collected according to activity; gravity coring, ROV surveying, biological samples, push cores and rock samples.

Table 1 Gravity cores that retrieved sediment.

Gear	Set up (m)	Sample	Stn No	Latitude	Longitude	Water depth (m)	Retrieval (m)	Success (%)
GRC01	3	CE14011_01	003	56.5108	-14.1201	688	0.81	27.0
GRC02	3	CE14011_02	013	56.5106	-14.1202	690	0.86	28.7
GRC03A	3	CE14011_03A	014	56.4809	-14.1150	761	1.05	35.0
GRC03B	3	CE14011_03B	015	56.4808	-14.1148	763	0.08	2.7
GRC04A	3	CE14011_04A	016	56.4740	-14.1241	772	0.09	3.0
GRC05	3	CE14011_05	021	56.4097	-14.2361	692	0.02	0.7
GRC06A	3	CE14011_06A	023	56.1805	-14.1393	1735	2.06	68.7
GRC06B	3	CE14011_06B	024	56.1802	-14.1394	1736	1.79	59.7
GRC07A	3	CE14011_07A	025	56.1616	-14.1678	1695	1.57	52.3
GRC07B	3	CE14011_07B	026	56.1615	-14.1679	1695	0.74	24.7
GRC08A	3	CE14011_08A	027	56.1428	-14.2033	1672	1.68	56.0
GRC08B	6	CE14011_08B	028	56.1342	-14.2034	1669	2.65	44.2
GRC09A	6	CE14011_09A	035	55.8432	-14.3972	1980	2.75	45.8
GRC09B	6	CE14011_09B	036	55.8434	-14.3971	1988	0.95	15.8
GRC10	6	CE14011_10	037	55.8541	-14.3838	1959	1.25	20.8
GRC11	6	CE14011_11	038	55.8533	-14.3822	1965	2.62	43.7
GRC12	6	CE14011_12	041	56.1201	-14.1370	1845	1.89	31.5
GRC13A	6	CE14011_13A	042	56.1643	-14.2020	1604	1.40	23.3
GRC13B	6	CE14011_13B	043	56.1642	-14.2021	1604	1.38	23.0

GRC14	6	CE14011_14	045	55.3133	-12.8036	2858	1.89	31.5
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Table 2 Gravity cores that failed to retrieve sediment.

Gear	Station No	Latitude	Longitude	Water depth (m)
GCF01	006	56.661467	-13.900767	702
GCF02	008	56.661383	-13.900583	702
GCF03	007	56.667483	-13.899833	678
GCF04	009	56.656967	-13.910250	705
GCF05	010	56.639500	-13.951500	584
GCF06	019	56.450750	-14.206533	668
GCF07	020	56.451033	-14.203800	668
GCF08	030	56.085300	-14.579250	745
GCF09	031	56.073650	-14.576133	863
GCF10	032	56.065467	-14.567083	936

Table 3 ROV dives

Final sample number	Start Date	Start Time GMT	Start Lat Degr N	Start Lat Min N	Start Long Degr W	Start Long Min W	Start WD (m)	End Date	End Time GMT	End Lat Degr N	End Lat Min N	End Long Degr W	End Long Min W	End WD (m)	Comments	Photos
CE14011_ROV01	17/07/2014	06:08:00	56	30.15	14	6.713	723	17/07/2014	12:00:00	56	30.869	14	7.4302	656		IMG_9662-IMG9860
CE14011_ROV02	17/07/2014	19:53:00	56	39.676	13	53.99374	552	18/07/2014	01:30	56	39.168	13	55.003		record for ROV on bottom and ROV leaving the seabed	IMG_9861-IMG_9900, IMG_0001-IMG_0233
CE14011_ROV03	18/07/2014	04:12:00	56	40.04042	13	53.987	677	18/07/2014	11:09	56	40.185	13	54.153	487.5	record for ROV on bottom and ROV leaving the seabed	IMG_0234-IMG_0493
CE14011_ROV04	18/07/2014	17:46	56	40.4487	13	55.0494	593	19/07/2014	00:50	56	40.888	13	55.533	440	record for ROV on bottom and ROV leaving the seabed	IMG_0401-IMG_0619
CE14011_ROV05	19/07/2014	04:00	56	30.1599	14	6.723	725	19/07/2014	04:59	56	30.1439	14	6.7113	726.2	Picking up the beacon, records for ROV on and off seabed	IMG_0601-IMG_0619
CE14011_ROV06	19/07/2014	14:29	56	40.6602	13	55.463	571	19/07/2014	23:56:06	56	40.838	13	54.161	461	multibeam dive, including some bottom time	IMG_0620-IMG_0809
CE14011_ROV07	20/07/2014	04:09	56	14.4261	14	16.4401	1080	20/07/2014	12:20	56	14.1365	14	17.499	860	record for ROV on bottom and ROV leaving the seabed	IMG_0810-IMG_1191
CE14011_ROV08	20/07/2014	20:36	56	13.9801	14	18.0446	1033	21/07/2014	05:49	56	13.9272	14	16.7336	1004		IMG_1101-IMG_1912
CE14011_ROV09	21/07/2104	20:52	56	3.9005	14	33.9968	950	22/07/2014	5:34:00	56	5.1217	14	34.7817	750		IMG_1912-IMG_2483
CE14011_ROV10	22/07/2014	13:17:00	55	58.591	14	29.122	1550	23/07/2014	05:38	55	58.4899	14	29.6761	1388		IMG_2484-IMG_4087
CE14011_ROV11	23/07/2014	17:50:10	55	58.78163	14	28.81138	1541	23/07/2014	20:54:52	55	58.74186	14	1708.684	1504	multibeam dive - dive aborted - oil leak in motor	no photographs
CE14011_ROV12	24/07/2014	02:17:03	55	58.776	14	28.76454	1546	24/07/2014	10:30	55	58.83	14	28.8079	1534	multibeam dive contnd	
CE14011_ROV13	25/07/2014	06:01	56	0.2755	14	46.1216	648	25/07/2014	07:51	56	0.2586	14	46.4987	536		IMG_4001-IMG4171

Table 4 Biological Samples

Bio_ID	Dive	Event	Description	Sample photo	Date	Time	Latitude	Longitude	Water Depth (m)
1	01	2	Anemone, 2 Polychaetes		17/07/2014	09:41	56.5012	-14.11072	695
2	02	3	<i>Spantagus</i> Urchin		17/07/2014	21:21:00	56.6581	-13.90666	710
3	02	2	<i>Echinus</i> Urchin		17/07/2014	21:13:00	56.6581	-13.90653	709
4	03	9	<i>Mycale</i> Sponge		18/07/2014	08:32	56.6793	-13.90267	509
5	03	8	Stylaster Coral	DSC_0380	18/07/2014	08:10	56.6788	-13.90284	517
6	03	2	<i>Stichopus tremulus</i> Sea Cucumber	DSC_0381	18/07/2014	05:36	56.672	-13.90146	640
7	07	2	White Soft Coral		20/07/2014	06:17	56.2383	-14.27927	1057
8	07	3	Pink Soft Coral	IMG_5779	20/07/2014	06:22	56.2383	-14.27927	1057
9	07	13	<i>Caryophyllia</i> Solitary Corals	IMG_5767	20/07/2014	10:19:44	56.2359	-14.28672	899
10	07	13	Ophiuroids	IMG_5770	20/07/2014	10:19:44	56.2359	-14.28672	899
11	07	13	Asteroids	IMG_5771	20/07/2014	10:19:44	56.2359	-14.28672	899
12	07	13	Polychaetes	IMG_5772	20/07/2014	10:19:44	56.2359	-14.28672	899
13	07	13	Scleractinian	IMG_5776	20/07/2014	10:19:44	56.2359	-14.28672	899
14	07	13	Bivalves		20/07/2014	10:19:44	56.2359	-14.28672	899
15	07	6	Red Bushy Soft Coral	IMG_5782	20/07/2014	07:31	56.2377	-14.28142	992
16	07	7	White Soft Coral	IMG_5783	20/07/2014	08:18	56.2372	-14.28253	982
17	07	7	White Soft Coral	IMG_5784	20/07/2014	08:18	56.2372	-14.28253	982
18	07	8	<i>Desmophyllum</i> Solitary Corals	IMG_5785	20/07/2014	08:24	56.2372	-14.28253	982
19	07	9	Soft Coral	IMG_5786	20/07/2014	09:09	56.2365	-14.28535	912
20	07	11	<i>Caryophyllia</i> Solitary Corals	IMG_5789	20/07/2014	09:50	56.2362	-14.28653	909
21	07	15	Purple Cnidarian growing on coral rubble	IMG_BIO021	20/07/2014	11:34	56.2347	-14.28688	833
22	07	6,7,8	Bivalves	IMG_5790	20/07/2014	07:31	56.2372	-14.28253	982
23	07	6,7,8	Majidae, Spider Crab	IMG_5791	20/07/2014	07:31	56.2372	-14.28253	982
24	07	6,7,8	Ophiuroids		20/07/2014	07:31	56.2372	-14.28253	982
25	07	15	Majidae, Ophiuroids		20/07/2014	11:34	56.2347	-14.28688	833
26	07	16	<i>Lophelia pertusa</i> (peach color)	IMG_BIO026	20/07/2014	11:43	56.2346	-14.28808	822
27	07	14	Ophiuroid		20/07/2014	10:50	56.2352	-14.2876	863
28	07	14	Coral rubble for carbon dating	IMG_5827	20/07/2014	10:50	56.2352	-14.2876	863
29	08	11	Small Asteroid	IMG_5792	21/07/2014	05:09	56.232	-14.2742	1066
30	08	6	Tunicates	IMG_5793	21/07/2014	23:08	56.2338	-14.29342	922

31	8	6	Polycheates	IMG_5795	21/07/2014	23:08	56.2338	-14.29342	922
32	8	6	Solitary Coral	IMG_5800	21/07/2014	23:08	56.2338	-14.29342	922
33	8	6	Ophiuroids	IMG_5798	21/07/2014	23:08	56.2338	-14.29342	922
34	8	6	Polycheates	IMG_5796	21/07/2014	23:08	56.2338	-14.29342	922
35	8	8	Yellow branching soft coral	IMG_5802	21/07/2014	01:45	56.2329	-14.28389	921
36	8	2	Solitary Coral	IMG_5799	21/07/2014	21:56	56.2338	-14.29404	943
37	8	10	Solitary Coral	IMG_5801	21/07/2014	04:04	56.2321	-14.27318	1079
38	8	5	Yellow branching soft coral	IMG_5803	21/07/2014	22:52	56.2337	-14.29345	925
39	8	9	Pink Soft Coral	IMG_5806	21/07/2014	02:03	56.2329	-14.28389	921
40	8	NA	NA	NA	NA	NA	NA	NA	NA
41	8	9	Polycheates		21/07/2014	02:03	56.2329	-14.28389	921
42	8	1	Anemones living on coral	IMG_5811	21/07/2014	21:28	56.2334	-14.29609	1018
43	9	5	<i>Echinus</i> sp	IMG_5818	22/07/2014	00:49	56.0766	-14.58042	861
44	9	2	Sponge, cup white	IMG_5822	21/07/1924	21:58	56.0679	-14.5694	929
45	9	2	Ophiuroids	IMG_5819	21/07/1924	21:58	56.0679	-14.5694	929
46	9	2	Cridoid	IMG_5821	21/07/1924	21:58	56.0679	-14.5694	929
47	9	2	Solitary Coral	IMG_5820	21/07/1924	21:58	56.0679	-14.5694	929
48	9	8	Sponge, fan-shaped	IMG_5824	22/07/2014	01:44	56.0786	-14.583	817
49	9	12	Anemone	IMG_5825	22/07/2014	05:14	56.0848	-14.57912	754
50	10	6	Slender orange coral	IMG_5842	22/07/2014	16:42	55.9803	-14.47685	1453
51	10	6	Yellow branching soft coral	IMG_5844	22/07/2014	16:42	55.9803	-14.47685	1453
52	10	6	dark red coral	IMG_5845	22/07/2014	16:42	55.9803	-14.47685	1453
NA	8		Cerianthid lost on ascent	NA	NA	NA	NA	NA	NA
53	10	14	Purple pom-pom anemone	IMG_5846	22/07/2014	21:29	55.9914	-14.4663	1137
54	10	11	<i>Solesnosmilia variabilis</i> , pink color	IMG_5847	22/07/2014	20:10	55.9901	-14.46868	1214
55	10	9	Slender orange coral	IMG_5848	22/07/2014	19:22	55.9887	-14.46801	1296
56	10	12	Pink Soft Coral	IMG_5850	22/07/2014	20:32	55.9903	-14.46801	1189
57	10	13	Yellow stringhy coral	IMG_5851	22/07/2014	21:07	55.9912	-14.46587	1164
58	10	5	Solitary coral on dead coral framework	IMG_5854	22/07/2014	15:36	55.9796	-14.47752	1538
59	13	2	<i>Madrepora occulata</i>	DSC_0721	25/07/2014	07:04	56.0042	14.772238	586
60	13	2	Anemones	DSC_0729	25/07/2014	07:04	56.0042	14.772238	586
61	13	2	Yellow Sponge	DSC_0731	25/07/2014	07:04	56.0042	14.772238	586

Table 5 Push cores

Dive	Event	Latitude	Longitude	Date	Time	Water depth (m)	Comments
01	PSH01	56.502617	-14.112067	17/07/14	06:42	728.0	Sediment appears quite sandy and stiff. ~30cm recovered
01	PSH02	56.510678	-14.120340	17/07/14	10:44	693.5	Lots of force needed, but only half tube with sediment.
01	PSH03	56.510678	-14.120340	17/07/14	10:54	694.5	Hard to push down more sediment collected
01	PSH04	56.514497	-14.123837	17/07/14	11:55	658.9	Push core, only ~30cm long.
02	PSH01	56.661387	-13.900712	17/07/14	20:11	705.0	muddy fine sands
02	PSH02	56.657167	-13.910172	17/07/14	22:00	706.0	muddy sands (very easy to core above the floor)
02	PSH03	56.654563	-13.914300	17/07/14	23:58	604.0	core tube half full, but falling out.
02	PSH04	56.653317	-13.915867	18/07/14	00:39	568.0	push core muddy sands
02	PSH05	56.652817	-13.916700	18/07/14	01:20	566.0	push core sandy mud (more mud than previous)
03	PSH01	56.668105	-13.900323	18/07/14	04:47	673.0	repeat successful, but core only ~10cm
03	PSH02	56.671965	-13.901457	18/07/14	05:36	640.0	sandy sediment unseccessful
03	PSH03	56.676817	-13.903155	18/07/14	06:52	626.8	Very granular angular sand with gravel
07	PSH01	56.240400	-14.274002	20/07/14	05:04	1081.0	
09	PSH01	56.065400	-14.566667	21/07/14	21:09	939.0	pushcore 2
09	PSH02	56.073428	-14.575970	21/07/04	23:42	871.0	full push core
09	PSH03	56.076615	-14.580422	22/07/14	01:05	861.0	sandy sediment - similar to event 04
09	PSH04	56.081110	-14.574268	22/07/14	04:03	862.0	pushcore 6
09	PSH05	56.085072	-14.579543	22/07/14	05:28	752.0	pushcore 5
10	PSH01	55.976525	-14.485350	22/07/14	13:31	1555.0	pushcore 4
10	PSH02	55.976525	-14.485350	22/07/14	13:34	1555.0	pushcore 5
10	PSH03	55.984703	-14.471110	22/07/14	18:10	1341.0	bottom of pushcore empty
13	PSH01	56.004598	-14.768692	25/07/14	06:11	662.0	first attempt fell out, second attempt with same tube unsuccessful
13	PSH02	56.004167	-14.774983	25/07/14	07:40	536.0	sediment
13	PSH03	56.004167	-14.774983	25/07/14	07:47	536.0	sediment, second attempt at same point

Table 6 Rock samples

Dive	Event number	Latitude	Longitude	Date	Time	Water depth (m)	Comments
02	BBX06	54.85750	-13.91429	18/07/14	00:10	604.0	rock, hard, not crumbly
02	GEO01	56.65457	-13.91429	18/07/14	00:39	574.0	rock sample
03	BBX02	56.67459	-13.90232	18/07/14	06:12	635.7	rock x2
03	BBX03	54.18360	-13.90306	18/07/14	07:24	608.0	in situ sample from bedrock
03	BBX04	56.67833	-13.90298	18/07/14	08:01	574.0	rock sample in crate
03	BBX05	56.67884	-13.90284	18/07/14	08:10	516.7	rock sample with coral

03	BBX06	54.16780	-13.90280	18/07/14	09:10	509.0	limestone-type rock
03	BBX07	54.16210	-13.90270	18/07/14	10:02	496.0	rock sample from overhang escarpment
04	BBX01	56.67691	-13.91989	18/07/14	18:57	596.4	Scoop of pebbles (Pre cliff)
04	BBX02	56.67717	-13.92269	18/07/14	20:28	557.3	Rock sample (First Cliff)
04	BBX03	56.67885	-13.92272	18/07/14	20:49	557.0	Rock sample (First Cliff-557m-)
04	BBX04	56.67892	-13.92280	18/07/14	21:11	546.0	Rock sample- second cliff
04	BBX05	56.67886	-13.92301	18/07/14	21:31	526.0	Rock, terrace after 2nd cliff
04	BBX06	56.67942	-13.92347	18/07/14	21:42	510.0	Undefined samples(white & black sample)
04	BBX07	56.67969	-13.92366	18/07/14	23:20	502.0	scoop of unconsolidated sediment
04	BBX08	56.68032	-13.92442	18/07/14	23:56	458.0	scoop of unconsolidated sediments - scarp
07	BBX04	56.23833	-14.27917	20/07/14	06:41	1056.0	rock sample x 2
07	BBX06	56.23619	-14.28653	20/07/14	09:33	909.0	black rock
07	BBX07	56.23591	-14.28672	20/07/14	10:14	899.0	rock from edge
07	BBX08	56.23591	-14.28672	20/07/14	10:19	899.0	flat rock slab with corals
08	BBX02	56.23371	-14.29350	20/07/14	22:23	926.0	small rock with cup corals
08	BBX04	56.23376	-14.29342	20/07/14	23:08	922.0	round cobble
08	BBX05	56.23377	-14.29342	20/07/14	23:16	922.0	small black rock
08	BBX06	56.23199	-14.27420	21/07/14	05:09	1066.0	rock sample
09	BBX02	56.06962	-14.57193	21/07/14	22:41	888.0	cobble
09	BBX04	56.07829	-14.58261	22/07/14	01:35	831.0	big rock with encrusting sponges
09	BBX07	56.08406	-14.57821	22/07/14	04:55	762.0	rock sample
10	BBX01	55.97759	-14.48041	22/07/14	14:30	1565.0	rock of light colour
10	BBX02	55.97759	-14.48041	22/07/14	14:48	1565.0	rock of black colour
10	BBX05	55.98869	-14.46801	22/07/14	19:22	1296.0	slab of rock
10	BBX06	55.98870	-14.46802	22/07/14	19:29	1296.0	basaltic rock
10	TBE03	55.98093	-14.49144	23/07/14	00:37	1550.0	sample of brittle rock
10	BBX08	55.97481	-14.49458	23/07/14	05:29	1389.0	rock samples
13	BBX01	56.00422	-14.77224	24/07/14	07:04	586.0	in situ sample from ledge

Some example photographs from the different ROV dives are displayed below:

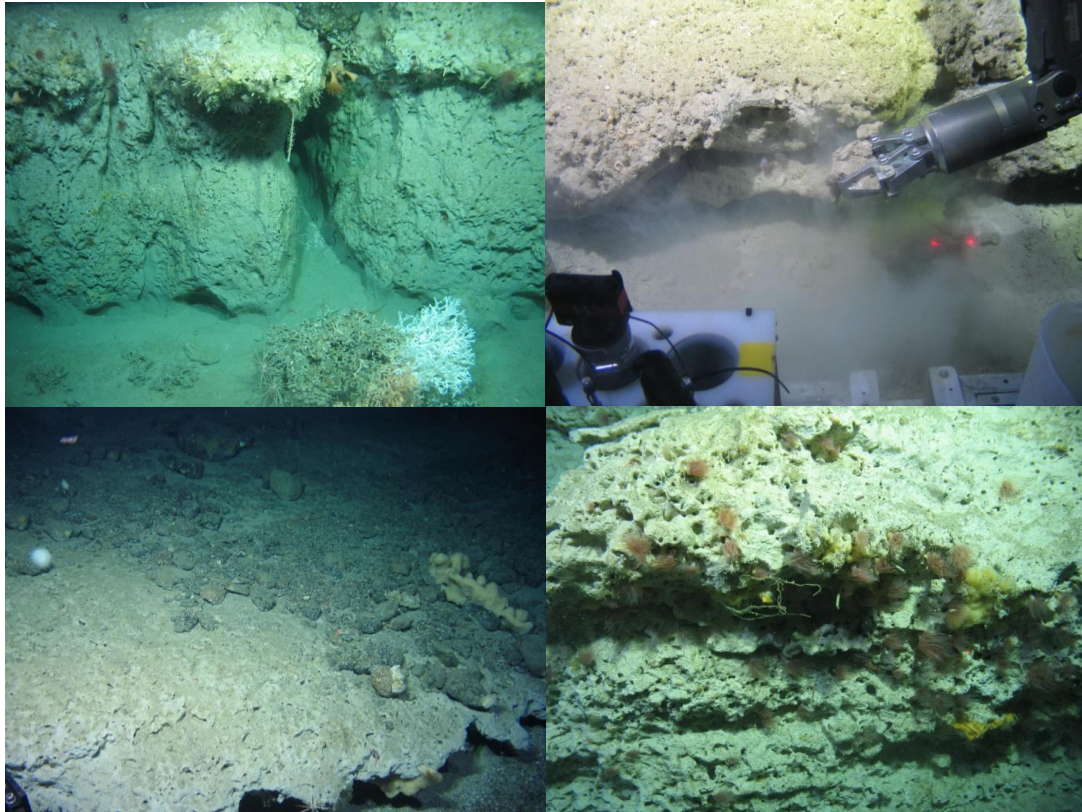


Figure 8 Tabular outcrops of calcareous and rather friable rocks encountered during Dives 02, 03 and 04 in the northern scarp. Faunal coverage was limited with a large number of boring organisms (e.g. tube worms, sponges, limited numbers of cold-water corals).

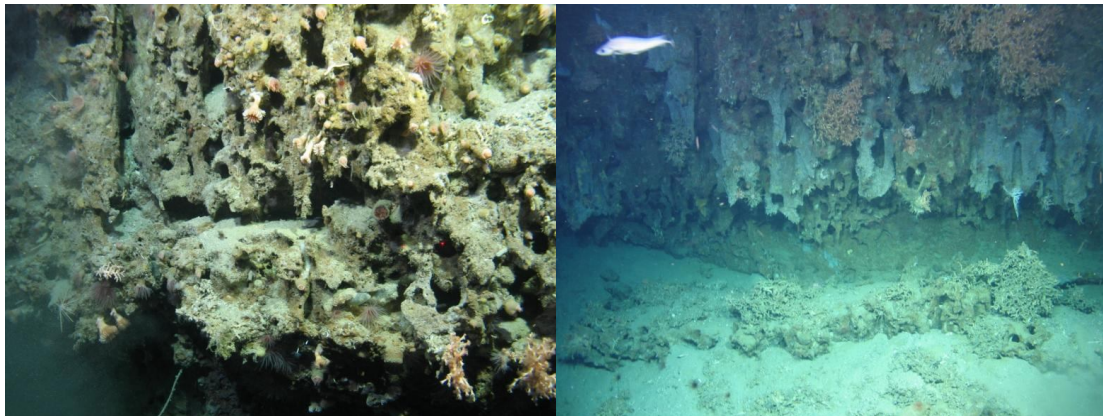


Figure 9 The appearance of the southern scarp is very different, with intricately eroded calcareous banks and a higher density in colonising fauna (Dive 13).

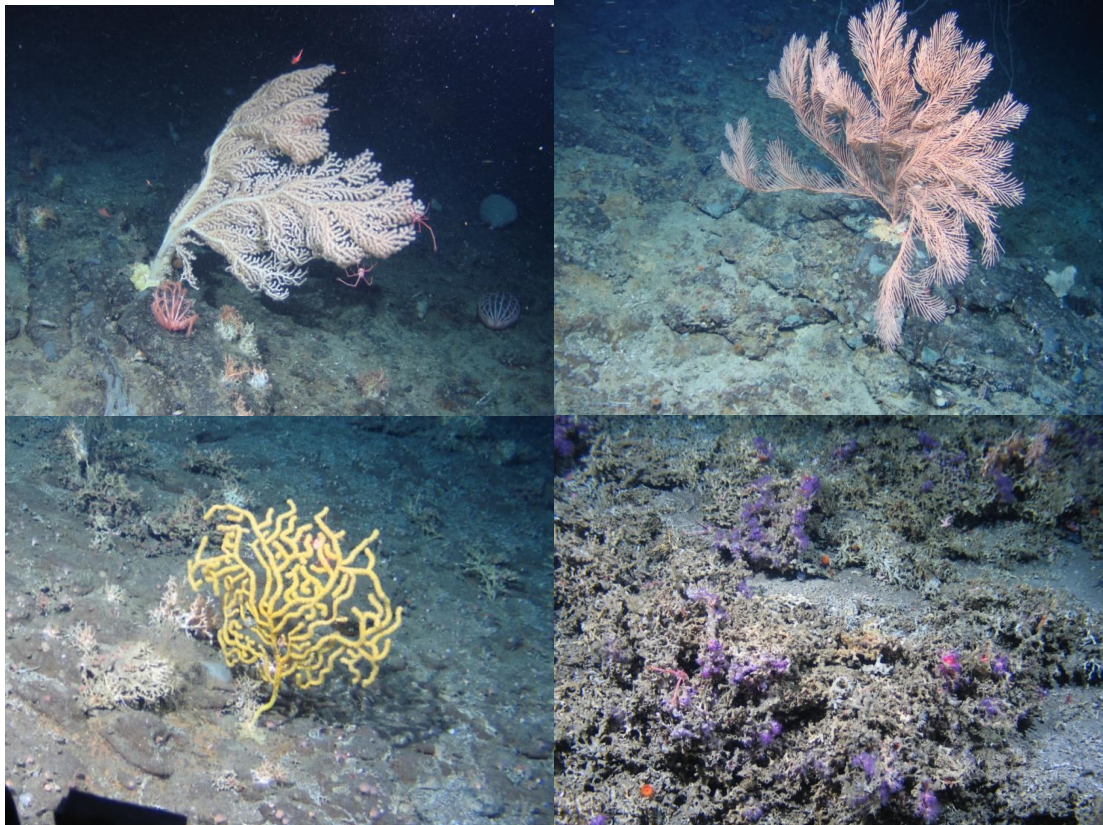


Figure 10 Illustration of the rich faunal community, including cold water corals and encrusting species, encountered on the shallower water pinnacle (isolated pinnacle) (Dives 07 & 08).



Figure 11 Dives 07 & 08 on the shallower-water pinnacle demonstrated the volcanic origin of this feature with very good examples pillow lavas, lava tubes and fissures.

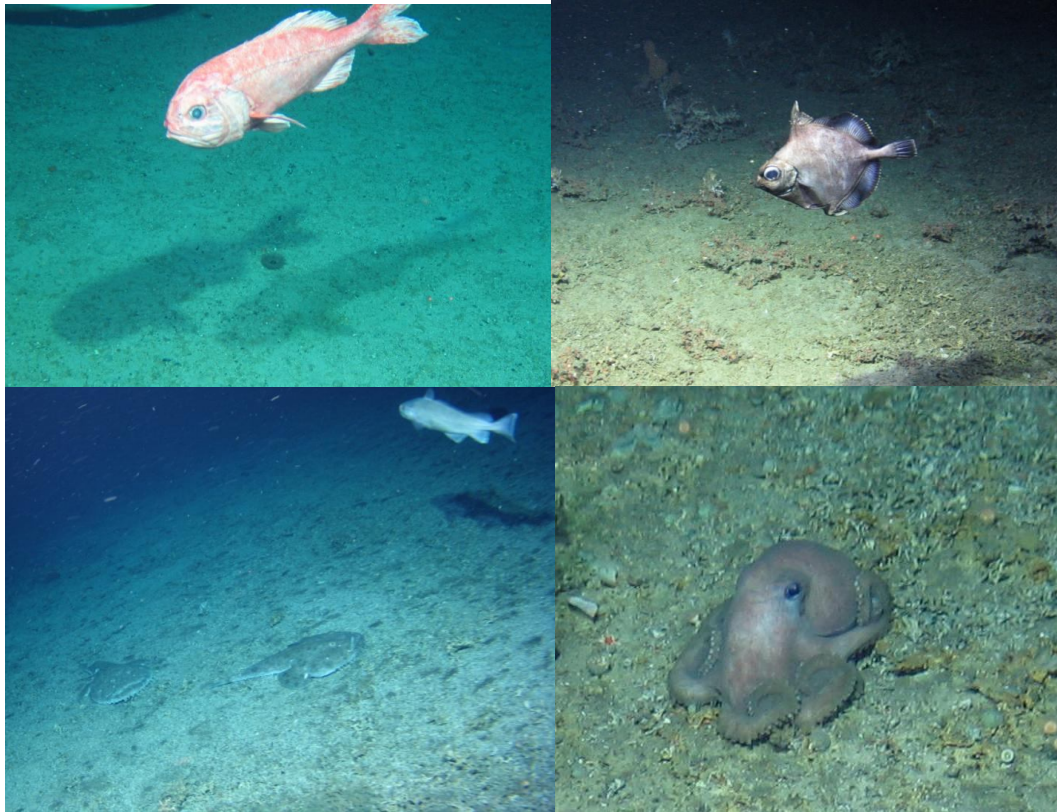


Figure 12 This pinnacle is also home to a rich fish community, including Orange Roughy (upper left) and Monkfish (lower left).

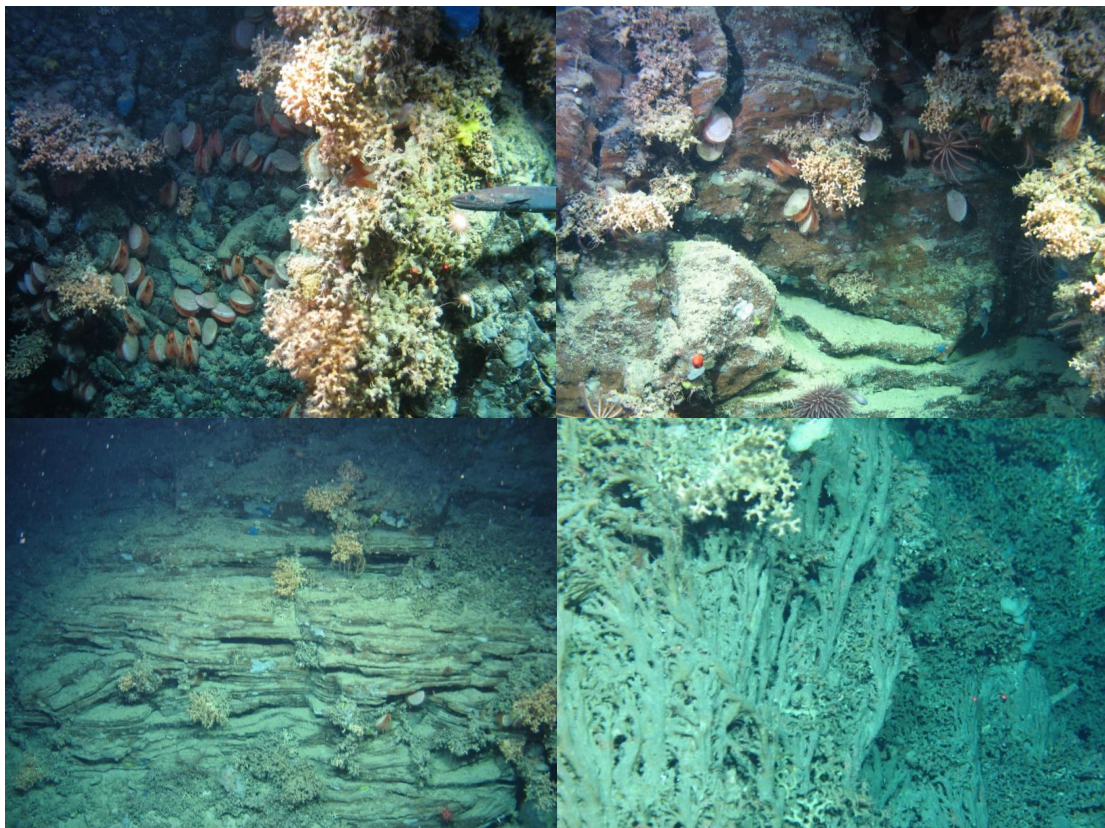


Figure 13 The most spectacular communities were encountered on Dive 10, on the vertical cliffs of a small headwall scarp next to a volcanic cone (deeper water pinnacle). Communities included *Acesta excavata* and

large colonies of potentially *Solenosmilia variabilis*. The top of the volcanic cone was covered with extensive frameworks of fossil scleractinians.

B6 Contribution to marine research programmes

Outline specific National/EU/International research programmes this survey supported. Please include the funding sources for these programmes as well as the total amount of funding leveraged (Repeat the table below, if necessary).

National/EU/International Research programme(s):	ERC CODEMAP
Total Programme cost:	<i>1.4M EUR</i>
Value to Irish partners:	<i>Indirect value through collaborations, CODEMAP contribution to CE14011: 15k EUR</i>
Project duration:	<i>5 years, potentially extended with 1 year</i>
Contract no.:	<i>258482</i>
Project partners:	<i>NERC-NOC</i>
Project web address:	<i>www.codemap.eu</i>

Appendices

Please number and attach any relevant Appendices here.