National Oceanography Centre, Southampton

Cruise Report No. 22

RRS *James Cook* Cruise 10

13 MAY – 07 JUL 2007

Hotspot ecosystems in the NE Atlantic,
UK contribution to the HERMES Project

Mud volcanoes in the Gulf of Cadiz
Submarine canyons west of Portugal
Submarine canyons in the northern Bay of Biscay

Principal Scientists

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2007

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ABSTRACT

The major objective of RRS James Cook 10 was to increase our understanding of how seafloor environmental variables affect the biodiversity, structure, function and dynamics of faunal communities in two specific 'biological hotspot' environments, mud volcanoes and submarine canyons, on the NE Atlantic continental slope. The cruise was jointly supported by OCEANS 2025 (Theme 5) and the EU Hotspot Environment Research on the Margins of European Seas (HERMES) project. The work was based mainly on the use of the ISIS Remotely Operated Vehicle (ROV) ISIS, but a wide suite of additional techniques including sediment coring, water column measurement and sampling, benthic trawling and swath mapping were also deployed. Forty-one ROV dives, some lasting for up to 36 hours, were completed during a highly successful cruise. The ROV programme included swath mapping, video and still photography, sediment coring using both push and mini-box corers, rock sampling, collection of biological samples, water sampling, subseafloor temperature measurement, and the placing and manipulating of a variety of seafloor experiments.

KEYWORDS

Biscay Bay, Cadiz Gulf, cruise 10 2007, HERMES, OCEANS 2025, *James Cook*, NE Atlantic, ISIS ROV, submarine canyons, mud volcanoes, Nazare Canyon, Setubal Canyon, Whittard Canyon

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Healy	Anthony	3rd Engineer	x	x	
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Maclean	Andrew	CPOD	x	x	x
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Duncan	Steven	SG1A	x	x	x
Maidment	James	SG1A	x	x	x
Setters	Stephen	SG1A	x	x	x
Williams	Emlyn	ERPO	x	x	x
Preston	Mark	H/Chef	x	x	x
Link	Walter	Chef	x	x	x
Sutton	Lloyd	Chef		x	
Paterson	Jacqueline	Stwdess	x	x	x
Whalen	Amy	Cat/Asstd	x	x	x
Wythe	V	D/ENG			x

ITINERARY

Departed Vigo	13th May 2007
Arrived Cadiz	2nd June 2007
DepartedCadiz	3rd June 2007
Arrived Lisbon	21st June 2007
Departed Lisbon	22nd June 2007
Arrived Southampton	7th July 2007

BACKGROUND AND SCIENTIFIC RATIONALE

The major objective of the EU-funded FP6 Integrated Project HERMES (Hotspot Ecosystem Research on the Margins of European Seas), coordinated by the National Oceanography Centre Southampton, is to understand how environmental variables affect the biodiversity, structure, function and dynamics of faunal communities on the continental slope (Weaver et al, 2004). The overall aim is to provide the scientific context for the management for European continental margin systems. The work is important in habitat conservation, the potential disposal of carbon dioxide, hydrocarbon exploitation, fisheries management, and the long-term effect of pollutants reaching deep-sea ecosystems from land. As part of HERMES, the NOC is committed to work on 'hotspot' ecosystems including canyons, cold seeps, landslides and coral mounds, as well as the slope sedimentary environments surrounding each of these hotspot types.

This NOC ROV cruise was one of the key cruises outlined in the HERMES proposal. It was planned to bring together scientific experimentation and investigation in canyons, cold seeps and open slope areas with a major public outreach campaign that will advertise HERMES, NOC and NERC science. To accomplish this 3 legs of 2 weeks duration are required as outlined below:

1. Gulf of Cadiz Mud Volcanoes

Improving our understanding of the processes involved in transporting organic-rich fluids from the geosphere into the biosphere is an important HERMES goal, because these fluids have a profound impact both on benthic ecosystems and the deep biosphere. Flux rates within passive margin fluid flow systems vary by several orders of magnitude from small, episodically active cold seeps to continuously active mud volcanoes. However, little is known of the subsurface processes that control fluid flow or about the impact of these processes on benthic ecosystems. The mud volcanoes in the Gulf of Cadiz are more active and more numerous than anywhere else on the European Atlantic margins because they are located in a compressional tectonic province (Gutscher et al., 2002). Background information has been built up during Charles Darwin cruise 178 when bathymetric, video and high resolution seismic surveys were undertaken over a number of mud volcanoes at varying depths. The ROV will be used to image the mud volcanoes in detail and to identify fluid escape areas/features. Fluid sampling will then be carried out to identify the origin of the fluids (biogenic or thermogenic). Comparisons will be made between *in situ* measurements and samples from the ROV CTD water bottle samples. Cold seep communities living on the mud volcanoes, identified on previous cruises such as CD178 will be sampled and the environmental conditions on which they depend will be established.

2. Canyons off Portugal

Here we will investigate ecosystems in the Nazare, Cascais and Setubal Canyons where the supply of organic material is considerably greater than on the adjacent continental slopes but sedimentary processes can be dramatic. We have completed major TOBI surveys of the Setubal and Nazare Canyons via a ship barter agreement with NIOZ in 2003. Subsequent sediment coring in 2004 and 2005 has led to a broad appreciation of the complexity of sedimentation in the canyons with large sediment fluxes entering the upper canyon but low sedimentation rates being recorded at the canyon mouths. In 2005 and 2006 we were able to mount biological sampling campaigns and to complete camera surveys to provide background for detailed sampling and investigations with the ROV. Our wealth of background information will enable us to pinpoint key areas for the ROV dives to be carried out. Our plan is to sample organisms seen during the dives and locate these precisely in relation to the canyon environments. The imprecise box core sampling carried out in 2005 produced a new genus of Xenophyophore, organisms that may be specialised for canyon environments. We will carry out dives in the upper, middle and lower canyon and expect to see considerable variation between sites related to sediment (food) supply, seabed stability and substrate type. Another major objective will be to sample the deep channel (thalweg) that cuts into the canyon floor. We have made numerous attempts with a wide range of instruments to sample this feature but without success. The thalweg is however critical as this is where the fastest currents flow and the greatest sediment transport takes place.

3. Whittard Canyon

The HERMES partners have identified Whittard Canyon, on the northern margin of the Bay of Biscay, as an active system which has continued to transport sand to the deep ocean through the Holocene, when sand input to many canyons, including Nazare and Setubal, was cut off by rising sealevels. Although this canyon is less well studied than canyons on the Portuguese margin, bathymetry and backscatter maps allow the sand transport paths to be identified. Our major objective in Whittard Canyon will be to undertake a mapping and sampling transect down the canyon axis, in order to make a preliminary assessment of the similarities and differences in biological habitat between this canyon and the less active and less energetic Portuguese canyons. This will form the basis of a more extensive programme later in the HERMES project.

Outreach

Two teachers will participate in each of the 3 legs, 3 from the UK, one each from Spain, Portugal and Ireland. The plan is that they will feed information from the cruise directly to the classroom in each country and enthuse young people in marine research. We also hope to have media events at each port call. A programme of press releases for the media is also planned.

OBJECTIVES

To address the programme outlined above, we proposed the following objectives:

1. A series of ROV dives investigating mud volcanoes in the Gulf of Cadiz (total time 2 weeks). The following scientific questions will be addressed:
(i) What are the rates of fluid venting and what is the source of the fluids?
(ii) What is the composition of cold-seep communities associated with the mud volcanoes and how do these compare to cold seep communities from other areas in the Atlantic and elsewhere?
(iii) What is the total contribution of mud volcanoes to the carbon cycle in the Gulf of Cadiz?
(iv) Does the new NOC methane sensor produce good results at a range of water depths?

2. A series of ROV dives at different water depths in the axes of the Nazare, Setubal and Cascais Canyons on the Portuguese canyons (total time 2-3 weeks). The following scientific questions will be addressed:
(i) How do the ecosystems vary down canyon, between canyons where the environmental drivers may be different, and between the canyons and the adjacent slopes?
(ii) What is the small scale variability in seabed faunas related to local topography e.g. boulders, ledges and local changes in environmental parameters e.g. current strength or water mass?

(iii) Are cold water corals present in the canyons and under what environmental conditions?

3. A series of ROV dives at different water depths or a downslope transect in the axis of Whittard Canyon (total time 1-2 weeks). Objectives are similar to those listed for the Portuguese canyons (see above) with in addition:
(i) Is the higher energy environment of the Whittard Canyon, compared with the Nazare and Setubal canyons, reflected on the biological communities that exist there?

NARRATIVE

Leg 1

May 12th. In port Vigo. Equipment unpacked and Labs set up. Safety briefing and ship familiarisation talk carried out in the afternoon.

May 13th. Sailed at 0800 on passage to Gulf of Cadiz. Weather poor with winds of Force 7-8 and moderate swell. Boat drill carried out at 16.15. No permission yet to operate in Moroccan waters.

May 14th. Still on passage. Security drill at 10.30. Introduction to the cruise objectives given to all ship's staff at 15.30 and followed by a science meeting at 16.00 with background talks by Andre and Marina. Discussed sample numbering protocols and devised a system. Permission to operate in Moroccan waters was given at 1800 so we steamed for the shallow water site on the Mercator mud volcano.

May 15th. Arrived on station at 13.30. This station is located 2.5 km to the SW of the mud volcano and will be used as a reference site. A piston core (Station JC10-001) was attempted first and recovered 2.4 m of hemipelagic mud in a 6m barrel. There was a high tension spike on the monitor on triggering. This core was used for geochemistry. The second core was a megacore with 6 tubes (Station JC10-002) at the same site. All tubes were full. A sound velocity probe was attached to the megacorer but did not function and so a separate SVP station was carried out (Station JC-10-003). The third core at the same site was a repeat piston core to be used for microbe studies. More allowance was made for rebound and a good core was achieved with 3.75 m of mud (Station JC10-004). Two temperature probes were placed on the outside of the barrel and gave good *in situ* measurements. A ROV survey was planned next to produce a detailed swath bathymetry map of the mud volcano crater (Station JC10-005). This began at 2100 with a smooth launch.

May 16th. The ROV survey continued but leaking oil on the vehicle meant it had to be recovered at first light at 0700. No leak was identified and it was relaunched at 10.00 (Station JC-06). The swath survey was resumed but by 2000 it had to be abandoned because of further oil leaks. At this point the survey was nearly complete and showed a large mud flow emanating from the crater to the south. A pinnacle to the south-east of the crater was also identified. We reverted to coring whilst the ROV was checked and refilled with oil. Core (Station JC10-007) was taken at the "bubbles site" – a location where a recent German cruise had identified methane leakage at the seabed. This was a piston core with a 6m barrel, but it only recovered 0.7 m of stiff mud. There was no indication of penetration on the outside of the barrel. The core was set aside as we hoped for longer cores in this area. A second piston core was attempted to provide samples for geochemistry (Station JC10-008). This returned empty.

May 17th. The sea state was now too rough to launch the ROV and so more cores were suggested. Crew staffing policies however, meant there were no qualified personnel and so work stopped until 0400. This staffing policy was changed for the rest of the cruise to allow 24 hr working. Two gravity cores were attempted at the same "bubbles site" using a 6m barrel (Stations JC10-009 and JC10-010). These produced 0.8 m and 1.5 m of sediment. Core JC10-009 was used for microbiology. A megacore was then attempted at the same site and recovered 5 out of 6 tubes of mud (Station JC10-011). By now the sea state had improved and it was daylight so the ROV was relaunched at 0900 to complete the swath survey and do some camera and sampling work (Station JC10-012). This ROV dive continued until 1900 at which time the oil levels again became critically low and the ROV was brought in. A megacore was collected from the area to the south of the crater where the "BSR" appears to outcrop (Station JC10-013), followed by two gravity cores at the same site (Stations JC10-014 and JC10-015. The megacore produced 5 full tubes out of 6 and the gravity cores recovered 0.5 and 0.9 m, respectively. Samples consisted of mud breccia with some gypsum crystals.

May 18th. The ROV was prepared for an Aquamonitor survey and was launched at 0100 (Station JC10-016). This continued until 0900 again due to oil loss. The full sampling programme could not be completed because the water samples took much longer to collect than expected. Nevertheless 17 samples were collected especially around the "bubble site". A kasten core was then taken (Station JC10-017) from the "BSR outcrop" north. This recovered 1.3 m of reduced mud with stones and rock pieces and fragments up to 8 cm across. We then moved 2 km to the north-east to carry out an ROV survey on an outcrop area away from the Mercator mud volcano (Station JC10-018). This survey was aimed at finding the origin of the outcrops and 7 rock samples were collected on a transect up the slope of the feature, including one that was part of an ancient chimney. The slopes were composed of mud with rock outcrops and talus areas. There were many biological specimens on the hard substrates. The dive was completed at 1830. On recovery of ISIS an oil leak was discovered on the vehicle that was repaired. We then moved back to the Mercator mud volcano to take a 9 m piston core west of the centre of the crater (Station JC10-19). This produced 2.7 m of mud breccia with gypsum crystals and was used for microbiology. We then took a 6 m gravity core on the same site and this produced a core of 0.8 m length (Station JC10-020) again with gypsum crystals. The final ROV dive at Mercator was then prepared. This dive was aimed at push core sampling, heat flow work and high resolution swath bathymetry of the "bubbles" site (Station JC10-021).

May 19th. The coring and heat flow work worked well, but the swath bathymetry did not produce good data because the range settings were not correct. The dive ended at 0900 and we steamed to the Darwin Mud Volcano that lies at a depth of about 1100 m. Most of the planned work for Mercator had been completed though many of the cores were rather short. We arrived at the Darwin mud volcano at 12.30 and began deployment of the ROV to carry out a swath survey of the area (Station JC10-022). Again problems were experienced with the swath system although all the data were recorded. The survey was completed by 2230 and the ROV was brought in. A reference site was chosen 1 km to the NE of the mud volcano and this was cored with a 9 m piston corer that recovered 5 m (Station JC10-023).

May 20th. We relaunched the ROV to carry out video transects across the crater (Station JC10-024). These showed a rocky crater centre in which elongate cracks were filled with mussel shells. Most of these were dead but a few living individuals were also seen. Around the rocky centre the seabed appeared to be sedimented. This dive then carried out a photo-mosaic survey across the crater centre and then investigated two targets seen on TTR sidescan data. These turned out to be rocky outcrops. The ROV was then brought back just before it ran out of oil and we moved back to the reference site to collect a megacore and a piston core. The piston core consisted of a 12 m barrel and recovered 5 m of sediment that was used for microbiology (Station JC10-025). The megacore recovered 8 tubes (Station JC10-026). The ROV was fitted with the Aquamonitor and launched at 2000 (Station JC10-027).

May 21st. The time taken to fill each water bag on the Aquamonitor was quicker this time due to changes in the flushing activity. Nevertheless, the work was not completed before the ROV had to be recovered due to reduced oil levels. It was refilled with oil and relaunched at 0800 (Station JC10-028). The aquamonitoring was completed and six stations were occupied on top of the crater for rock sample collection. This ROV dive was completed by 1430 and the ROV was recovered. We then took a 3 m gravity core on the northern rim of the crater, which recovered 0.4 m of mud breccia with a veneer of hemipelagic mud (Station JC10-029). This was followed by a megacore that recovered 6 tubes of mud (Station JC10-30) and a second gravity core (Station JC10-031) that recovered 0.5 m. The ROV was fitted with bio-boxes and a suction sampler and launched at 2130 (Station JC10-032). The mussel beds were targeted for suction sampling and several specimens were recovered. However fine meshes had been placed in the chambers and these led to problems in obtaining samples. Only two suction samples were therefore recovered.

May 22nd. A number of other biological samples were collected and colonisation rings were dropped off. The ROV was brought back at 0800. We wanted to sample the solid mud (or mud breccia) at the centre of the crater and so a 3 m gravity core was attempted (Station JC10-033). This produced 0.4 m of reduced sediment with strong hydrogen sulphide smell. A second core at the same site produced a similar length core but with less hydrogen sulphide (Station JC10-34). This core also contained numerous coral pieces. A 3 m gravity core was then attempted near the centre of the crater in an area of cemented sediment (Station JC10-35). The corer fell over at the seabed bending the fins, but recovered a small bag of shell gravel and small piece of cemented shell hash. We now relaunched the ROV for a push core, heat-flow and swath dive (Station JC10-036). At one of the locations near the edge of the cemented area the act of coring released numerous gas bubbles. This was repeated several times indicating gas pockets just below the surface. Possible small bacterial mats were also found in the vicinity. Push cores into the gassy sediment were seen to de-gas on their assent through the water column when the ROV was recovered. It proved very difficult to sample the bacterial mats, as they were located on hard substrates. The heat flow probes only penetrated enough for one sensor to work. The swath survey had to be abandoned because the data were not logging correctly.

May 23rd. The ROV was brought back and we took two 3 m gravity cores on the southern sedimented rim (Stations JC10-037 and JC10-038). These recovered 0.25 m and 1 m of mud respectively, with a strong hydrogen sulphide smell. This brought the work at Darwin to an end. We then steamed to the Western Mud Volcano area. We arrived at 0930 and deployed a sound velocity profiler (Station JC10-039) and then carried out a ship's swath survey over the feature (Station JC10-040). The swath worked well but only when the ship's speed was reduced to 4.5 knots in a sea state 3-4. Some artefacts are present in the data near the maximum range. The swath was followed by a gravity core on one of the pinnacles on top of the structure (Station JC10-041). This core produced 4.6 m of pale hemipelagic sediment that did not represent an active mud volcano. To confirm whether the mud volcano was inactive we collected a second piston core on one of the other pinnacles (Station JC10-42). This recovered only hemipelagic mud, again not representative of mud volcano activity. We therefore decided to move directly to the Carlos Ribeiro Mud Volcano.

May 24th. On arrival we collected a piston core, megacore and second piston core at one station off the mud volcano to act as a reference (Stations JC10-43, JC10-44 and JC10-45, respectively). These all contained hemipelagic mud. We next carried out a swath survey (Station JC10-46) and again had to reduce the ship's speed to 4 knots to obtain good data, even though the sea state was very low. During the last 24 hours the technicians had identified an oil leak on the ROV and this was fixed. The ROV was launched at 1400 with the intention of making a long dive to include swath survey, video transect and aquamonitor stations (Station JC10-47). The swath data was still not recording properly – time information was being incorrectly written. Since the problem could not be resolved we abandoned this swath survey and began a video survey.

May 25th. The swath system was tried again later but was still not recording properly and so we continued with the aquamonitor work. The oil on the ROV held out until 2100 and the ROV was recovered.

May 26th. A site was selected near the centre of the crater and two 6 m gravity cores and a megacore were collected (Stations JC10-48, 49 and 50, respectively). The gravity cores were 1.6 and 1.25 m long. The megacores showed about 16 cm of brown hemipelagic sediment over reduced mud and mud breccia. At 0500 the ROV was relaunched to complete the aquamonitor work, reassess the swath, carry out a photomosaic survey and collect specimens and push cores (Station JC10-51). After some detective work it was discovered that one of the control van monitors could look at the swath system in 3 ways, but 2 of these prevented proper time allocation to the swath lines.

27th May. The swath survey of the central mud volcano was repeated and excellent data recovered. All old data should also be of good quality when replayed. The ROV proceeded to collect biological specimens including a number of coral species. The ROV survey continued until 1900, and this represented the longest dive of ISIS to date. We then occupied a site at the centre of the crater to collect gravity and megacores. The first attempt was a gravity core that recovered 2 m of "mousse-like" mud (Station JC10-52), presumably caused by degassing of methane as the core was retrieved. The second attempt was a piston core (Station JC10-53) which recovered 5.4 m of the same sediment including a layer that may have hosted gas hydrates (very wet and mousse-like). This piston corer had 5 m of freefall and 1 m rebound.

May 28th. A megacore on the NE flank recovered good cores (Station JC10-54). The next megacore at the centre of the crater failed, perhaps because the sediments were too soft (Station JC10-55). ISIS was then relaunched to carry out heat flow stations, push coring and biological sampling (Station JC10-56). During the day earlier swath data was extracted from the database and processed thus filling the gaps in the coverage. The ISIS dive lasted until 2100 and it was then recovered.

May 29th. A series of piston gravity and megacores were then taken at a variety of sites at the centre of the crater, part way across the crater, at the edge of the crater and on the recent mudflow in the channel. The piston and gravity cores collected similar lengths (c 1-5 m) of mud breccia overlain by a few centimetres of brown hemipelagic mud (Stations JC10-58-60). The megacores, generally collected at the same sites as the longer cores, recovered excellent quality cores all penetrating into the mud breccia (Stations JC10-57 and JC10-61-63). This coring lasted until 1700 and brought to an end work on Carlos Ribeiro mud volcano. We then planned to set off to visit a shipwreck (probably that of a bulk carrier that sank in 1989). However, the azimuth thruster snagged one of its electrical cables during recovery and had to be fixed. This delayed our departure by 2.5 hours. Work continued on the problem during the transit but it could not be rectified without new parts. With good weather conditions prevailing it was agreed to carry out the ROV dive without the azimuth thruster. Some swath and profiler data was collected underway to the site (JC10-64)

May 30th. The survey of the wreck began with an ROV swath survey at 100 m above seafloor (Station JC10-65). This showed the shape of the wreck and many features. It is lying upright with some debris distributed nearby. A second swath survey was carried out at 40 m above the seabed and showed many more details. This was used by the ROV team to guide their video survey. This video survey showed many features on the wreck including the name "Kumanovo", details of damage to the hull caused by a collision, (that eventually led to the sinking), deck features such as the anchor and spare propeller, bridge features, and several ropes and a cargo net extending vertically into the water column. The survey was completed at 0600 and ISIS was recovered. We then steamed to the Captain Arutynov Mud Volcano to take a single core for microbiology (Station JC10-66) and then onward to revisit Mercator mud volcano. This site was revisited to improve the quality of the data collected earlier in the cruise. This included repeats of some swath lines, repeats of aquamonitor stations and collection of more cores. We arrived at Mercator mud volcano at 2000 and began with a piston core (Station JC10-67). This core brought up a large ball of mud on the outside of the barrel that fell away at the surface and dragged the sediment out of the barrel. Thus no core was recovered. The second core was a gravity core on the flank (Station JC10-68), but this also failed.

May 31st. Three more gravity cores and two megacores were collected from the mud volcano and then we launched the ROV again at 0630 to do heatflow work and aquamonitor stations (station JC10-74). The ROV again had the oil loss problem that was seen at this mud volcano earlier in the cruise and the vehicle had to be recovered at 2230.

June 1st. The ROV oil was refilled and the vehicle relaunched (station JC10-75) to complete the aquamonitor work and complete a swath survey. The aquamonitor failed on this dive. At 0719 we recovered the ROV and moved to the Darwin mud volcano to redo some swath lines and take a few more pushcores. This ROV dive (station JC10-76) was successful and was completed at 2330. During the dive an attempt was made to collect gas bubbles emanating from the seabed and this was successful. We them made for Cadiz.

June 2nd. Arrived in Cadiz at 0800 at the end of Leg1 of JC10.

Leg 2

June 3rd. Left Cadiz at 0815 for the start of Leg 2. On passage to first station in the upper Lisbon Canyon at about 750 m waterdepth.

June 4th. Arrived at first station on Leg 2 (JC10-77) at 0827. ROV launched and reached the seabed at 964 m at 0930. Completed a difficult transect up a steep and rocky canyon wall, viewing and sampling a diverse fauna that was particularly abundant on the upper canyon slope at around 550 m waterdepth. Five pushcores were also recovered for organic chemistry and foraminiferal studies. ISIS was recovered on deck at 2242. A CTD station was then carried out (station JC10-78) in the axis of Lisbon canyon, starting at 2307.

June 5th. The CTD station (station JC10-78) was completed at 0028. A SAPS (stand alone pumping system) station was then occupied on the same site (station JC10-79) between 0055and 0318. Following this the ship moved to a new station in the upper Setubal canyon to undertake a biological survey and sampling of the steep canyon wall between 1450 and 1000 m (station JC10-80). ISIS was deployed at 0557 and completed two transects of the canyon wall. A diverse fauna was found attached to near vertical and overhanging rock faces, with a sparser fauna on the sediment slopes between. A number of biological specimens were recovered using the suction sampler and manipulators; 6 push cores were also obtained. ISIS was recovered on deck at 1806. A CTD station (JC10-81) and a SAPS deployment (JC10-82) followed between 1836 and 1955 and 2005 and 2255 respectively. The elevator carrying the NOCS oxygen consumption chambers was launched at 2337 ((JC10-83).

June 6th. ISIS was launched at 0105 and reached the seabed at 0217 ((JC10-84). The first operation was to collect a starfish to put into the oxygen chamber. This proved a time consuming task that was finally completed at 0815. An experimental ROV swath survey of the steep canyon wall was then attempted, with good results, between 0830 and 1436. Following this, the ROV returned to the seabed experiment and confirmed that the starfish was moving around the chamber. Three push cores were then collected before the ROV returned to the surface, to be recovered aboard the James Cook at 1730. The elevator was then released from the seabed and ascended to the surface. It was recovered at 1930, after which passage to the western Nazare canyon area began.

June 7th. The James Cook arrived at the new work area, in the western Nazare Canyon at 4350 m, at 0650. A sound velocity probe was launched at 0710 ((JC10-85) to enable calibration of the multibeam system. The acoustic releases for the bathysnap system and the amphipod trap were deployed on the same wire for testing. This station was completed at 1005, when it was discovered that the amphipod trap release had failed to operate. The ship then repositioned to the site where we planned to deploy the Aberdeen oxygen respiration experiment at 4300 m depth in the canyon axis, but this had to be abandoned when a battery on one of the experimental rigs was found to have discharged overnight. Instead, the bathysnap was rigged for deployment ((JC10-86) and launched at 1145. With the problem of the Aberdeen experiment unresolved, it was decided to continue with the ROV programme, and ISIS was deployed at 1346 (JC10-87). A video transect across the channel thalweg was completed between 1639 and 1949. This showed a gradual transition from muddy seafloor outside the thalweg to rippled sands, then sand dunes and finally a thin sand sheet covering coarse gravel in the thalweg axis. The southern boundary of the thalweg was a 30 m high cliff made of poorly consolidated conglomerate with rounded boulders up to a metre or more in size. A ROV swath survey was then completed between 1956 and 2202. We then broke off the survey to launch the elevator with the Aberdeen experiment at 2208 (JC10-88).

June 8th. While the elevator was descending, we moved off the southeast to locate the bathysnap deployed earlier (JC10-86). This was located at 0005, approximately 100 m north of the location where it was released at the surface. Because of this, it was position in an area of smooth rippled sand, rather than in the dune field as wanted. The elevator was located on the seabed at 0136 and the complex operation of deploying the Aberdeen experimental units began. This was completed at 0339. The ROV swath survey was restarted at 0407 and completed at 1606. Between 1640 and 1905, nine push cores were then taken along part of a transect across the thalweg, although the sands in the deeper part of the channel proved impossible to sample. Isis was then recovered on deck at 2154 and the megacorer deployed at 2215 (JC10-89).

June 9th. A megacore sample was successfully recovered at 0212. The ship then sailed east to the 3400 m sampling site in Nazare canyon, arriving at 0432. An elevator carrying the NOCS respiration chambers and holothurian experiment was then deployed at 0445 (JC10-90), followed by the ROV at 0538 (JC10-91). Once on the bottom a brittle star was captured for the respiration chamber using a scoop. This scoop fortuitously also caught two Holothurians. The brittle star was tipped into the chamber and the experiment started at 0925. Five Holothurians were then caught and inserted into the chambers so that their faeces could be collected over a 2 to 3 day period. The experiment was set up, and the cover closed with some difficulty, by 1221. A further 15 Holothurians were then collected, using a wide-mesh scoop, and stored in the biobox for study onboard. This was completed at 1339. Isis was then moved to the bottom of the thalweg channel and a video transect across the northern wall of the canyon axis was completed between 1442 and 1629, although apart from a spectacular ledge with abundant crinoids, little macrofauna appeared to be able to survive on the steep, unstable sedimented slope that showed abundant evidence of recent small scale instability. Part of swath survey was then completed between 1648 and 2300, when we had to break off to collect some push cores before terminating the dive. A total of 6 push cores were collected between 2327 and 2355 after which Isis recovery began.

June 10th. Isis was brought on deck at 0235. Passage back to the 4300 m Nazare canyon site was then completed by 0450, after which the ROV was relaunched at 0526 to recover the Aberdeen experiment (JC10-92). The ROV reached the seabed at 0756 and located the elevator at 0801. The two experimental units were then secured on the elevator. This was an extremely difficult task due to the size of the units that tended to block the pilot's view and the tight fit of the units on the elevator. However if was skilfully achieved by 1055. We then moved some 500 m to the north to search for the DOSOL lander lost during Discovery cruise 297 in 2005. To our surprise, both pingers on the lander were still operational, although the detected ranges were somewhat erratic. However, despite searching a box of about 700 x 700 m centred on the deployment site using the 425 kHz sonar we were unable to locate it. Given that we detected some very small features at considerable ranges (e.g. a 30 cm deep furrow caused by attempted dragging for the lander in 2005 was detected at 50 m range) we are confident that DOSOL is located outside the search area. However, with limited time and no indications where else to search, we reluctantly gave up the hunt at 1615. Three ROV box cores, each containing a xenophyophore, were then recovered between 1720 and 1854. Six push cores for geology and microbiology were then taken between 1903 and 2242. Three video transects of the conglomerate cliff at the southern side of the thalweg channel were then completed before Isis recovery began.

June 11th. Isis was recovered on deck at 0302. The James Cook was then positioned over station JC10-88 to release the elevator from the seafloor at 0415. This elevator was carrying close to its maximum payload and it was very slow to come free from the seabed and equally slow in ascending, finally surfacing at 0845 and recovered on deck at 0908. Passage back to the 3400 m site began at 0924 and was completed at 1100. A megacore was deployed at 1116 and recovered with 6 out of 12 full tubes at 1441 (JC10-93). The elevator carrying the Gent university *in situ* feeding experiment (Feedex) was then launched at 1528 (JC10-094), followed by the ROV at 1556 (JC10-094). A single ROV push core was taken at 1850 to ensure that the substrate was suitable for the experiment deployment. Installation of the nine Feedex units started at 1958.

June 12th. Installation of the Feedex units was completed at 0150. A swath survey was then run between 0215 and 0908. We then moved back to the elevator at station JC10-90 to close the NOCS Holothurian experiment. This was successfully undertaken at 0940. One of a number of squat lobsters that had gathered around the experiment was collected at 1000. Next it was required to take the first 9 pushcores from the Feedex units at station JC90-94, as well as 6 reference cores nearby. This was completed between 1120 and 1330. An attempt was then made to free the elevator from the soft seabed sediments in which it had become embedded. The ROV then ascended to the surface and was recovered at 1854. As the ROV was brought onboard a release command was sent to the elevator at station JC10-90. This command appeared to be successful but the elevator refused to leave the seabed. After tracking the elevator for some time it was decided that we should move some 500 m away from the location and complete CTD and SAPS deployments, while continuing to monitor the acoustic signal from the elevator in case it should release during the night. The CTD was deployed at 2200.

June 13th. The CTD station (JC10-96) was completed at 0025 and the SAPS station completed between 0037 and 0618 (JC10-97). At 0645 an attempt was made to release the second elevator at station JC10-94, but this too failed to leave the seafloor. Isis was then launched at 0814 (station JC10-98) with the intention of freeing the elevators which were believe to be stuck in the soft muddy seafloor. However, with only about 500 m of wire out, it was noted that the station JC10-94 elevator had released from the seafloor. The Isis launch was therefore aborted and the ROV brought aboard at 0935. The elevator surfaced at 1130 and was onboard by 1035. The ROV was then relaunched at 1150 in order to free the second elevator and to complete the ROV swath survey and video transect begun on earlier dives (JC10-99). Examination of the elevator on the seabed showed that the release had worked perfectly but that the feet were indeed stuck in the mud. A small nudge from the ROV was all that was needed to free it. It was released from the seabed at 1431 and secured onboard by 1636. Time during the ascent was used for training purposes by the ROV team. The ROV swath survey at this site, started on an earlier dive, was completed between 1714 and 2327.

June 14th. Two video transects, one on each flank of the canyon, were run between 0015 and 0352. A number of biological specimens were also collected on the second transect up the north canyon wall. Isis was recovered on deck at 0643 and the ship repositioned to take a mega core (JC10-100). This was completed between 0732 and 1110, followed by a second megacore on the same site between 1134 and 1508 (JC10-101). A 12 m piston core (JC10-102) was collected from the main '3400 m' study area between 1557 and 1850, and a second 21 m piston core (JC10-103) from a terrace about 1.5 miles down canyon between 2015 and 2340. The ship then repositioned to the '3400 m' site to redeploy two elevators carrying seafloor experiments. Elevator 1 was launched at 2328 (JC10-104) and elevator 2 at 2351 (JC10-105).

June 15th. The ROV was launched at 0020, but an electrical fault was discovered and it was immediately recovered. Repairs completed, the ROV was relaunched at 0207 (JC10-106) to initiate the experiments sent down earlier by elevator. Isis reached the seabed at 0421 and both Aberdeen experimental units were initiated by 0622. Six reference pushcores were taken at the experimental site between 0636 and 0651. After several false starts, and the 'escape' of a large holothurian and two brittle stars, a third brittle star was captured and inserted into the NOCS oxygen chamber at 1021. Five infaunal holothurians were dug up and inserted into the NOCS experimental chambers between 1032 by 1318. Four reference pushcores were also taken at this site between 1348 and 1401. Finally, approximately 12 holothurian specimens were captured using the dredging scoop and collected in the biobox. This was completed by 1453, when recovery of the ROV began. The dive ended at 1728, with Isis safely recovered onboard. The vessel then proceeded up canyon to a station at 1800 m waterdepth in the canyon axis, where a CTD was run between 1940 and 2105 (JC10-107). This was followed by the deployment of the ROV at 2126, to undertake a video survey of the canyon wall starting at 1800 m waterdepth and traversing upslope (JC10-108). However, by the time Isis had reached a depth of 1650 m it was clear that the strong current (up canyon) and extreme turbidity would make both ROV operation and seabed observation impossible. The ROV was therefore brought back to a depth (1450 m) where the current was acceptable for ROV operation and then moved laterally to intersect the canyon wall.

June 16th. Finally, at 0018, the canyon wall came into view. Six push cores were recovered from a patch of sediment on the steep, often rocky slope between 0032 and 0051. A video transect was then completed from 1400 to 450 m waterdepth, with a large variety of animals, including gorgonians, sponges, corals, anemones and echinoids, observed. The seabed consisted of patchy sediment and rock outcrop throughout. A sea urchin was collected using the suction sampler at 1285 m waterdepth. The transect ended at 0605 and the ROV was recovered onboard at 0645. The ship then proceeded back to the previous CTD station and a SAPS station was completed between 0735 and 1050 (JC10-109). The ship then repositioned to a site in the canyon axis at 2240 m waterdepth. A CTD (JC10-110) was then run between 1253 and 1423. The ROV was then launched at 1142 (JC10-111) to conduct a video survey of the canyon wall, from 2250 m up to about 1000 m. The seabed came into view at 2243 m waterdepth and although visibility was very poor, 4 pushcores were taken between 1700 and 1716. Little life was seen on the seabed until 1920 (1830 m waterdepth) at which the turbidity had begun to decrease. A large variety of animals were observed for the rest of the dive. Single pushcores were taken at 1684 and 1000 m waterdepth. An attempt was made to sample a xenophyophore growing on a steep sedimented slope at 1555 m, but on recovery no sample was found.

June 17th. The ROV left the seabed at 0050 and was recovered onboard at 0153. A passage back to the 3400 m site was then completed, in order the recover experiments placed on the seafloor at stations JC10-104 and 105, and to perform the 2nd phase of sampling on the experiment at station JC10-94 (Feedex experiment). The ROV was relaunched at 0357 and reached the seabed at 0705 (JC10-112). The Aberdeen experimental units at station JC10-104 were replaced on their elevator that was released from the seabed at 0850 and recovered onboard at 1051. In the meantime 5 reference pushcores were taken between 0906 and 0918, adjacent to the experiment site. The ROV then repositioned to the Feedex experiment, where 9 pushcores required for the 2nd sampling phase were taken between 1332 and 1526. The ROV then moved to station JC10-105, where the NOCS holothurian experiment was closed and the elevator released, after some difficulty freeing it from the muddy seafloor, at 1803. The elevator was recovered at 2009 and the ROV at 2046. A SAPS station (JC10-113) was started at 2250 at the 2240 m site previously occupied by a CTD station.

June 18th. The SAPS was completed at 0235. The ship then moved to a site at 1110 m waterdepth and a CTD station (JC10-114) was completed between 0412 and 0505. We then moved inshore to a station some 4 miles off Nazare to await the arrival of a party of journalists who were to be brought out to the James Cook by the Portuguese hydrographic survey vessel Don Carlos 1. The media event was successfully completed between 1015 and 1310, when the last party of journalists departed for the Don Carlos. The ships boat, that had been used to transfer journalists, was secured onboard at 1333 and the ship sailed for the next science station, at 1100 m waterdepth in the upper Nazare Canyon. This was reached at 1458 and a SAPS deployment was carried out between 1512 and 1815 (JC10-115). The ROV was then launched at 1831 to undertake a video survey of the steep canyon wall between 1150 and 600 m waterdepth (JC10-116). The seabed was sighted at 1930 at exactly 1150 m waterdepth. However, the turbidity was high, making observation difficult. The seabed consisted almost entirely of angular rock scree with only occasional sedimented patches. Almost no biology was sighted on the lower 100 m of the canyon wall. Above that, brisyingid starfish, possibly 3 varieties with 9, 10 and 11 arms, became common, especially on the steep rock faces, composed of soft sedimentary rock. A relatively rich fauna was observed from 900 m to the end of the dive at 660 m.

June 19th. The ROV dive was completed at 0556 and the ROV recovered aboard by 0655. We now continued our passage down canyon, to undertake a CTD station at approximately 3000 m waterdepth. The CTD station was completed between 0905 and 1115 (JC10-117). A SAPS deployment (JC-118) was then completed at the same station between 1130 and 1656. We then proceeded back to the 3400 m site to deploy the elevators carrying a repeat of the Aberdeen and NOCS experiments (JC10-119 and JC10-120), which were to be left on the seabed while we made our port call in Lisbon. Isis was deployed at 1927 and reached the seabed at 2130 (JC10-121). A brittlestar was captured and placed in the NOCS respiration chamber by 2233. Five holothurians were then caught for the NOCs experiment.

June 20th. The holothurian experiment was closed at 0106. The ROV then repositioned to the second elevator and removed the Aberdeen chambers from the elevator. Both were activated by 0306. Six pushcores were then recovered between 0312 and 0330. The ROV left the seabed at 0405 and was recovered onboard at 0608. A megacore from the 3400 m site was recovered between 0700 and 1025 (JC10-122). The vessel then moved to a station at about 900 m waterdepth on the slope south of Nazare Canyon, where a CTD station was run between 1336 and 1435 (JC10-123). A megacore (JC10-124) and a SAPS station (JC10-125) were then completed at the same site between 1452 and 1945. This completed the scientific programme for Leg 2 and the James Cook set sail for Lisbon at 2048.

June 21st. Docked in Lisbon at 0700 (0800 local time).

Leg 3

June 22nd. James Cook sailed from Lisbon at 1518 heading for the first station at 3500 m waterdepth in Cascais Canyon. An Agassiz trawl (JC10-126) was carried out between 1805 and 2120, but caught only a few prawns. Course was then set, at 2140, for the 3400 m site in Nazare Canyon, where the elevators and experiments had been left during the port call.

June 23rd. Arrived on station at 0605, after a passage slowed by poor weather. The ROV was deployed at 0722 (JC10-127). The Aberdeen experiments were placed on their elevator that was released at 1324, although it again refused to leave the seafloor until lifted out of the mud by the ROV. The elevator reached the surface at 1507. However, it became trapped under the stern of the vessel during recovery. It was eventually freed and recovered at 1748, but in a badly damaged state and having lost it load of experiments. After checking that no damage to the starboard propeller had occurred, the vessel and ROV moved back towards the other experiments. However, at 1948 the ROV became caught on the seabed, under what was later discovered to be a disused telephone cable. Visual inspection using the ROV showed that the last two floats on the ROV cable were wrapped around the obstructing cable, with too little cable between the floats and the ROV to allow the latter to be manoeuvred clear. It was therefore agreed that we should try to cut the cable to effect escape. After much anxiety, this was achieved at 2346, and the ROV brought back to the surface.

June 24th. The ROV was brought onboard and secured at 0216. A new cable termination was required, so the ship moved to the 4300 m site, where the megacorer was deployed at 0530 (JC10-128). This was successfully recovered at 1040. We now moved to release the bathysnap camera system previously deployed at station JC10-86 on Leg 2. This was successfully released and recovered at 1334. A second megacore was recovered from the 4300 m site between 1352 and 1820 (JC10-129). With repairs completed, the ROV was launched at 1907 to complete the scientific programme at the 4300 m site (JC10-130). The seabed was reached at 2145 and two mini-boxcores were attempted in the sand dune area. Both failed because the spades became jammed by the coarse sediment and only a small, probably washed sand sample was recovered. A photomosaic over the sand dune field in the thalweg channel, using the 'Pixelfly' camera, was started at 2309.

June 25th. The photomosaic over the sand dune field in the thalweg channel was completed at 0130. The ROV then repositioned to an adjacent area where abundant xenophyophores had previously been observed. To mini-boxcores each containing a xenophyophore, were collected between 0254 and 0349. A 'Pixelfly' mosaic over part of the xenophyophore field was completed between 0400 and 0431. A final search for the DOSOL lander lost during Discovery cruise 297 again proved unsuccessful and the ROV was brought onboard at 1103. The vessel then sailed back to the 3400 m station to recover the second elevator and perform the final sampling of the Feedex experiment. The ROV was launched at 1348 (JC10-131) and the elevator released at 1643. Two pushcores of 'background' sediment were taken while the elevator ascended. The elevator was then recovered on board at 1837 and the ROV repositioned to the Feedex experiment. Sampling was completed between 2021 and 2139, after which recovery of the ROV began.

June 26th. The ROV was recovered on deck at 0009 and the ship steamed for the first of 3 megacore sites on a transect up the slope immediately north of Nazare Canyon. A megacore was collected at 1968 m waterdepth between 0220 and 0435 (JC10-132). The second megacore, at 1445 m waterdepth, was collected between 0630 and 0809 (JC10-133). At the third station on the transect, at 670 m waterdepth a CTD was collected between 0930 and 1020 (JC10-134), a SAPS station was completed between 1100 and 1315 (JC10-135), and a final megacore was collected between 1400 and 1516 (JC10-136). At this point it was finally decided that we would not proceed north to the Whittard Canyon area because of continuing bad weather in that area. Instead, a course was set to return south to Setubal and Lisbon canyons to follow up observations of diverse filter feeding communities observed on the steep canyon flanks during the early part of Leg 2.

June 27th. Arrived in the Cascais Canyon area at 0309. The Agassiz trawl was deployed at 0309 (JC10-137) to repeat the failed station at 3500 m attempted during Leg 2. It was recovered at 0552 but had again failed, this time due to tangling of the rigging. A megacore was then collected on the same site between 0635 and 1020 (JC10-138). A passage to the upper Lisbon was then completed by 1344 and the ROV was launched at 1409 (JC10-139). The ROV reached the seabed at 1523 and 9 pushcores were collected on the canyon floor between 1635 and 1657. A video transect was then carried out up the steep southern wall of the canyon from 1690 to 940 m waterdepth. Spectacular filter feeding communities were observed and 2 sponges and some brachiopods were sampled. The transect was completed at 2141, after 2 pushcores had been collected from a sedimented terrace on the upper canyon wall. The ROV was then lowered back to the canyon floor to begin a transect of the northern flank at 2325.

June 28th. The transect of the northern wall of Lisbon Canyon, from 1690 to 770 m waterdepth was completed at 0332 and the ROV recovered on deck at 0430. A CTD cast (JC10-140) and SAPS station (JC10-141) were then completed in the canyon axis, ending at 0945. The ship was then moved to Setubal Canyon, to run another video transect up the canyon wall, from 2200 to 1500 m. The ROV was launched at 1111 (JC10-142), and reached the seabed at 1242. A site suitable for deployment of an elevator carrying the NOCS oxygen chambers was identified and the elevator was launched at 1353 (JC10-143). While the elevator was sinking, two large holothurians were captured for use in the experiment. Ten pushcores were also recovered from the muddy canyon floor between 1408 and 1435. The holothurians were placed in the chambers and the experiment started at 1532. An attempt was also made to dredge for infaunal holothurians, but none were found. Because the elevator had drifted near the western wall of the canyon, a survey up that wall was completed between 1559 and 1800. The wall was entirely sediment covered and little macrofauna was observed. The ROV then transited back to the eastern canyon wall to make a transect up the steeper slope from 2220 to 1884 m waterdepth. Here we found large rock outcrops with vertical cliffs 80 m or more in height, with a varied fauna of filter feeding organisms including stalked and other crinoids, brisingids, sea spiders, corals, sponges and gorgonians. The transect was completed at 2352, when the ROV moved back down to the canyon floor.

June 29th. A second transect was completed up the eastern wall of Setubal Canyon, to expand on the observations made on the first transect. A coral sample was collected at 1980 m waterdepth, before the transect ended at 0324. The ROV then transited back to the elevator site, and the elevator released at 0444. It was secured on deck at 0609, followed by the ROV at 0741. A transit to the next ROV site, at 4500 m waterdepth in Cascais Canyon over a suspected recent landslide, was completed at 0945, and the ROV deployed at 1000 (JC10-144). The seabed was reached at 1238 and was observed to consist of large fields of rocks, covered by a thin veneer of sediment, interspersed with flatter sedimented areas. A sea pen was collected at 1307. A total of 12 pushcores were collected at various sites during the dive, with the aim of dating the post landslide sediment veneer. A ROV swath survey was started at 1755.

June 30th. The swath survey was completed at 0309 and the ROV recovered on deck at 0540. The James Cook then proceeded north towards the Whittard Canyon site.

July 1st. Continued passage north. Severe rolling experienced in the early hours of the morning in moderate to severe swell. At 1235, speed was reduced to stream the trawl wire, to try to improve the scrolling. This was completed at 1800, when we continued north at normal passage speed towards Whittard Canyon.

July 2nd. Completed passage to Whittard Canyon at 1810. A 15 m piston core was deployed at 1910 and recovered at 2205, containing a 10 m core (JC10-145). A megacore station was then started at the same site at 2233 (JC10-146).

July 3rd. The megacore was recovered at 0230. After a short passage, the ROV was deployed over the thalweg channel of the distal Whittard Canyon at 0411 (JC10-147). Photographs and a single boxcore sample were taken from an extensive xenophyophore field on a terrace just above the channel floor between 0658 and 0738. Four pushcores were taken in the channel floor. A traverse across a field of ripples with some boulders outcropping then followed. An *Umbellula sp* was sampled at 4040 m at 0904. Eight additional pushcores were collected from the top of the channel levee at the end of the transect between 1225 and 1248. The ROV was then brought back to the surface and recovered on deck at 1540. A passage was then completed to the middle Whittard Canyon at 3500 m waterdepth for an ROV traverse up the steep western canyon wall. The ROV was launched at 1921 (JC10-148) and reached the seabed at 2130. Three pushcores on the canyon floor were taken between 2136 and 2144. A traverse over the canyon floor revealed an extremely rough landscape covered in enormous boulders with many attached anemones. The transect up the steep canyon wall started at 2325.

July 4th. Six pushcores were taken on a terrace at 3134 m between 0105 and 0137. A crab and a sea urchin were sampled at 2750 m waterdepth. The transect ended at 2314 m waterdepth at 0707 and the ROV was recovered on deck at 0839. A short passage was then completed to the final ROV dive site, where Isis was deployed at 1130, after a short delay due to problems with the azimuth thruster. This dive (JC10-149) was intended to complete a video transect up the steep eastern canyon wall between 2600 and 500 m waterdepth. The ROV reached the seafloor at 1307 and three pushcores were taken from a rippled seafloor at 2595 m waterdepth. A spectacular rocky slope with abundant attached fauna was traversed between 1420 and 2052. Two anemones and a stalked sponge were collected for stable isotope analysis. At this point, six pushcores were collected from a relatively flat area of seafloor at 1231 m waterdepth. Two gorgonians were also collected at this site. Some corals and coral rubble were observed at 920-950 m waterdepth.

July 5th. The transect was completed at 0304, and three pushcores taken at 466 m waterdepth. The ROV then left the seabed at 0329 and was recovered on deck at 0410. With the weather worsening, it was decided to end the scientific programme, and after securing all equipment, the James Cook set sail for Southampton at 0840.

July 6th. Continuing passage to Southampton.

July 7th. Docked in Southampton at 0920.

SUMMARY OF RESULTS

Ship-board multibeam, echosounder and sub-bottom profiler (Leg 1)

Multibeam System EM120

During JC10, leg1, the multibeam system and sub-bottom profiler were used concurrently on three occasions. The first over the Western Mud volcano (23.05.07) lasted for approximately one hour and 15 minutes. The second, run over Carlos Ribeiro mud volcano a day later (24.05.07) lasted nearly one and a half hours. The final run over the "Kumanovo" the shipwreck site (29.05.07) lasted about an hour. On the first two occasions, the sea was relatively smooth with only a half metre swell and wind speeds of force 2 at maximum. Despite these perfect sea conditions, survey speed had to be cut down to 5 knots maximum to preserve data quality. Thus the system works but only in light winds with little swell. The multibeam data also suffered from what appears to be beam segmentation problems in mid- and far range. Inquiries were made to the manufacturer by the technical support team onboard.

Sub-bottom profiler Systems SBP120

On three occasions (for dates, see above), the sub-bottom profiler SBP120 produced good data. The data quality appeared to be fine. The data was stored and exported as TOPAS raw data file, although no processing software for it was onboard. Since no hardcopy printout is available, the scientific consultation of data timed outside of the screen display is only possible by replaying the recorded data on the screen again. It should be noted that the SBP120 takes its sound velocity input from the EM120 multibeam; hence it needs to be entered in there first!

Echosounder System EA600 (12 kHz)

The EA600 echosounder system provided good data on all occasions used. Its data could be saved as screenshot during the recording and exported as a picture file. A paper hardcopy output is also not available. As a consequence, longer profiles will have to be compressed along the X-axis (time) in order to fit on to the screen.

Veit Hühnerbach

ISIS high resolution bathymetric survey preliminary results (Leg 1)

Survey parameters

Surveys were done with vehicle altitude between 20 and 40 m above seabed and speed of 0.4-0.6 knots, which gave swaths with an effective width of 40 to 80 m and a data grid with 0.5 m cell size. At the end of the leg a short survey was conducted at 10 m altitude at the Darwin mud volcano that produced bathymetry data of good quality that were gridded with 0.2 m cell size.

Processing workflow

The bathymetry data processing utilised the following field data produced by the ISIS: the sonar head data, USBL and Doppler navigation data and attitude data from the vehicle's sensors.
The processing was done with the Caraibes package (V 3.3) developed by the IFREMER and customised for the ISIS specification.
The processing workflow included:

- Integration of ISIS sonar head data with attitude sensors data and conversion into the CARAIBES native format.
- Calculation of the true water depth using vehicles altitude and pressure sensors data.
- Cleaning of the bathymetry data (removal of extreme values).
- Filtering and smoothing of navigation data.
- Merging of sonar head and navigation data.

- Gridding and output of XYZ data

The resulting grids were then imported into other packages such as Golden Software's Surfer (TM) and ESRI's ArcGIS (TM) for further processing, mapping and visualisation. Surfer was used for fast data QC, corrections for obvious depth and lateral misfits of adjacent swaths and merging of the individual swaths into a complete coverage. The coverage was then imported into ArcGIS and used for the production of maps, data visualisation and mission planning.

Mercator mud volcano
High resolution bathymetry data were obtained over an area of about 1.2 km^2 at the top of the mud volcano at water depth between 437 and 348 m. The data showed a series of concentric ridges and depressions produced by cyclic expulsion of stiff mud breccia and subsequent subsidence of the upper pert of the mud volcano. The smooth character of the seabed over the most of the mud volcano indicates the presence of a cover of hemipelagic sediment. The most prominent topographic variations were observed at the centre of the volcano where the boundary of the most recent tongue of extruded material can be identified on the seabed. The area of about 24 000 m^2 recognised at the very top of the volcano is characterised by a hummocky appearance with topographic variations of 0.5-1 m. This area is interpreted as the most active part of the mud volcano. Among other features recognised on the multibeam data it is worth mentioning a large boulder with dimensions of 10x15x5 m which is found approximately 350 m away from the volcano's crater on its southeastern slope. The boulder seems to have been there for some time as the southwest-flowing bottom current has formed a moat around it. It is thought that the boulder was expelled from the mud volcano and rolled down the slope during one of the earlier vigorous eruptions.

Darwin mud volcano
An area of about 0.2 km^2 at top of the Darwin mud volcano at a depth range 1110-1160 m was covered by the ISIS high resolution bathymetric survey. The initial survey was done with similar parameters as at the Mercator mud volcano, comprising 80 m swath with resolution of about 0.5 m. However this resolution did not resolve features, known from earlier video observations to be at the seafloor, with a satisfactory level of detail. A follow-up survey - a trial of a higher resolution mode with the vehicle towed at about 10 m above the seafloor - resulted in a bathymetry image with resolution of 0.2 m. The new data showed much more detail but due to the lack of time the survey was not completed and the higher resolution data cover only a portion of the volcano top. Most of the volcano appears to have a smooth appearance due to the presence of hemipelagic cover. At the very top of the volcano a patch of seafloor, about 80 m in diameter, is characterised by rougher microtopography. The microtopography is created by the presence of large carbonate slabs broken up by a network of fissures that are thought to develop due to slow extrusion of mud breccia. The individual slabs can be up to 10 m across and are often jacked up, producing local escarpments up to 0.5 m high.

Carlos Ribeiro mud volcano
The survey of the Carlos Ribeiro mud volcano top covered about 0.4 km^2 of the seabed at water depths between 2276 and 2194 m. The survey produced a spectacular image of the seafloor topography with resolution of 0.5 m (Figure 1). The crater of the mud volcano comprises a pie-like structure, 360 m across, with a series of concentric ridges and depressions produced by repeated expulsions of mud breccia from the centre of the crater. The most active part of the crater is located closer to its northern edge and represents a patch of the relatively smooth seafloor about 100-110 m across. To the southeast of the crater the survey mapped the upper reaches of the most recent mud flow pathways. These flows have formed a 300 m wide and 25 m high ridge on the slope of the mud volcano. The slopes of the ridge also show evidence of instability and formation of localised slumps a few tens of meters across. Individual flow pathways can be resolved on the seafloor

representing 15-20 m wide channel-like features with narrow, well-developed marginal levees 3-4 m wide. The pathways are usually elevated above the seafloor for about 1 m and leeves are about 0.5 m high. The characteristic morphology of the pathways is similar to that produced by flows from onshore mud volcanoes and indicates low flow viscosity. The high resolution bathymetry data showed that after the vigorous expulsion of the low viscosity material, a plug of stiffer mud breccia has been extruded from the crater of the mud volcano. The plug spreads out from the crater at places and partially covers the mud flow ridge providing evidence for the sequence of events. The high-resolution image shows that the newly extruded material reached a steeper slope at the south of the crater and has collapsed along a 100 m long section of the crater edge.

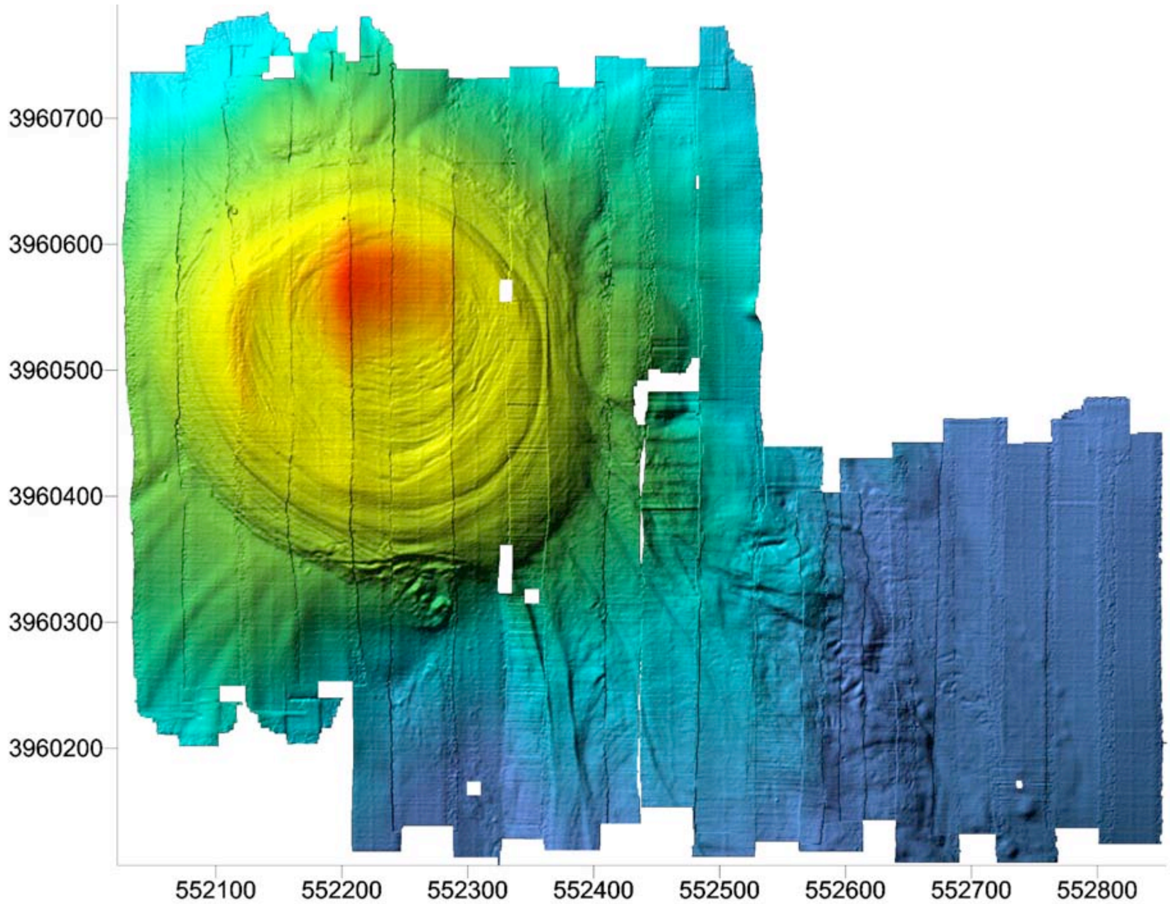

Figure 1. Preliminary processed ROV swath data from the Carlos Ribeiro MV. Image shows the central ‘mud pie’ character of the MV with the proximal parts of the more recent mudflows seen to the southwest. Scale is in metres.

Kumanovo shipwreck

An ISIS dive was carried out over the wreck of a large coal-bearing bulk carrier found by the TTR-15 cruise. In order to perform a safe fly-over of the wreck a bathymetric survey was first conducted. The first run was done at 100 m altitude and, once the safety has been ensured, two additional lines were run at an altitude of 50 m providing a swath of about 150 m each. The details of the wreck were successfully resolved, showing that the 200 m long and 30 m wide vessel is relatively intact and lies on the seafloor in near-upright position. Seven open hatches, the bridge, and details of the bow can be observed on the image. The data show that the bow of the vessel has partially collapsed when she hit the seafloor. The image also shows debris cast from the vessel during its descent and the disturbance of sediments surrounding the wreck caused by the impact.

A. Akhmetzhanov, V. Hühnerbach

Megafauna (Leg 1)

The megafauna is rather limited around the three mud volcanoes examined. The main method of sampling was the use of DV video and stills. Master and slave copies were made of all video and approx 250 hours of bottom video were taken. Although awaiting detailed analysis and confirmation there are some general broad conclusions. At Mercator (~340 m depth) the megafauna is sparse consisting of fish and an octopus. Close by Mercator was the 'Pinnacle', a feature composed of lithified mud, supporting a rich megafauna of crinoids and cidarid sea urchins. Also surrounding the mud volcano was evidence for the seapen *Pennatula aculeata*.

At Darwin MV (~1100 m depth) much of the mud volcano was covered in lithified crust and the dominant megafauna was banks of mainly dead mussels. Small patches of living mussels could still be found but the overall impression was of a declining chemosynthetic influence. Other megafauna consisted of isolated bushes of stylasterine and scleractinian corals, and a single large crab. In the sedimentary areas there was indication of active bioturbation.

The richest megafauna was found associated with the Carlos Ribeiro MV. Although megafauna in the crater of the mud volcano was sparse there was a halo of suspension feeding megafauna including dense bushes of the bamboo coral ?*Acanella*, as well as small bushes of *Acanella arbuscula*, together with a pink primnoid gorgonian, a whip coral and the antipatharian *Bathypathes*. On the mud flow emanating from the mud volcano there were herds of the holothurian *Bathyplotes*, numerous ophiuroids and the occasional seapen *Umbellula*.

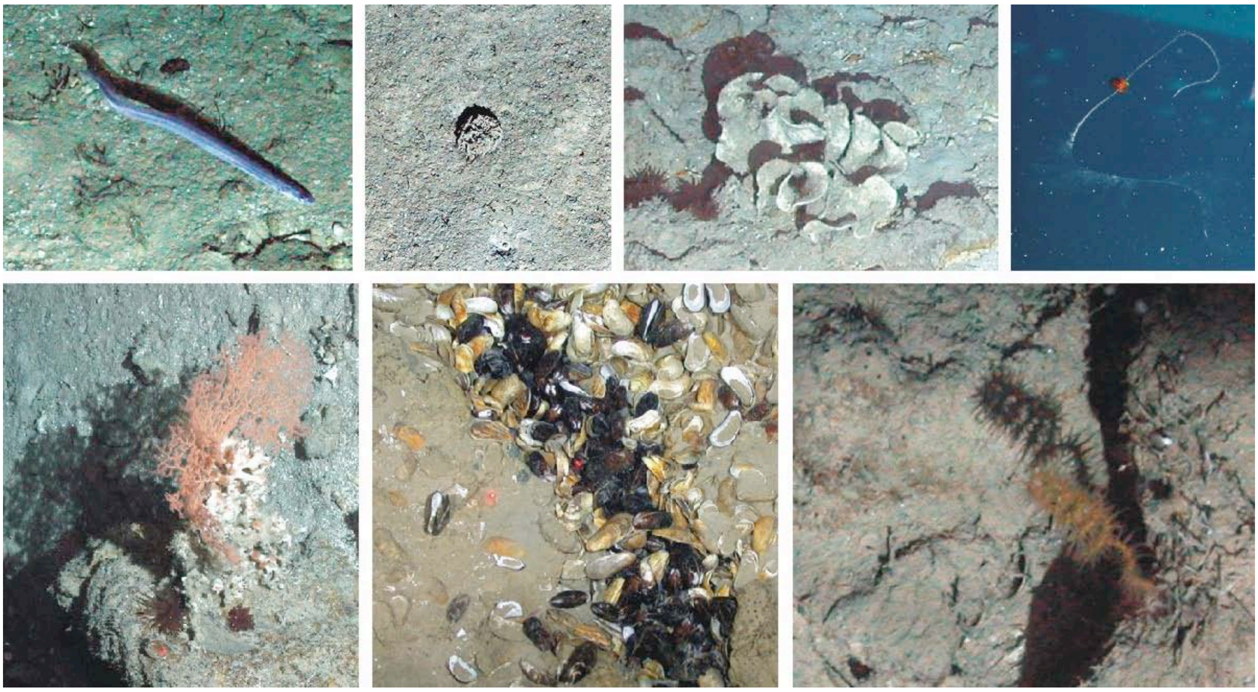

Figure 2. Examples of fauna from Darwin MV. Clockwise from top left: *Synaphobranchus*: a deep-sea eel; a xenophyophore: a large single-celled organism; a bryozoan; a sea whip; deep-sea coral possibly *Lophelia*; live and dead mussels of the genus *Bathymodiolus*; coiled gorgonian.

Paul Tyler (NOCS)

Macrofauna sampling (Leg 1)

The biological material collected during the cruise will contribute to the following specific objectives: 1) to gain more information on the biodiversity and distributional ecology of macroinvertebrates; 2) to determine the trophic status of key species using stable isotope analyses; 3) to identify chemosynthetic prokaryotic endosymbionts in macrofaunal hosts using molecular methods.

Macrofauna biodiversity

Push-core samples were taken at the three studied mud volcanoes (3, 1 and 6 samples at Mercator, Darwin and Carlos Ribeiro, respectively) and mega-core samples were taken also at Carlos Ribeiro (3 to 8 liners from 6 core sites taken at different areas of the MV). The material was sliced at 0-5 and 5-20 cm (push-cores) or at 0-1, 1-5, 5-10, 10-20 cm (megacores) and the sediments washed through a 0.5 mm mesh sieve. Two suction samples were also taken from mussel beds at Darwin using a mesh size of 0.25 mm. All samples were kept in 95% ethanol and will be sorted later on in the lab. Some of the sampling operations for geology or biogeochemistry purposes provided occasional specimens that were washed and preserved in the same way. All biological samples are listed in Table 1. Biological specimens will be curated and deposited in the Biological Research Collection of the University of Aveiro (Department of Biology) for further ecologic, taxonomic, morphologic and genetic studies.

Stable isotopes and molecular analyses

Analyses of the natural, stable isotopic composition ($\delta^{13}C$, $\delta^{15}N$, $\delta^{34}S$) of the tissues of bivalve species will be carried out in specimens collected from Darwin (7 *Bathymodiolus* sp. and 1 *Solemya* sp.) and Carlos Ribeiro (2 *Thyasira* sp. and 1 *Acharax* sp.) Whenever possible, the specimens will also be used for phylogenetic analysis (16S rRNA sequence), DGGE community profiling of the chemosynthetic prokaryotic endosymbionts and fluorescence *in situ* hybridization (FISH). Tissues for stable isotope analysis and PCR-DGGE analysis of bacterial and archaeal 16S rRNA genes were frozen (-20ºC). Tissues for FISH were fixed in a dilute solution of gluteraldehyde in sterile seawater.

Larval sampling

This component of the biological sampling aimed to collect invertebrate larval stages in the water column above the studied mud volcano craters. Water was filtered through two 64 µm meshes at 1 to 2 m above the seafloor in Mercator, Darwin and Carlos Ribeiro (2, 1 and 2 samples respectively). At Mercator an additional sample was also collected at 40 m above the seafloor. From each sample, one filter was fixed in 4% formaldehyde in seawater and the other in 95% ethanol.

Colonisation experiments

The colonisation experiments were designed to gain insight on the ability of the chemosynthetic communities to recolonize after disturbance events. Sets of colonisation rings (TRAC) containing organic (wood and alfafa grass) and inorganic (carbonate) substrates were deployed in selected sites at the three studied mud volcanoes (Dive 28: 3 sets; Dive 33: 1set; Dive 36: 1 set; at Mercator, Darwin and Carlos Ribeiro, respectively). These deployments were carried out as a collaboration with the EUROCORES-EuroDEEP project CHEMECO.

*Table 1: Preliminary list of the main macrofaunal taxa present in the samples. Po: Porifera; Hy: Hyrozoa; Sc: Scyphozoa; An: Anthozoa; Ga: Gastropoda; Bi: Bivalvia; Si: Siboglinidae; Po: other Polychaeta; Le: Leptostraca; De: Decapoda; My: Mysidacea; Am: Amphipoda; Is: Isopoda; Ta: Tanaidacea; As: Asteroidea; Cr: Crinoidea; Op: Ophiuroidea; Bry: Bryozoa. * samples with no conspicuous fauna.*

		Po	**Cnidaria**			**Mollusca**		**Annelida**		**Crustacea**						**Echinodermata**			**Br**
	Class		Hy	Sc	An	Ga	Bi	Si	Po	Le	Malacostraca					As	Cr	Op	
Station JC10											De	My	Am	Is	Ta				
	Mercator																		
JC10-18	Dive 27-RS	+	+	+	+		+		+		+		+				+		+
JC10-21	Dive 28-PC02							+	+									+	
	Dive 28-PC03		+				+	+											
	Dive 28-PC04							+											
	Darwin																		
JC10-28	Dive 32-RS		+		+	+	+		+										+
JC10-32	Dive 33-SS01					+	+		+	+		+	+	+	+	+			
	Dive 33-SS02					+	+		+	+		+	+	+	+	+			
JC10-36	Dive 34-PC09							+											
	Carlos Ribeiro																		
JC10-51	Dive 36-PC01							+											
	Dive 36-PC02							+											
	Dive 36-PC03							+											
	Dive 36-PC04*																		
	Dive 36-PC05*																		
	Dive 36-PC06*																		
JC10-54	MGC *																		
JC10-57	MGC						+	+	+										
JC10-61	MGC							+	+										
JC10-62	MGC							+											
JC10-63	MGC																		

Marina Cunha

Biogeochemistry and Microbiology (Leg 1)

This research focussed on microbially-driven methane flux in mud volcano sediments and the prokaryotic organisms involved. At present it is unknown how much of the methane in mud volcanoes is brought up from depth during eruptions and how much may be produced *in situ* by prokaryotes being stimulated by substrates supplied from depth in the mud (e.g. volatile fatty acids and hydrocarbons). In addition, the effectiveness of prokaryotes to consume the high levels of methane in mud volcano sediments, and thus prevent release of this potent greenhouse gas, needs to be assessed. Another aspect was an assessment of general prokaryotic biodiversity to detect the presence of deep-sourced "deep biosphere" prokaryotes and to compare the diversity of different mud volcanoes and contrast this with non-mud volcano reference sites. Participants involved were from Cardiff University (John Parkes & Barry Cragg) and the University of Ghent (Lois Maignien).

The general approach was to take at least 3 piston or gravity cores plus a parallel surface mega-core sample at each mud volcano: at a reference site, at the rim of the volcano and at the centre of the mud volcano. Samples were taken in a depth sequence in sterile plastic or glass syringes and/or minicores either by sequentially extruding the core (mega core and near surface gravity core) or cutting sections from the gravity core. This minimised exposure to air. Often gas samples were taken from cut ends of the gravity/piston cores or from holes drilled in the core liner for methane analysis prior to sampling. This enabled the methane:sulphate transition zone (SMTZ) to be targeted where rates of anaerobic oxidation of methane (AOM) are usually highest. Prior to analysis the cores were either stored at 4°C or on deck, whichever temperature was closest to bottom water temperature measured by the ROV. In addition, two push cores from the NW rim of the Darwin Mud volcano were analysed immediately after recovery. These targeted mud breccia outcrops, potentially saturated with methane near the surface, identified on a previous ROV dive.

Samples were taken for direct prokaryotic counts (Acridine Orange Direct Counts, AODC), counts of specific prokaryotic groups (Fluorescent *In situ* Hybridisation, FISH), porosity, gas analysis, pore water (using a pore water press in the cold room), activity measurements, DNA analysis and enrichment of methanogens and appropriately stored/preserved.

Activity samples in syringes were equilibrated at the incubation temperature (*in situ* temperature) prior to injection with radiotracer: either ^{14}C –acetate, -bicarbonate, -methanol, -methylamine for rates of methanogenesis; ^{14}C-methane for AOM; ^{35}S-sulphate for sulphate reduction rates (SRR); or [*methyl*-^{3}H]thymidine for measurement of prokaryotic productivity. Incubation was in nitrogen-flushed aluminium bags except for AOM and SRR as these were in glass syringes, the other activity syringes were plastic. After incubation activities were terminated by extracting the sediment into either: 1) NaOH for ^{14}C-substrates which stopped bacterial activity, displaced ^{14}C-methane into the headspace and absorbed ^{14}C-carbon dioxide. Containers were stored upside down to prevent ^{14}C-methane being adsorbed to stoppers; 2) zinc acetate for SRR or 3) cold trichloroacetic acid for [*methyl*-^{3}H]thymidine samples. Incubation times were 4 hours for [*methyl*-^{3}H]thymidine, 8 hours for acetate, methanol and methylamine, 24 hours for bicarbonate and SRR, and 36 hours for AOM. Further processing of these samples will be conducted on return to the laboratory.

Pore waters will be analysed for sulphide, chloride, sulphate, nitrate, volatile fatty acids, methanol and methylamine at Cardiff University.

The following gravity/piston cores were analysed along with their associated mega core at each mud volcano: Mercator 2, 9, 15 & 19, Darwin 25, 29 and 38, Carlos Ribeiro 45, 48 & 53, Arutynov 66 (centre only).

At Carlos Ribeiro Mud Volcano (Mega Core 61) the effect of different incubation temperatures and pressures on measured activities was evaluated. An anoxic layer below 20 cm was taken and mixed anaerobically in the cold room. Then replicate syringes were filled and injected with either ^{14}C-methane, acetate or bicarbonate, or ^{35}S-sulphate, in triplicate. Replicates were either incubated at 1 atmosphere at either 4 or 14°C on-board ship or sent down with the ROV during dive number 38 for incubation under *in situ* conditions. These incubations were in glass syringes using the rubber stoppers and plunger to transfer pressure to the sediment inside. All of these syringes survived the ROV deployment and recovery and were processed within 30 minutes of the ROV reaching the ship.

John Parkes, Lois Maignien

Temperature measurements

Sites of advecting fluids are related to elevated temperature fields. This is particularly clear at hydrothermal vent sites along the ocean ridges. Recently, however, temperature measurement in surface sediments at a number of seep sites or so-called cold vents has also revealed temperatures that are significantly higher than the surrounding sediments and bottom water. Mud volcanoes, in particular, have temperatures that are significantly enhanced compared to the surrounding bottom water temperatures. Two examples are the Håkon Mosby mud volcano in the Barents Sea (Kaul et al., 2006) and the Dvurechenskii mud volcano in the Black Sea off the Crimea Peninsula (Bohrmann et al., 2003).

Two Miniaturised Temperature Data Loggers (MTL) from ANTARES Datensysteme GmbH were mounted on the Gravity/Piston corer and three MTLs were welded on a lance of 75 cm length that could be manipulated by the ROV. The thermometers work autonomously over a preset period of time and with a set sample rate. The MTLs are operate at temperatures between -4°C to + 50°C with a resolution of 0.001°C (at 5 °C) and an accuracy of +/- 0.1°C.

Temperature measurements on gravity and piston coring

Unfortunately, the MTLs on the long coring devices had to be dismounted due to problems during deployments of the device with the existing core rig early in the cruise. Therefore measurements from only three sites exist, 2 of them being reference sites. No measurements were possible at the Darwin MV because the extensive carbonate crusts prevented penetration of the probe.

Table 2. Temperature probes on piston/gravity cores

Site	Station	Depth (cm)	Depth (cm)	Comments
Mercator MV	JC10-004	460	595	Reference site
Mercator MV	JC10-020	400	585	Crater
Darwin MV	JC10-023	700	885	Reference site
Darwin MV	JC10-025	400	585	Reference site

Temperature measurements using the ROV

Four grids of various lateral extent were carried out using the temperature lance on the ROV (Figure 4). At Mercator MV we carried out a small grid of four stations around a site of bubble expulsion (Dive 28). In addition measurements were taken on two transects on top of the most recent mudflow during dive 39. At Darwin MV extensive carbonate coverage prevented the intrusion of the temperature lance over large areas. Measurements accompanied push coring at and in the vicinity of the 'black spot' at the northern rim of the carbonate platform on Darwin mud volcano (Figure 3). Two transects of temperature measurements were carried out throughout the crater of Carlos Ribeiro mud volcano.

The logged data will be evaluated at the NOC and compared to the continuous temperature data from the CTD mounted on the ROV and to possible changes in the composition of the bottom water that was collected with the Aqualab system.

Table 3. Temperature lance sample list

Site	Station	ISIS Dive	Sites	Comments
Mercator MV	JC10-021	28	4	around bubble site
Darwin MV	JC10-036	34	5	carbonate coverage prevented grid
Carlos Ribeiro MV	JC10-056	37	16	transect
Mercator MV	JC10-074	39	11	transect

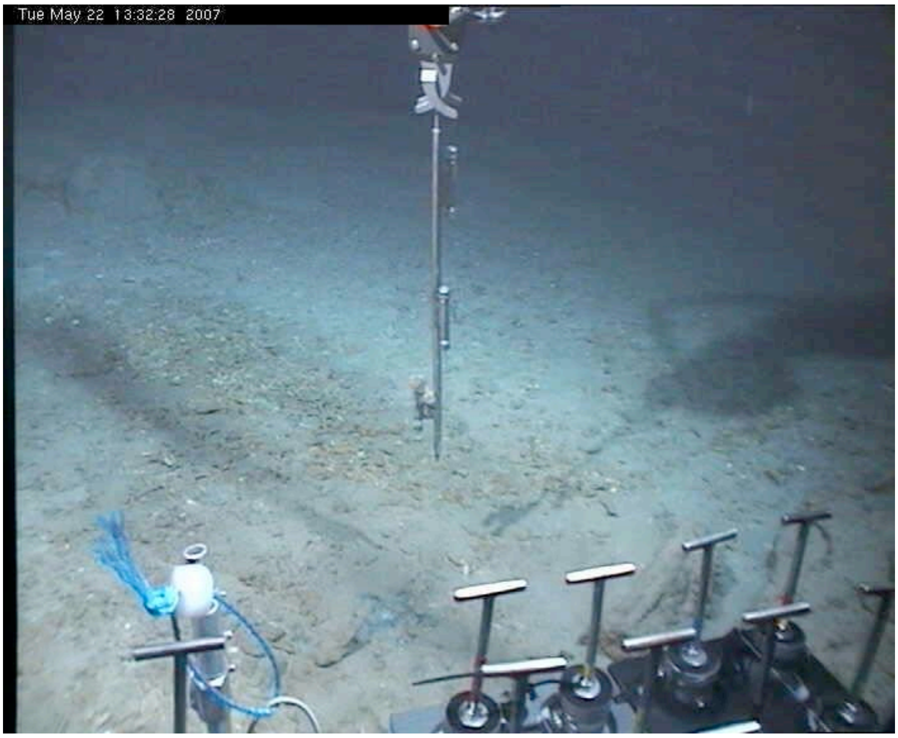

Figure 3. Temperature measurement in a small outcrop of black sediments at the northern rim of the carbonate platform at Darwin mud volcano using the ROV and the temperature lance (length: 75 cm)

Katja Heeschen

Aqualab - ROV operated bottom water sampling

Obtaining measurements of the flux of heat, elements and especially methane from mud volcanoes (MV) is a major goal of studies of lithosphere-hydrosphere exchange at continental margins. However, the low resolution of bottom water sampling grids on top of these geological features severely restricts the usefulness of most existing datasets. So far towed rosette systems and single measurements from lander deployments comprise the few measurements available; however, they do not allow any horizontal interpolation.

The Aqualab (AL) is a proprietary instrument from EnviroTech (USA) that allows the collection of up to 48 water samples via a 50-port rotary valve and their injection into gas tight parenteral (plasma) bags (Figure 4). Each injection has a maximum volume of 200 ml, although the maximum water volume in a single bag can be up to 1000 ml. The AL can run completely automatically in a time-series mode when mounted on moorings or can be remotely controlled using a master device, e.g., an ROV, as during JC10. Using the ROV, the AL enables precise water sampling close to the seafloor (1 m above seafloor). Furthermore, the total number of 48 samples allows a good horizontal coverage of the crater areas. The gas tight sample bags allow methane measurements to be made either in the ships laboratory or onshore.

During JC 10 the AL was used four times, once each at Darwin and Carlos Ribeiro MVs, and twice at Mercator MV (Table 4). A good sampling grid was covered on Darwin MV and Carlos Ribeiro with approximately 80% collection efficiency. Difficulties with air contamination and the instrument itself prevented a full coverage at Mercator MV. Whilst during the first deployment the samples were air-contaminated, this problem did not occur during the following dives, since all bags were vacuum emptied in the lab and sealed until deployment on the instrument. Tests showed that the bags hold the vacuum for at least a month time. Apart from JC10-016 each sample bag (600 ml) was sub-sampled for oxygen, nutrients and ICP measurements. The majority of the sample was kept in the gastight sample bags for methane analysis back at NOC. No gas measurement will be possible on JC10-016 since the air-contamination made the analysis of both dissolved methane and oxygen unreliable. The reason for the Aqualab malfunction during JC10-075 is unknown so far and will be investigated at NOC.

Table 4. Aqualab sample list

Site	Station	ISIS Dive	Samples	Comments
Mercator MV	JC10-016	26	16	air contamination
Darwin MV	JC10-027 JC10-028	31 32	28	
Carlos Ribeiro MV	JC10-047 JC10-051	35 36	32	
Mercator MV	JC10-074 JC10-075	39 40	9 0	Aqualab failed during dive 40

The maximum number of samples during one dive was 32 since taking each sample took up to 20 minutes for a 600 ml sample volume. Looking forward, the Aqualab offers a good way of collecting water samples *in situ* on the ROV but there are 2 main issues relating to its use: the speed of sample collection, up to 25 minutes on occasion, and the issue of the residual air contamination in the bags. Both of these issues will be explored back at NOC and will involve communication with EnviroTech to improve sampling efficiency and speed.

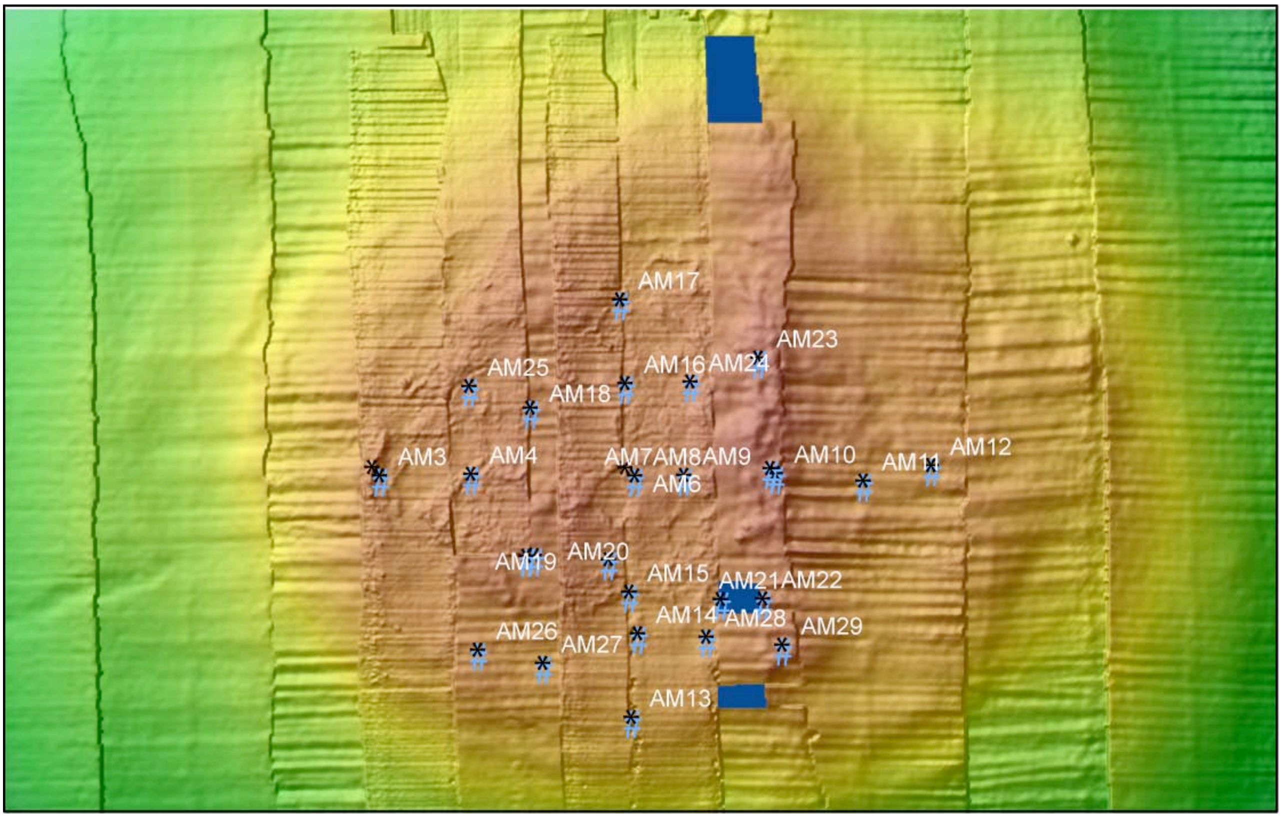

Figure 4. Aqualab sampling grid at Darwin Mud volcano, superimposed on preliminary Isis swath bathymetry map.

Doug Connelly, Katja Heeschen

Sediment Geochemistry (Leg 1)

Mud volcanoes serve as a window into the underlying strata due to the deep source of mud and fluids transported to the sediment surface where they influence ecosystems and element cycles. The information gained from geochemistry of pore waters, sediments and carbonates at mud volcanoes can be threefold. They shed light on 1) the origin of the fluids and mud extruding at the seafloor, 2) compositional changes that occur due to authigenic mineral precipitation, cementing and other sediment-fluid interactions during the ascent through the sediment column, and 3) the advection rates themselves that can be estimated by applying transport-reactions models to the pore water chemistry. In the shallow sediments, the biogeochemistry further characterises the ecological habitats of the specialised fauna often related to focused and diffuse fluid flow which is in turn modified by biological processes.

In the Gulf of Cadiz numerous mud volcanoes occur between depths of 300 – 3800 m. Over the last decade investigations have discovered a considerable diversity of genesis, sources, locations, and evolution between the sites, most of which is represented in the geochemistry [*Somoza et al*., 2003; *Hensen et al*., 2007]. During cruise JC10 we chose three mud volcanoes over a range of different depths and morphology to look at the geochemistry of the pore waters, sediments, and carbonates: the well-surveyed small and shallow Mercator MV (MMV, 350 m), the carbonate-covered Darwin MV (DMV, 1000 m), and the deep Carlos Ribeiro MV (CRMV, 2100 m) with its long, high-backscatter mud flows. In addition, we took two cores at the so-called Western Mound (2800 m) to determine whether or not this feature is a mud volcano, as was suggested from seismic data. At each of the MVs we anticipated taking a set of 3 cores, a central, a rim and a background station. Depending on earlier investigations or local specialities the choice of sampling sites could differ.

Methods

Three sets of sediment cores were retrieved during the cruise, all of which served a different purpose. Deep fluid investigations and fluid flow quantifications will be based on long gravity (GC), piston (PC) and kasten (KC) cores. The PC was equipped with a trigger corer (TC). Some TC cores were stored for shore-based investigations. At each GC/PC station we also deployed a megacorer (MC) to get a high-resolution pore water profile close to the sediment surface where gradients are steepest in case of strong fluid flow. Push cores (PUC) collected via the ROV Isis support the habitat mapping with detailed biogeochemical characterisation of well-defined sites.

Immediately after core recovery, the sediment cores were sub-sampled under laboratory conditions into slices of 1 – 3 cm thickness in case of the MC and 3 – 5 cm in case of long cores. Whereas slicing on MCs was continuous, the samples of the long cores were taken from the working half in intervals of 15 – 50 cm depending on visual changes in the sediment and core length. For CH_4 analysis 3 ml of these slices were transferred into headspace vials using plastic syringes with their top cut off. The vials contained 5 ml 1N NaOH to stop any biological process. They were sealed and will be measured onshore. Small samples for porosity measurements were collected in pre-weighed containers. The other parts of the samples were stored in parafilm (long cores, PUC) or press trays (MCs) in the glove bag until pore water extrusion took place either immediately or within 3 hours after sampling. The pore water was extracted using a pore water press applying a pressure of 3 – 4 bars (nitrogen) on the press trays that were equipped with cellulose acetate filters (0.2 µm). We collected the filtered pore water into acid cleaned nalgene® bottles from which they were sub-sampled for later analysis onshore (Tables 5, 6). ICP sub-sampling and acidification was undertaken in the glove bag. The sediments were stored at 4°C for further analysis onshore including CNS element analysis and ICP-AES measurements after sequential leaching. The on board measurements of TA, H_2S and NH_4 followed the method of *Grasshoff et al*. (1999, *http://www.ifm-geomar.de/index.php?id=mg_analytik&L=1*, cited July 2007). All sub-samples are listed in Table 5.

Table 5. Pore water sub-sampling and methodology

Sub sample	**Elements**	**Instrument and Method**
Ammonium	NH4	Photometer, on board. Complex: indophenol blue
Hydrogensulphide	H2S	Photometer, on board. Complex: mythylene blue
Total Alkalinity	TA	Titration, on board. Titrant: 0.02 N HCl Standard: IAPSO
Nutrients (frozen)	PO4, NO3	Photometer, on shore
IC	Cl, SO4, Br	IC, on shore
ICP (acidified HCl))	major cations, + isotope analysis	ICP-AES, MS, on shore
Isotopes (2 sub-samples if possible)	δ18O, δ13C	Mass spectrometer

Samples

A total of 56 cores were taken for on board geochemical pore water analysis, including 18 longer cores, 11 megacores and 27 push cores (Table 6). Another 21 cores were collected for on shore geochemical analysis or investigations of the sediment record (Table 7). They were not opened on board. Core locations are shown in Figure 21 and listed in the station list.

Additional samples taken for geochemical and sediment analysis include 1) large clasts that were found in the mud breccia of the cores and 2) carbonate rocks collected with ISIS during dives 27 (NE of Mercator MV) and 32 (Darwin MV). The latter are listed in the station list. The collected clasts are mostly of sedimentary origin. At Mercator MV, however, gypsum crystals were obtained from cores at two stations and halite from one station. All archived cores are stored at 4°C in the NOC cold store.

Table 6 Sediment cores collected for onboard geochemical analysis. MMV = Mercator mud volcano, DMV = Darwin mud volcano, WMV = Western mud volcano, CRMV = Carlos Ribeiro mud volcano.

Station	**Location**	**Device**	**Length**	**Samples**	**TA**	**NH_4**	**H_2S**	**CH_4**	**Sub-samples**			
JC10-			**(cm)**						**Isotope**	**Nutrients**	**IC**	**ICP**
001	MMV	PC	241	20	x	x	x	x	x	x	x	x
002	MMV	MC	42.5	10	x	x	x	x	x	x	x	x
004	MMV	PC	375	2		x		x		x		x
010	MMV	GC	150	20	x	x	x	x	x	x	x	x
011	MMV	MC	40	15	x	x	x	x	x	x	x	x
013	MMV	MC	28	10	x	x	x	x	x	x	x	x
014	MMV	GC	53	7	x	x	x	x	x	x	x	x
017	MMV	KC	106	5	x	x	x	x	x	x	x	x
021-PUC01	MMV	PUC	14	6		x	x		x	x	x	x
021-PUC05	MMV	PUC	19	6		x	x		x	x	x	x
021-PUC06	MMV	PUC	16.5	6		x	x		x	x	x	x
021-PUC07	MMV	PUC	13	5		x	x		x	x	x	x
021-PUC08	MMV	PUC	7	2		x	x		x	x	x	x
023	DMV	PC	505	22	x	x	x	x	x	x	x	x

026	DMV	MC	36	12	x	x		x	x	x	x	x
030	DMV	MC	22	13	x	x	x	x	x	x	x	x
031	DMV	GC	49	11				x			x	x
033	DMV	GC	40	14	x	x	x	x	x	x	x	x
036-PUC01	DMV	PUC	14	7	x	x	x		x	x	x	x
036-PUC02	DMV	PUC	17	6				x				
036-PUC03	DMV	PUC	20	10	x	x	x		x	x	x	x
036-PUC04	DMV	PUC	17	7				x				
036-PUC06	DMV	PUC	15	7				x				
036-PUC07	DMV	PUC	18	9	x	x	x		x	x	x	x
036-PUC08	DMV	PUC	16	6				x				
036-PUC10	DMV	PUC	19	8	x	x	x		x	x	x	x
036-PUC11	DMV	PUC	17	7				x				
037	DMV	GC	24	6	x	x	x	x	x	x	x	x
041	WMV	GC	464	25	x	x	x	x	x	x		?
043	CRMV	PC	546	21	x	x	x	x	x	x	x	x
044	CRMV	MC	18	7	x	x	x	x	x	x	x	x
049	CRMV	GC	124	10	x	x	x	x	x	x	x	x
050	CRMV	MC	20	16	x	x	x	x	x	x	x	x
052	CRMV	GC	200	15	x	x	x	x	x	x	x	x
053	CRMV	PC	548	9	x	x	x	x	x	?	x	
056-PUC01	CRMV	PUC	12	7		x	x		x	x	x	x
056-PUC03	CRMV	PUC	17	7				x				
056-PUC05	CRMV	PUC	15	5		x	x		x	x	x	x
056-PUC06	CRMV	PUC	14	6				x				
056-PUC07	CRMV	PUC	23	6		x	x		x	x	x	x
056-PUC08	CRMV	PUC	18	7				x				
056-PUC12	CRMV	PUC	12	5		x	x		x	x	x	x
056-PUC13	CRMV	PUC	22	8				x				
056-PUC14	CRMV	PUC	15	6		x	x		x	x	x	x
056-PUC15	CRMV	PUC	24	6				x				
056-PUC17	CRMV	PUC	17	6		x	x		x	x	x	x
056-PUC18	CRMV	PUC	15	7				x				
056-PUC19	CRMV	PUC	14	6		x	x		x	x	x	x
057	CRMV	MC	32	18	x	x	x	x	x	x	x	x
058	CRMV	PC	231	15	x	x	x	x	x	x	x	x
059	CRMV	PC	133	12			x				x	x
060	CRMV	GC	197	10		x	x	x	x	x	x	x
063	CRMV	MC	36	14	x	x	x	x	x	x	x	x
069	MMV	GC	101	10	x	x	x	x	x	x	x	x
070	MMV	MC	38	15	x	x	x	x	x	x	x	x
071	MMV	MC	37	14	x	x	x	x	x	x	x	x
073	MMV	GC	454	20	x	x	x	x	x	x	x	x

Table 7. Sediment cores stored for laboratory geochemical analysis. MMV = Mercator mud volcano, DMV = Darwin mud volcano, WMV = Western mud volcano, CRMV = Carlos Ribeiro mud volcano.

Station JC10-	Location	Instrument	Stored	Length	Comments
002	MMV	MC	x	42	Complete liner, Geochem
007	MMV	PC	x	70	Under anaerobic (N_2) conditions, Geochem
020	MMV	PC	x	79	Geochem
023	MMV	TC	x	46	Geochem
032	DMV	TC	x	?	Station Number needs to be verified
033	DMV	GC	x	40	Geochem
042	WMV	PC	x	470	Geochem
056-PUC02	CRMV	PUC	x	37	Sedimentation record
056-PUC09	CRMV	PUC	x	22	Sedimentation record
056-PUC10	CRMV	PUC	x	17	Sedimentation record
056-PUC11	CRMV	PUC	x	33	Sedimentation record
056-PUC16	CRMV	PUC	x	31	Sedimentation record
057	CRMV	MC	x (2)	42/42	Sedimentation record
059	CRMV	TC	x	31	Geochem
061	CRMV	MC	x (2)	32/32	Sedimentation record
062	CRMV	MC	x (2)	34/35	Sedimentation record
063	CRMV	MC	x (2)	25/36	Sedimentation record
066	CAMV	TC	x	28	Geochem
070	MMV	MC	x (2)	42/42	Sedimentation record
071	MMV	MC	x (2)	40/42	Sedimentation record
076-PUC01	DMV	PUC	x	22	Sedimentation record (yellow/green)
076-PUC02	DMV	PUC	x	20	Sedimentation record
076-PUC03	DMV	PUC	x	24	Sedimentation record
076-PUC04	DMV	PUC	x	22	Sedimentation record

<u>Preliminary results</u>

All three MVs show indications of active fluid flow, including active bubbling at Mercator MV, very gassy sediments and rich chemosynthetic fauna at Darwin MV, and strong geochemical gradients at Carlos Ribeiro MV. The latter site showed neither gas bubbles nor complex chemosynthetic macrofauna in the ROV video surveys, although the shallow subsurface geochemical gradients of TA and H_2S are the steepest we measured during JC10. The simultaneous increase of these two parameters indicates ongoing anaerobic oxidation of methane (AOM) that is commonly found where CH_4 laden fluid advects from depth into sediments that are effected by SO_4 supply from seawater (*Niemann et al*., 2006, *Ziebis and Haese*, 2005). Products of the AOM are HS and HCO_3, both increasing the alkalinity. The geochemical indicators for AOM were also found at distinct sites at Mercator and Darwin MV.

Mercator MV

Mercator MV has been a target of several expeditions before JC10, including those of RV Belgica (e.g., *Depreiter et al*., 2005), TTR (e.g., *Pinheiro et al*., 2003), RRV Charles Darwin (*Berndt et al.*, 2007) and RV MS Merian (*Haeckel et al.*, 2007). A total of seven coring stations were therefore chosen from a range of seismic and geochemical data. Five stations are located in the centre and rim of the crater. Within the crater we revisited two of the most active sites found during the RV MS Merian cruise and collected cores for a more detailed investigation on the sediment physical properties and geochemistry. The station at the bubble site of Mercator MV was further sampled using push cores, temperature probes, and the Aquamonitor (see appropriate chapters and station list for details). The MC and GC cores (JC10-011, JC10-010) have a distinct AOM (anaerobic oxidation of methane) reaction zone between 40-80 cm, with a simultaneous increase of TA and H_2S in the pore water profiles. However, the maximum values of 7.5 meq/l and 0.6 mM, respectively, are much lower than those measured at the central sites of Darwin MV and Carlos Ribeiro MV and gradients are less steep. Two additional cores from these central sites at Mercator MV were stored for investigations of clasts, authigenic minerals, cements, and clay minerals. At both stations the cores contained gypsum crystals and halite. The station to the northwestern rim of the crater was positioned following indications from seismic data (NOCS) that in this area a Bottom Simulating Reflector (BSR) intersects with the sediment surface. The two longer cores will be analysed for sediment geochemistry. Pore water profiles indicate low advection rates. Two further stations were positioned at the S and SE rim of the carter in mudflows of different ages. The station located at the margin of the youngest mud flow (JC10-013 and JC10-014) have TA, NH_4 and H_2S gradients comparable to those at the bubble site, whereas the pore water profiles within the older mud flow (JC10-068 and JC10-071) are less steep and no H_2S was detected within the upper 30 cm.

In addition to these stations, a reference station was cored to the southwest. Despite the distance from the MV, both H_2S and TA indicate a limited supply of CH_4 from below. A second station, located next to the carbonate outcrop 2 km to the NE of Mercator MV, was chosen to prove the possible existence of a cap rock in the area. Several carbonate rocks collected from the outcrop will hopefully prove useful for further investigations regarding the formation of this carbonate structure.

Darwin MV

Before JC10, the fluid origin, areas of active fluid flow, and related advection rates at Darwin MV were poorly known. A combined effort of swath mapping, video observations and coring led to a very comprehensive picture of this small MV, which is very different from Mercator or Carlos Ribeiro MV due to its lack of sediment cover. Thus, coring was only possible at the rim of Darwin MV, and not in its crater, which is covered by an extensive carbonate platform that exhibits faults and broken slaps but no sediments. A total of four stations were sampled, two at the northern rim, one at the southern rim and a reference station. Neither TA nor H_2S pore water profiles at the NE

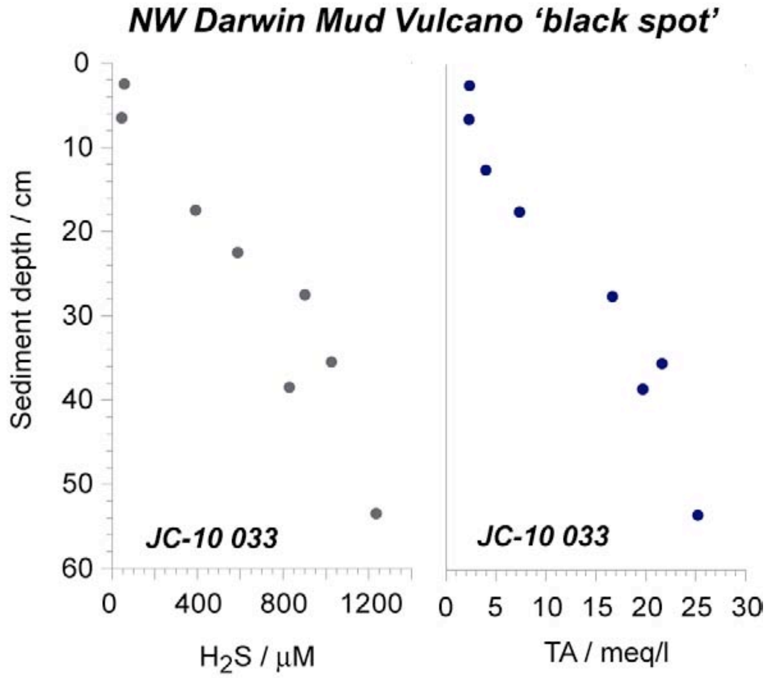

Figure 5. Pore water profiles of H_2S and TA at JC10-33 at the northwest rim of Darwin MV.

or at the S of the crater indicate fluid flow. This is unlike the north western station (JC10-033), where TA and H_2S profiles strongly increase at only 10 cm depth, reaching TA > 20 meq/l and H_2S of 1.2 mM (Figure 5). These steep gradients are not accompanied by any increase in NH_4 and relate to AOM. The station roughly coincides with ISIS video observations of a small area with black surface sediments and gas bubbles escaping the sediment when it was disturbed (Figure 6). A push core (ISIS Dive 34) from the area has H_2S concentrations of several mM up to the surface, whereas a few meters away no increase in H_2S were observed within the short length of a push core.

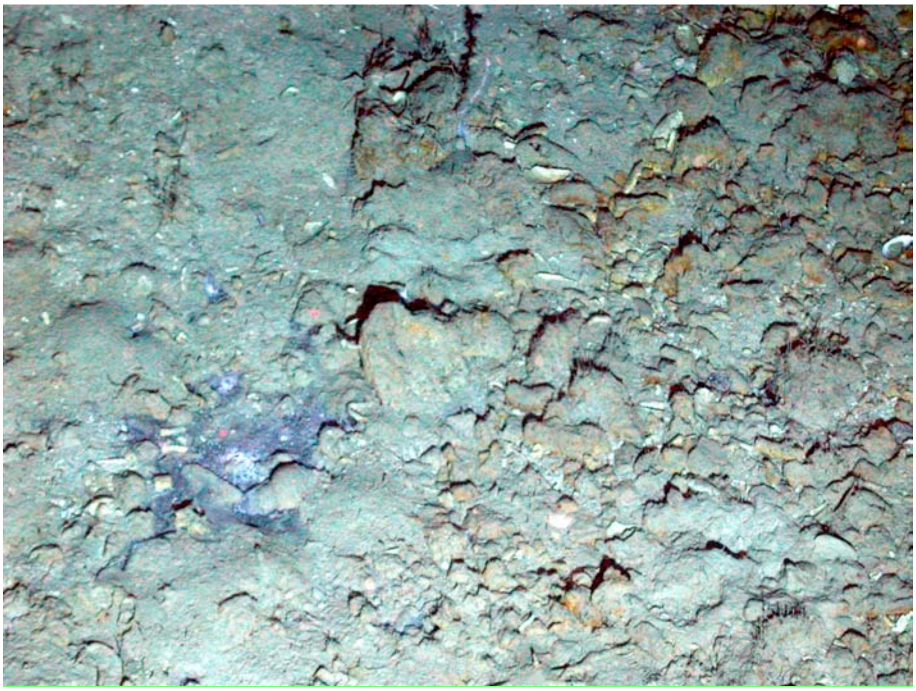

Figure 6. Gas-enriched sulphidic black sediment at crater of Darwin MV.

Carlos Ribeiro MV

Carlos Ribeiro MV is the deepest MV investigated during JC10. It is supposed to be one of the most active mud volcanoes in the Gulf of Cadiz (M. Ivanov, Univ of Moscow, pers. comm., 2007). Its centre and mudflows have very strong backscatter values, which may indicate comparably recent mudflows. A transect of 5 coring stations was collected starting at the centre of the MV with its very rough topography, crossing the rim and ending in the centre of the long mudflow to the SE (see station list). The locations were chosen based on ROV swath and video observations as well as previous geochemical studies during TTR-cruises (A. Akhmetzhanov, NOCS, pers. comm., 2007). A reference station was positioned in an area of normal hemipelagic sediments adjacent to the MV. Cores from each station of the transect were stored and will allow a detailed analysis of the sediment records.

In the crater and rim of Carlos Ribeiro MV, the geochemical profiles of TA, H_2S and NH_4 are determined by advecting fluids and AOM as is indicated by strong gradients in TA and H_2S concentration-depth profiles in shallow subsurface sediments. Cores from both the central and SE crater reach H_2S maxima of > 6 mM within 30 cm below the seafloor and even at the crater rim this maxima is to be found within the first meter of the sediment column (Figure 7). NH_4 concentrations are high but only parallel the H_2S profile in the central position.

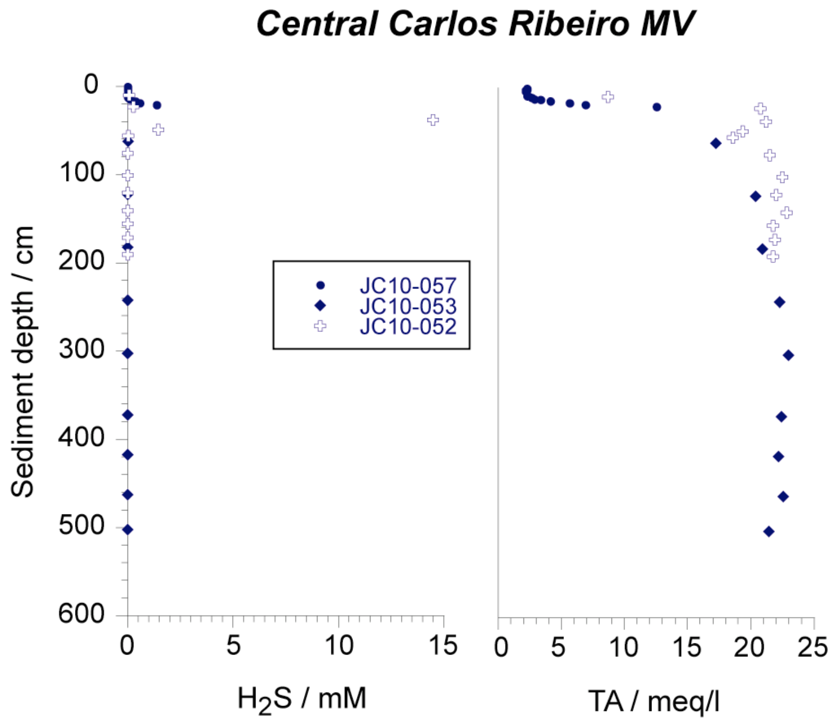

Figure 7. Pore water profiles of H_2S and TA in the central crater of Carlos Ribeiro MV.

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Meiofaunal structural, functional biodiversity and geochemical conditions (Leg 1)

As with all cold seeps, mud volcanoes are characterised by strong gradients and high variability in biogeochemical conditions in the sediment on a relatively small scale. Moreover the presence of multiple mud volcanoes in different stages of activity and at different water depths in a restricted geographical area allows a comprehensive study of the fauna in relation to the present geochemical conditions in the Gulf of Cadiz area. The three targeted MVs Mercator, Darwin and Carlos Ribeiro at depths of 350 m, 1100 m and 2300 m respectively were sampled for meiofauna and geochemistry of the pore water along a gradient from the centre of the most recent active areas towards the edge of the crater or the flank of the MV. The combined analysis of meiofauna community structure and geochemistry on the same core samples will allow fine scale variation in the micro- and macrohabitats and its associated fauna to be unravelled.

The study had the following specific objectives:

- to understand changes in meiofauna community from the centre of the MV towards the edge in relation to increasing cover of hemipelagic sediment on top of mud breccia
- to understand changes in meiofauna community from the surface of the sediment to the deeper sediment layers in relation to vertical geochemical sediment profiles
- to understand differences in meiofauna communities between different mud volcanoes at different stages of activity and at different water depths

As well as community analysis and standing stocks, the reliance of the fauna in the different geochemical conditions on thiotrophic, methanotrophic or photosynthetic derived food sources will be investigated. The increasing importance of phytodetritus based food input with decreasing water depth is also a significant factor that will be considered in the comparison of the three MVs.

The biological samples will be analysed for densities, biomass, nematode species composition, species diversity and trophic structure (stable isotope analysis). The geochemical samples will be analysed for nutrients, sulphide and methane. Furthermore porosity, granulometry and C/N will be analysed.

At each MV 3 to 7 different sampling locations were identified which were sampled twice in most cases (except for Mercator) by means of push cores (5.7 cm diameter) deployed by the ROV Isis. At each location one push core was pre-drilled in order to extract the sediment pore water at 2 cm intervals (Figure 8) before the upper 10 cm of the sediment was sliced in cm intervals for meiofauna analysis. The slices for faunal analysis were fixed with borax buffered formaldehyde at a final concentration of 4 %. If a second push core was collected (at Darwin and Carlos Ribeiro), it was subsampled for methane and porosity, while the rest of the sediment was stored in 2 cm slices at -20°C for analysis of stable isotopes, sediment granulometry and C/N concentrations. At each MV two background stations at similar water depths were also sampled with the megacorer (cores of 10 cm diameter) for faunal analysis.

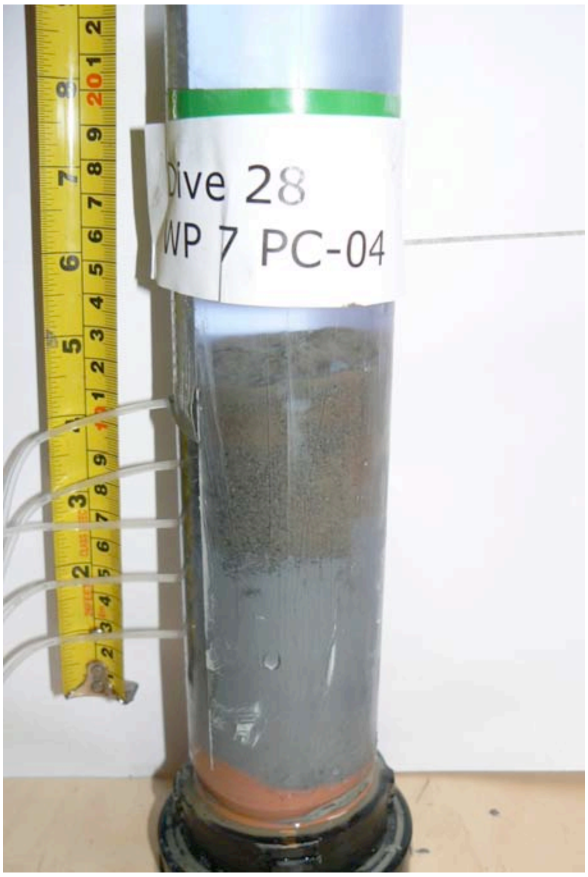


Figure 8. A push core modified for pore water extraction retrieved from Mercator MV. The core shows 4 cm of hemipelagic sediment on top of mud breccia.

Table 8. Station list with indication of sampling strategy (MC: megacorer; WP: waypoint and F: Formaldehyde fixed).

Station JC10-	Dive (WP)	No. of cores	Macrohabitat	Analysis
MERCATOR (350 m waterdepth)				
001		3	Background	Meiofauna (F)
021-PUC01	28 (8)	1	Crater – 7 cm hemipelagic	Geochemistry Meiofauna (F)
021-PUC04	28 (3)	1	Crater – 7 cm hemipelagic (Majofauna)	
021-PUC05	28 (11)	1	Crater – 4 cm hemipelagic	
021-PUC06	28 (10)	1	Crater – 1 cm hemipelagic	
021-PUC07	28 (6)	1	Crater – 0 to 7 cm hemipelagic (sloping)	
021-PUC08	28 (7)	1	Crater – 4 cm hemipelagic	
DARWIN (1100 m waterdepth)				
026		2	Background	Meiofauna
030		2	Background	
036-PUC01 036-PUC02	34 (29)	2	Crater – all hemipelagic	Geochemistry Meiofauna (F) Stable isotope C/N Granulometry Methane, Porosity
036-PUC03 036-PUC04 036-PUC06	34 (30A)	1 1 1	Crater- black sediment with gas (bubbles came out when coring)	
036-PUC07 036-PUC08	34 (30B)	1 1	2 m from black surface sediment (5 cm hemipelagic – no bubbles)	
036-PUC10 036-PUC11	34 (30C)	1 1	5 m from black surface sediment (10 cm hemipelagic – no bubbles)	
CARLOS RIBEIRO (2300 m waterdepth)				
044		3	Background	Meiofauna (F)
056-PUC01 056-PUC03	37 (4)	1 1	Flat centre North (8 cm hemipelagic)	Geochemistry Meiofauna (F) Stable isotope C/N Granulometry Methane Porosity
056-PUC05 056-PUC06	37 (12)	1 1	Flat centre South (8 cm hemipelagic)	
056-PUC07 056-PUC08	37 (11)	1 1	Compressional ridges (8 cm hemipelagic)	
056-PUC12 056-PUC13	37 (14)	1 1	Edge of crater (8 cm hemipelagic)	
056-PUC14 056-PUC15	37 (15)	1 1	Near octocoralia bushes at flank Hemipelagic sediments	
056-PUC17 056-PUC18	37 (17)	1 1	In channel of mud flow	
056-PUC19	37 (16)	1	Old mud flow	Geochemistry Meiofauna (F)

Katja Heeschen and Ann Vanreusel

Megabenthic Community Structure using Isis (Leg 2)

Observations of megabenthic community structure

Table 9. Summary of megabenthos observed during Leg 2 dives.

Dive no	Location	Depth (m)	Summary
42	Setubal	964-564	High density of echiuran worms on the slopes. Steep cliffs seen colonised by brisingid sea stars, anemones, soft corals. "Oyster" cliffs of last year located – reef like community in overhangs on the cliffs, though on closer inspection the oysters are brachiopods.
43	Setubal	1448-1001	Series of rocky ledges with more occurrences of brachiopod beds. Rocky areas supporting corals (*Madrepora* sp. or *Lophelia* sp.), gorgonians and sponges, with small hydroids and anemones. Sea urchins and sea stars seen on flat sedimented areas.
45	Nazare	4352-4368	Transect across channel. Zonation seen on either side of a barren channel characterised by large-scale sediment formations and small-scale ripples. Xenophyophores seen in large quantities on either side of the channel, by far the most abundant organism present, although some asteroids and ophiuroids also seen.
46	Nazare	3646-3525	Steep terrain, rocky cliffs with sheets of loose sediment hanging off. Stalked crinoids (quite abundant) seen growing under overhangs and on boulders. *Anthomastus* sp. type branched anemone seen on rock faces. Some areas covered in dense burrows.
47	Nazare	4347-4367	Similar terrain to dive 45, some *Umbellula* sp. sea pens observed, a crinoid, otherwise quite sparse.
48	Nazare	~3500	No video transect carried out, but large black shark, possibly *Centroscymus* sp. (Portuguese Dogfish) seen.
50	Nazare	3656-3524	Fairly turbid at start of transect, clearing later on. Rocks, boulders and large slabs of sediment seen on very steep slope. Some burrows with occasional ophiuroids, holothurians (*Benthodytes* sp.) and overhangs with yellow crinoids (*Anachalypsicrinus nefertiti*) and branched anemones (*Anthomastus* sp. type)
52	Nazare	1655-450	Steep slope with occasional rocks and boulders. Some ripples seen on the sediment. Sea urchins, cerianthids and some sponges present. On rocky surfaces, red and pink anemones seen, as well as brisingid sea stars, sponges and some stylasterene corals.
53	Nazare	2243-1003	Sedimented cliffs with overhangs, fairly turbid at the start, clearing with ascent. Sabellid worms appear common, cerianthid anemones, sea urchins and echiurans also present. Some stalked sponges (*Hylonema* sp.?) present on flatter areas. Lots of xenophyophores seen on some of the ledges, as well as some gorgonian corals.
55	Nazare	1150-700	Very turbid at start. 9-, 10- and 11-arm brisingid sea stars seen, 11-armed ones seen on rocks, 9-armed ones on mud. 9- and 11-armed brisingids quite abundant. Also a lot of mauve cerianthids seen, that retracted very quickly into their tubes when disturbed. Some thin armed, pink gorgonians seen.

Samples collected for molecular analysis

Where samples were collected using the ROV, these were processed as follows. After photographing, a small portion of the organism was dissected out and preserved in 99% molecular grade ethanol in individual Eppendorf capsules. These will undergo DNA analysis at NOC in order to obtain a 'genetic barcode' for each. After this, the remainder of the specimen was preserved in 10% buffered formaldehyde (borax) for species identification on return to NOC.

Table 10. Samples collected for molecular analysis.

Eppendorf label	Dive Number	Sampling Method	Contents
ABI 1	43	Suction sampler	Whole squat lobster
ABI 2			Scale worm
ABI 3			White bryozoan
ABI 4			Brachiopod 1 (brown)
ABI 5			Brachiopod 2 (white)
ABI 6			Anemone 1 (small, orange on coral)
ABI 7			Hydrozoan (thin, pale brown)
ABI 8			Coral (pink gorgonian)
ABI 9			Anemone 2 (small, yellow, found on bryozoan)
ABI 10		Biobox	Starfish gonad (paxillosid)
ABI 11			Same starfish – arm tip
ABI 12			Sponge 1 – beige, large, lots of spicules
ABI 13			Sponge 2 – brown, tabular form
ABI 15	50	Suction sampler	Anemone (*Anthomastus* sp. type)
ABI 16			Gorgonian 1 (bead necklace type)
ABI 17			Crinoid 1 (small, white)
ABI 18			Crinoid 2 (possibly *Anachalypsicrinus nefertiti*)
ABI 19			Gorgonian 2 (white, branching)
ABI 20	55	Biobox	Brisingid 1 – 9 arms
ABI 21			Brisingid 2 – 9 arms
ABI 22		Suction sampler	Brisingid 3 – 10 arms
ABI 23			Gorgonian – thin, pink polyps

Abigail Pattenden, Paul Tyler

Rates and pathways of carbon cycling by the sedimentary community (Leg 2).

Submarine canyons are hotspots of biodiversity (ROGERS et al 2003) and major pathways for the transport and burial of sediment and organic carbon from shelf depths to the deep-sea (PUIG et al. 1999, VAN WEERING et al. 2001). Canyons can act as temporary buffers for sediment and carbon storage (SCHMIDT et al. 2001), and soft sediments in canyons show higher oxygen uptake rates and organic carbon contents than comparable sites on the open slope (EPPING et al. 2002).). Rapid, episodic flushing of canyons may mobilise and transport large amounts of sediment into the abyssal plains (CANALS et al 2006), but the consequences of these events for benthic ecosystem functioning and resulting differences between canyon and slope ecosystems are largely unknown. During cruise D297 of RRS *Discovery* in 2005, a first geological and biological survey of both the Nazare and Setubal canyon systems was achieved (WEAVER 2005). Building on the results of this survey, a suite of *in situ* experiments was planned to address benthic food web structure and ecosystem functioning in these two canyon systems during JC010.

ROV deployable, autonomous benthic chamber modules (AROBICs – Aberdeen ROV Benthic Incubation Chambers), similar to those used on free-falling benthic landers (see e.g. Witte et al 2003), were used for pulse-chase experiments with isotopically (^{13}C/ ^{15}N) labelled phytodetritus. The tracer material is supplied by an injection unit mounted on the chamber lid. One hour after insertion of the chamber into the sediment, and its uptake, incorporation or respiration by benthic organisms as well as its subduction into the sediment are monitored. The chambers are sealed and at pre-programmed intervals during the incubation, a syringe water sampler removes 8 chamber water subsamples that allow us to quantify O_2, $DI^{13}C$ and nutrients fluxes across the sediment water interface. At the end of incubation, a shutter encloses the sediment before the chamber is slowly

removed from the sediment by its motor. This ensures that the complete sediment column in contact with the tracer is sampled and loss of labelled material is prevented, allowing establishment of a ^{13}C budget for each experiment. Water samples are processed for analysis of O_2 and $DI^{13}C$. Sediment is subsampled for analysis of prokaryote, meiofaunal and macrofauna abundance, biomass and isotope signatures as well as sedimentary $TO^{13}C$.
During JC010-2, the AROBIC chambers were deployed and recovered twice by means of elevator and ROV, at the 3500 m and 4300 m sites. Unfortunately, the first deployment at 4500 m failed completely. At the end of leg one the chambers were deployed again at the 3500 m site to be picked up at the beginning of JC010-3. However, these chambers were lost during recovery and no results were obtained.

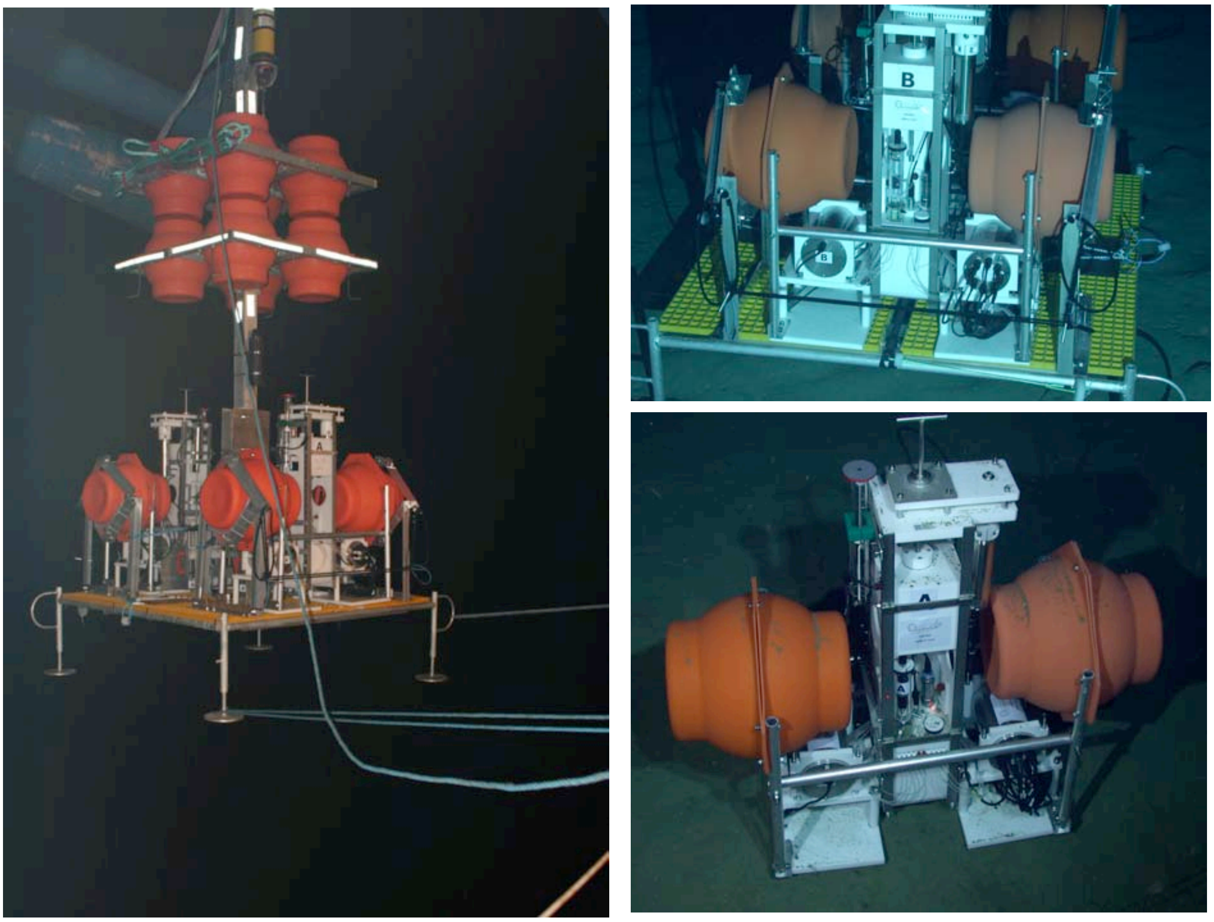


Figure 9. Deployment of the AROBICs using the free-fall elevator. Left: two AROBICs chambers on the elevator. Top right: close up of AROBICs on the elevator. Bottom right: AROBICs removed from the elevator and placed on the seabed using the ROV.

While the sediment community oxygen consumption (SCOC) was determined on board via Winkler titrations, the following analysis will be carried out: time series of DIC and $DI^{13}C$ in overlying chamber water; DIC and $DI^{13}C$ in porewater, uptake of labeled substrate by macrofauna (bulk 13C/ 15 N analysis of individual specimens, IRMS) and incorporation by bacteria (bacterial PLFAs, GC-c_IRMS).

In addition, background sediment samples were taken for analysis of natural stable isotope signatures of bacterial biomarkers (PLFAs), porewater DIC, sedimentary TOC and macrofauna.

Ursula Witte, Alan Jamieson

Benthic Sampling for microbiology (Leg 2)

Sediments from one station (JC10-84) in Setubal canyon and three stations (JC10-87, JC10-108, JC10-116) in Nazare canyon were collected by push cores during ROV dives. At all stations samples were collected for the following parameters: viral production, viral lysogenic fraction, organic matter degradation rates (measured as aminopeptidase, β-glucosidase and alkaline phosphatase enzymatic activities). Immediately after collection, sediment cores were transported to the cold laboratory and processed at *in situ* temperature.

To measure these parameters, onboard incubations were carried out. These included:

- measurements of bacterial enzymatic activities (by means of enzymatic cleavage of fluorogenic substrates and subsequent fluorometric determinations)
- measurement of viral production rates (following incubation with virus-free, 0.02 mm-filtered seawater)
- quantification of the viral lysogenic fraction (after incubation with Mytomicin C)

All incubations were carried out at *in situ* temperature and in the dark.

For other variables, the samples were stored at appropriate temperatures until return to UNIVPM laboratories, these variables include: chloroplastic pigments, total/soluble proteins, total/soluble carbohydrates, total lipids, sediment granulometry, bacterial biodiversity (assessed using molecular methods, such as Fluorescent *in situ* Hybridisation, Terminal–Restriction Fragment Length Polymorphisms and Automated Ribosomal Intergenic Spacer Analysis), total/active bacterial abundance, total viral abundance.

Silvia Bianchelli, Teresa Amaro

Molpadiid holothurian experiment (Leg 2)

Molpadiid holothurians occur in extremely high abundances at about 3500 m in the Nazare Canyon. These burrowing deposit feeders appear to be ideally suited to reworking OM in unstable canyon sediments. Preliminary results showed that there was no evidence for a specialised enteric bacterial community. This may indicate that the holothurians use the bacterial community present in the sediment to assist in the degradation of the organic material, or that the holothurians rework the sediment so intensively that enteric bacterial populations were introduced into the sediment. In order to look in more detail at the trophic interactions between these molpadiid holothurians with ingested and/or enteric sediment microbes, an experiment was planned using ISIS to look at the bacterial community present in the faecal material from these molpadiids. Three experiments were undertaken at ca. 3500 m at the Nazare canyon (Table 11).

Table 11 – List of ROV dive stations associated with the holothurian experiment in Nazare Canyon

Station	Leg	Dive	Gear	Date	Latitude	Longitude	Depth (m)
JC10-090	2	46	ISIS-Holothurian chambers	09.06.07	39°29.826N	10°55.890W	3534
JC10-091	2	48	ISIS-Holothurian chambers	12.06.07	39°29.822N	09°55.980W	3534
JC10-121	2	56	ISIS-Holothurian chambers	20.06.07	39°29.851N	09°55.822W	3508

During each dive, the ISIS ROV used a scoop to catch 5 *M. musculus* and put one specimen into each compartment. After 2 or 4 days, the vials with the faecal material were closed and the device was retrieved. When on board, each vial with faecal material was frozen at -80 ^{o}C. The five *M. musculus* were immediately dissected in a temperature-controlled room. In each case the gut was taken out and immediately placed in a sterilized Petri dish for further analysis in the lab. With a sterilized spatula a small sample of sediment was taken out of three different parts of the gut. Each sample was put in a small jar and stored at -80^{o} C freezer.

Immediately adjacent to the experiment, 20 *M. musculus* were caught with the ROV scoop and put in the biobox. In the temperature-controlled laboratory, each specimen was dissected and each gut taken out. A small sample of sediment was also taken in each compartment of the gut and stored in the -80^{o}C freezer. Moreover, nine push cores from the surrounding sediment were taken. These cores were immediately brought to the temperature-controlled laboratory to be processed. The sediment in the cores was extruded and sliced in layers to investigate the bacteria community with sediment depth: 0-1, 1-3, 3-5, 5-10, 10-15, 15-20 cm. Slices were immediately frozen at - 80^{o} C.

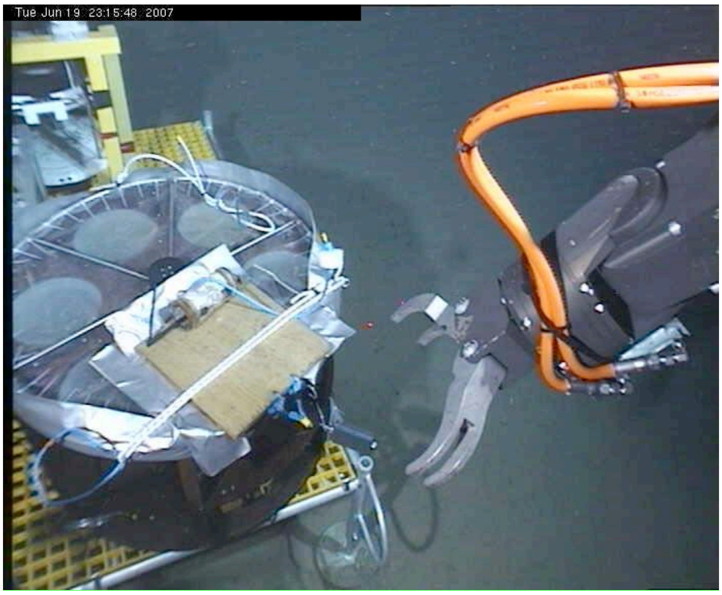


Figure 10. Holothurian experimental chambers at 3500 m in the Nazare Canyon.

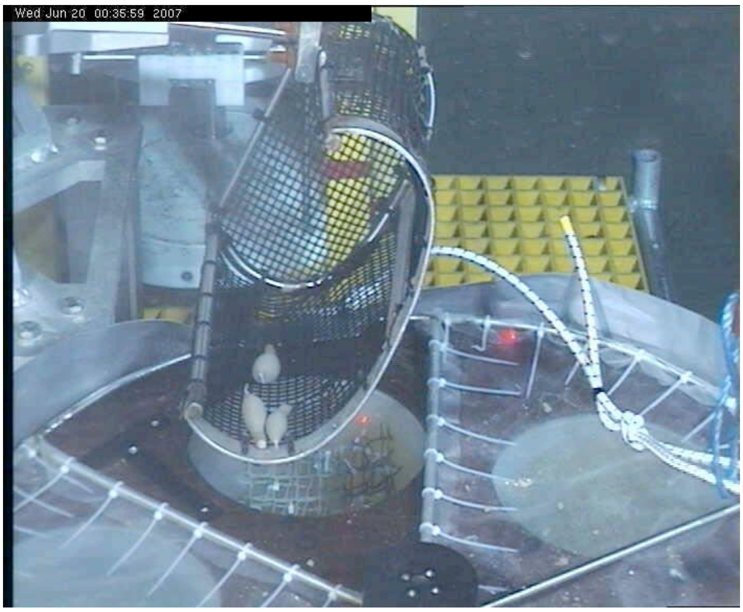


Figure 11. ISIS scoop putting *M. musculus* in each chamber of the experimental apparatus

Teresa Amaro

Bathysnap (Legs 2 and 3)

A single bathysnap time lapse camera system with a current meter attached was deployed for a period of almost 17 days in Nazare Canyon at 4353 m. The system had to be deployed in freefall mode since it was too heavy for the ROV and/or elevators. However, it was visited by the ROV and could be seen to have landed within a field of small sediment ripples at the edge of the canyon thalweg. On recovery, the current meter showed a dominance of low currents (<10 cm s^{-1}) with a distinct tidal periodicity.

Table 12. Bathysnap deployment details

Station	Latitude	Longitude	Depth (m)	Start date (time)	End time
JC10-086	39°34.35N	10°17.86W	4353	07/06/07 (1144)	24/06/07 (1338)

Ben Boorman, Doug Masson

ROV swath bathymetry processing (Legs 2 & 3)

Localised and detailed bathymetry surveys were carried out with the Kongsberg SM2000 system mounted onto the ISIS ROV. This high-resolution multibeam system runs at a frequency of 200 kHz and has 128 beams, spaced with equal angles over a total of 120°.

Three areas were surveyed during Leg 2 and one during Leg 3: one in the Setubal Canyon (ca. 0.452 km^2 at about 1400m depth), two in Nazare Canyon (0.394 km^2 at ca. 3400 m depth and 0.425 km^2 at 4300m depth) and one in Cascais Canyon (0.144 km^2 at 4600m depth). The first survey was intended as a test of the system in the canyon environment. Initially the survey lines were chosen parallel to the contours, as in traditional ship-borne multibeam surveys. However, for the other sites the strategy was changed to minimise the height differences within single pings (and hence the resolution of the final grid).

Previous experience during JC010 Leg 1 had shown that the best results are obtained when recording data at ca. 20 m above the seabed, travelling at a speed of ca. 0.4 knots. This setup was chosen for the two Nazare sites and the site in Cascais Canyon, but for the first survey the ROV was kept at an average height of ca 40 m above the bed. The theoretical swath width at 20 m is 70 m (140 m at 40 m height), but the line spacing was set to a conservative 40 m (80 m), in order to ensure sufficient overlap, full coverage and sufficient resolution.

Processing was carried out using the IFREMER software suite 'Caraibes', which has been adapted to handle the ISIS SM2000 data. The onboard processing steps were limited to the essential routines in order to create working maps for further dive planning and initial interpretation of the area. Detailed processing will be carried out at base.

The processing steps included importation of navigation, immersion and bathymetry data, basic filtering, basic manual cleaning using the module 'Odicce', DTM creation and export to ArcGIS. For the Setubal site the USBL navigation was used (after smoothing). For the two sites in Nazare Canyon and the site in Cascais Canyon we had to use the Doppler navigation, as the USBL data became too irregular due to the great depth. However, the Doppler system did lose bottom contact a few times on the steep canyon walls and had to be reset to an average USBL position after every survey line. Hence, in addition the data had to be rubber-sheeted with the module 'RegBat'. During the last survey the Doppler system experienced a drift of ca. 5.5 degrees eastward (corrected during survey line 6), and navigation had to be carried out by USBL. Still, the Doppler data was used for processing of the bathymetry, after rubber sheeting to the correct USBL start and end positions (also helped by feature linking between the different tracks).

One major processing issue is a repeatedly occurring problem of across-track striping. Although this problem was investigated in detail, no clear source was found. It may be related to pitch or heave of the vehicle, or to an irregular time delay between the systems, and increases *in situ*ations where the ROV experiences tug on the wire from the ship. The problem seems to occur especially when the ship is behind the ROV during the survey. Further detailed analysis is necessary to identify source and rectify problem. So far the best processing results have been obtained when 'heave' and 'pitch' were removed from the data (set to 0 values within the 'Corat' module)

During the surveys, the incoming data was broadcast in real-time to the tracking system 'Sumatra' to be displayed (in uncorrected form) on the interactive map. The performance of the system was intermittent, even after installation of a new version of the software. It is not clear what causes the irregular performance, and the investigations into the software continued during Leg3 of JC010. The last version obtained from Ifremer (beginning of Leg 3) appeared fairly stable, and did indeed provide a good help in real-time assessment of the multibeam coverage.

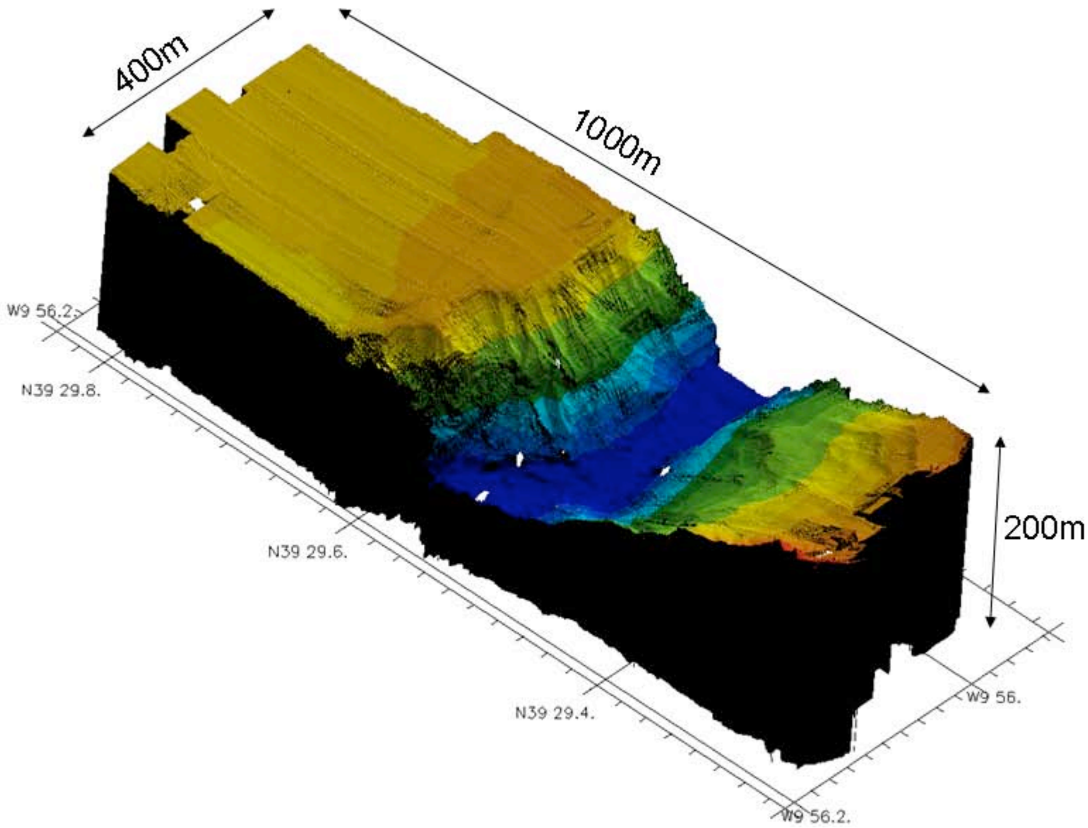


Figure 12. Nazare Canyon, 3400 m site. 3D view of high-resolution ROV bathymetry over part of the canyon thalweg with no vertical exaggeration. Preliminary on-board processing results.

Veerle Huvenne

Megacoring for sampling of macrofauna (Legs 2 and 3)

Two stations from each of two depths (ca. 3400 m and 4300 m) were sampled for macrofauna in the Nazare Canyon using the Megacorer. At each station 3 to 4 replicates were sampled (Table 13).

One station from 3400 m was also sampled for macrofauna in Cascais Canyon, and one station was sampled for macrofauna in the slope areas (Table 13). A total of 9 megacores were taken.

The upper 20 cm of the sediment were sampled in six sediment layers, 0-1, 1-3, 3-5, 5-10, 10-15, 15-20 cm. In some of the sites, just the upper 10 cm were sampled. Various foraminifera were picked up off from the sediment surface using forceps.

The sediment layers 0-1 and 1-3 cm were placed immediately in formalin, prior to sieving. Each sediment layer was carefully washed with seawater through 300 and 500 um sieves, including the overlying water with the 0-1 cm sample. The sieved material was fixed immediately in 10% buffered formalin in seawater.

Table 13 - List of megacores station completed during JC10 Legs2 and 3.

Station	Date	Location	Latitude	Longitude	Depth (m)	Number of cores	Depth sampled (cm)
JC10-089	09.06.07	Nazare Canyon	39°34.71N	10°18.11W	4355	6	20
JC10-93	11.06.07	Nazare Canyon	39°30.045N	9°55.882W	3447	6	20
JC10-100	14.06.07	Nazare Canyon	39°30.045N	09°55.881W	3462	8	20
JC10-101	14.06.07	Nazare Canyon	39°30.05N	09°55.88W	3466	7	20
JC10-122	20.06.07	Nazare Canyon	39°30.05N	09°55.88W	3461	6	20
JC10-124	20.06.07	Slope S of Nazare	39°10.37N	10°11.64W	896	2	10
JC10-128	24.06.07	Nazare Canyon	39°34.711N	10°18.113W	4368	8	15
JC10-129	24.06.07	Nazare Canyon	39°34.711N	10°18.113W	4370	7	20
JC10-132	26.06.07	Slope N of Nazare	39°38.798N	9°58.123W	1968	6	21-39
JC10-133	26.06.07	Slope N of Nazare	39°39.330N	9°43.650W	1445	6	5-15
JC10-136	27.06.07	Slope N of Nazare	39°43.080N	9°37.570W	670	6	23-38
JC10-138	27.06.07	Cascais Canyon	38°19.975N	9°49.282W	3640	6	15
JC10-146	02/07/07	Whittard Canyon	47°50.47N	10°12.95W	3872	6	11.5-17

Teresa Amaro

Foraminiferal samples and xenophyophores (Legs 2 and 3)

Push cores collected by the ROV, and multicore-sized cores collected by the megacorer, were used for studies of foraminifera (Table 14). At most stations, the surficial sediment (usually upper 2 cm) was sliced off, sieved on a 125 µm mesh in chilled water and selected foraminifera extracted for molecular analyses under a binocular microscope. 115 species were frozen in liquid nitrogen (LN), 42 placed in guanidine buffer and 40 mounted on dry slides. Reference specimens were fixed in formalin. At some stations, a subsample of surficial sediment, either unsieved or the <125 µm fraction, was frozen at - 80ºC or in LN as an ‘environmental sample’. All samples and specimens for molecular analyses were kept chilled on ice or in a refrigerator until preservation.

Pushcore and multi-sized megacore samples from selected sites in the Cascais, Lisbon, Nazare and Whittard canyons were sliced into horizontal layers down to a depth of either 5 cm (0-1, 1-2, 2-3, 3-4, 4-5 cm) or 10 cm (0-0.5, 0.5-1.0, 1.0-1.5, 1.5-2.0, 2-3, 3-4, 4-5, 5-6, 6-7, 7-8, 8-9, 9-10 cm). Each layer was fixed in 10% buffered formalin for faunal studies (Table 14).

Table 14. Samples collected for foraminiferal and xenophyophore studies

Dive/gear	Station JC10-	Canyon	Depth (m)	Sorted	Fixed 0-10 cm	Fixed 0-5 cm	Frozen sediment	Xenos
Leg 2								
42	77	Lisbon	568	PUC03		PUC04		
43	80	Lisbon	1050			PUC06		
43	80	Lisbon	1259			PUC05		
43	80	Lisbon	1455			PUC03		
Mega	89	Nazare	4368	0-2 cm		0-3 cm		
46	91	Nazare	3535	PUC02				
47	92	Nazare	4358			PUC06		
47	92	Nazare	4356					5
Mega	100	Nazare	3462			1 multi		
Mega	101	Nazare	3460	0-2 cm				
52	108	Nazare	1414	PUC05				
53	111	Nazare	2194	PUC04		PUC03		
53	111	Nazare	1555					1
55	116	Nazare	661	PUC05	PUC01			
Leg 3								
Mega	122	Nazare	3461	0-2 cm		1 multi		
Mega	124	Slope	896			1 mega		
57	127	Nazare		PUC05			PUC04	
Mega	128	Nazare	4365				0-2 cm	3
58	130	Nazare	4356					1
58	130	Nazare	4347				0-2 cm	1
Mega	132	Slope	1968		1 multi			
Mega	133	Slope	1445	1 multi	1 multi	1 multi		
Mega	136	Slope	670		1 multi	1 multi		
60	139	Lisbon	1664	PUC08				
60	139	Lisbon	1187			PUC10		
61	142	Setubal	2226	PUC09				
62	144	Cascais	4576	PUC10	PUC11		<125 µm	
Mega	146	Whittard	3872	Multi			<125 µm	
63	147	Whittard	4003					2
63	147	Whittard	3751	PUC01			<125 µm	
63	147	Whittard	3742		PUC05			
64	148	Whittard	3396	PUC01			<125 µm	
65	149	Whittard	466	PUC12			<125 µm	

Xenophyophores were collected either with box cores deployed from the ROV or fortuitously in megacore samples (Table 15). Two species were present at the 4300 m Nazare Canyon site. The most visibly conspicuous species on the seafloor had a large, hemispherical test consisting of curved, branching, plate-like elements separated by deep open spaces and resembling a human brain. Its generic placement is problematic. Large specimens resemble *Reticulammina* but small individuals obtained during Discovery cruise 297 comprised a single, often fan-shaped plate and were more reminiscent of the genus *Galatheammina.* The other species at this site was *Aschemonella ramuliformis,* first described by Brady (1884) based on material collected during the *Challenger* expedition and widely reported since then in several oceans. However, in the past, it has always been collected as fragments. Samples and *in situ* photographs taken in the Nazare canyon reveal that this species forms patches of various sizes on the seafloor, each patch consisting of a thicket of irregularly-shaped, branching tubes which project from the sediment surface. When teased apart, these clusters of tubules were found to include a number of separate interlocking individuals.

A third species was photographed clinging to a very steep slope in the upper part of the Nazare canyon. It was photographed *in situ* and an attempt was made to collect a specimen using the butterfly net. On recovery, there was no sign of the xenophyophore when the sediment inside the net was first examined. However, the sieved residue contained large numbers of tiny tubular fragments, presumably derived from the xenophyophore. These and the *in situ* photographs suggest that it was a species of *Syringammina.* Two specimens of an interesting new species were collected by the ROV in the deep part of the Whittard canyon. The outer region of the hemispherical test was characterised by thick, lobed ridges whereas the inner part consisted of a system of bars and perforated plate-like elements. The hollow test interior suggests that this species may also be related to *Syringammina*, although it lacks the regularity typical of this genus.

Table 15. Xenophyophores collected or observed

Stn JC10-	**Depth (m)**	**?*Reticulammina* sp.**	***Aschemonella ramuliformis***	***Syringammina* sp. 1**	**?*Syringammina* sp. 2**
92	4358	3 specimens in box cores; *in situ* photographs	2 tube clusters in box cores; *in situ* photographs		
111	1555			*In situ* photos; numerous tiny fragments of one individual collected	
128	4365		Clusters of tubes on 3 megacores		
130	4347, 4356	1 specimen preserved, 1 frozen (-80ºC); *in situ* photographs.			
147	4003				2 specimens photographed *in situ* and collected with ROV box core

Andy Gooday (NOCS)

An in-situ ^{13}C feeding experiment in the Nazare Canyon: unravelling selectivity and anomalous nematode feeding strategies (Legs 2 and 3).

Selective uptake by free-living nematodes in canyon ecosystems was investigated by in-situ addition of ^{13}C-labeled food sources (bacteria and diatoms; *Sceletonema* sp.). This in-situ enrichment experiment will enable us to unravel differences in structural and functional nematode diversity reflected in natural ^{13}C isotope abundances. Important questions to be answered are: Are nematodes what they eat? On what do canyon nematodes feed and do they feed on different sources than slope nematodes? Is there a nematode community shift linked to food availability and food preferences typical for canyons? Canyon nematodes, what's on their menu?

The ISIS ROV deployed 9 experimental units on the sea bottom at ca. 3500 m depth after which two kinds of ^{13}C-labelled food sources were injected. Six reference push cores were taken adjacent to the experimental site to investigate community structure and environmental parameters (CPE, org C/N, grain size). We mimicked the observed C-flux data for the experimental site and recalculated it for the duration of the experiment. The tubes are sealed at the top with a semi-permeable membrane to avoid organic influx and biological disturbance during the duration of the experiment.

After 0.5 (T1), 5.5 (T2) and 13.5 (T3) days of incubation, push cores were taken within the experimental unit tubes so uptake could be investigated through time. All experimental samples and samples for environmental variables were sliced (0-1, 1-2, 2-3, 3-4, 4-5 cm). The slices were placed in Petri dishes, wrapped in aluminium foil and stored at -20°C. The experimental samples will be analysed for natural and enriched stable C isotopes and fatty acids. The samples for environmental variables will be analysed for CPE (chlorophyll a and pigment breakdown products), sediment grain size and C/N ratio/content.

In addition to the experiments, various samples were taken for metazoan meiofaunal analysis (Table 16). These cores were brought to the temperature-controlled laboratory to be processed. The sediment was extruded and sliced in layers to investigate community variability with sediment depth: 0-1, 1-2, 3-4, 4-5 cm. The slices were washed into 250 ml bottles and fixed with borax-buffered formalin (end concentration at least 4%). In the laboratory the samples will be rinsed over 1000 and 32 µm mesh-sieves. Following a standard protocol, the samples will be re-suspended and centrifuged with the colloidal silica gel LUDOX HS 40% to separate the meiofaunal organisms from the surrounding sediment. After staining with Rose Bengal, all metazoan meiobenthic organisms will be classified at higher taxon level and counted under a stereoscopic microscope. Nematodes will be picked out and transferred ß an alcohol-glycerin solution to glycerine and mounted on glass slides. Nematodes will be identified to genus/species level.

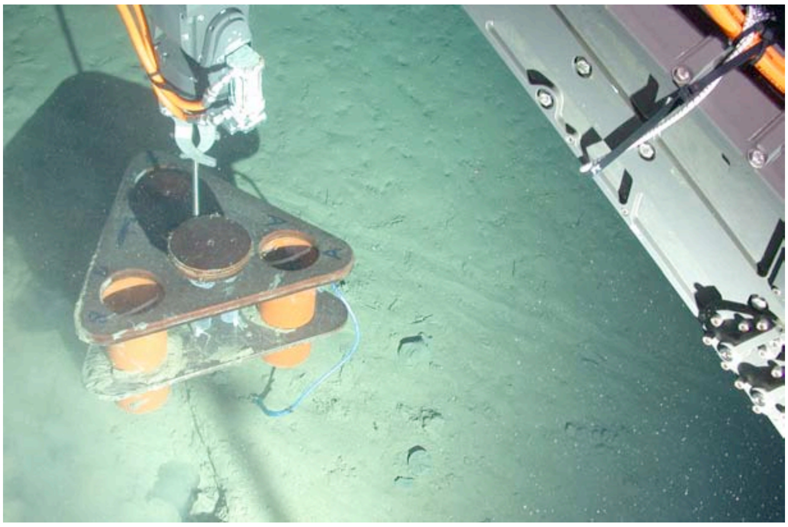


Figure 13. Deployment of experimental unit on sea floor

Figure 14. Close up of injection module

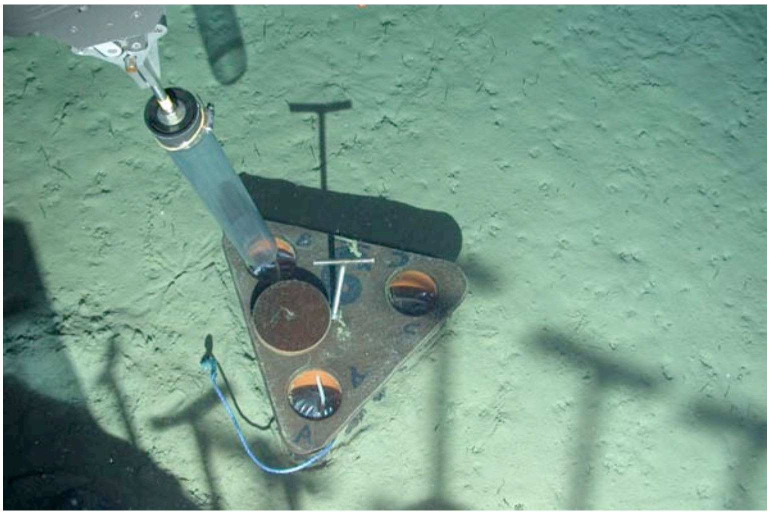


Figure 15. Subsampling with ROV push core

*Table 16. Samples collected by the University of Gent for analysis of metazoan meiofauna and during the in-situ ^{13}C feeding experiment. Me = Meiofauna, MeMe = Metazoan Meiofauna Exb = experimental background, Faun = fauna, Env = environmental variables, Exp = experiment, bact = bacteria, diat = diatoms, con = control. * = processed core length (total core length not recorded).*

Station JC10-	Canyon	Dive no.	Depth (m)	Analysis	Storage	Comments	length (cm)
77-PUC04	Lisbon	42	568	Me	Formalin		21.5
87-PUC03	Nazare	45	4356	Me	Formalin		18
87-PUC07	Nazare	45	4357	Me	Formalin		17
92-PUC05	Nazare	47	4358	Me	Formalin		15
95-PUC02	Nazare	48	3512	Exb, Faun	Formalin		19
95-PUC03	Nazare	48	3512	Exb, Faun	Formalin		21.5
95-PUC04	Nazare	48	3512	Exb, Env	-20°C		10
95-PUC05	Nazare	48	3512	Exb, Env	-20°C		18
95-PUC06	Nazare	48	3512	Exb, Env	-20°C		20
95-PUC09	Nazare	48	3512	Exb, Faun	Formalin		17.5
95-PUC10	Nazare	48	3514	Exp. T1 unit 7a	-20°C	control	11.5
95-PUC11	Nazare	48	3514	Exp. T1 unit 7c	-20°C	failed (bact)	0
95-PUC12	Nazare	48	3514	Exp. T1 unit 7b	-20°C	diatoms	16
95-PUC11	Nazare	48	3514	Exp. T1 unit 7c	-20°C	repeat (bact)	21
95-PUC13	Nazare	48	3514	Exp. T1 unit 8a	-20°C	failed (cont)	0
95-PUC14	Nazare	48	3514	Exp. T1 unit 8b	-20°C	diatoms	14
95-PUC15	Nazare	48	3514	Exp. T1 unit 8c	-20°C	failed (bact)	3
95-PUC16	Nazare	48	3515	Exp. T1 unit 4b	-20°C	failed (diat)	0
95-PUC17	Nazare	48	3515	Exp. T1 unit 4c	-20°C	bacteria	3
95-PUC18	Nazare	48	3515	Exp. T1 unit 4a	-20°C	control	20.5
111-PUC02	Nazare	53	2195	MeMe	Formalin	water lost	30
111-PUC05	Nazare	53	1685	MeMe	Formalin		19.5
111-PUC06	Nazare	53	1003	Me	Formalin		17
112-PUC06	Nazare	54	3514	Exp. T2 unit 9b	-20°C	diatoms	21
112-PUC07	Nazare	54	3514	Exp. T2 unit 9c	-20°C	bacteria	18
112-PUC08	Nazare	54	3514	Exp. T2 unit 9a	-20°C	control	16.5
112-PUC09	Nazare	54	3514	Exp. T2 unit 1c	-20°C	failed (bact)	0
112-PUC10	Nazare	54	3514	Exp. T2 unit 1b	-20°C	diatoms	19

112-PUC11	Nazare	54	3517	Exp. T2 unit 1a	-20°C	control	15
112-PUC12	Nazare	54	3518	Exp. T2 unit 2c	-20°C	failed (bact)	0
112-PUC13	Nazare	54	3519	Exp. T2 unit 2a	-20°C	failed (diat)	0
112-PUC14	Nazare	54	3520	Exp. T2 unit 2b	-20°C	failed (cont)	0
131-PUC03	Nazare	59	3517	Exp. T3 unit 5C	-20°C	bacteria	5*
131-PUC04	Nazare	59	3517	Exp. T3 unit 5B	-20°C	diatoms	5*
131-PUC05	Nazare	59	3517	Exp. T3 unit 5A	-20°C	control	5*
131-PUC06	Nazare	59	3517	Exp. T3 unit 6C	-20°C	bacteria	5*
131-PUC07	Nazare	59	3517	Exp. T3 unit 6B	-20°C	diatoms	5*
131-PUC08	Nazare	59	3517	Exp. T3 unit 6A	-20°C	failed (cont)	0
131-PUC09	Nazare	59	3517	Exp. T3 unit 3B	-20°C	failed (diat)	0
131-PUC10	Nazare	59	3517	Exp. T3 unit 3C	-20°C	failed (bact)	0
131-PUC11	Nazare	59	3517	Exp. T3 unit 3A	-20°C	failed (cont)	0
132-Mega1	Nazare		1970	Me	Formalin		39
132-Mega2	Nazare		1970	Me	Formalin	disturbed	21
132-Mega3	Nazare		1970	Me	Formalin	disturbed	22
133-Mega1	Nazare		1445	Me	Formalin	sub-sampled large diam core	5*
136-Mega1	Nazare		672	Me	Formalin		5*
139-PUC11	Cascais	60	1187	Me	Formalin	animal burrow?	20
139-PUC9	Cascais	60	1664	Me	Formalin		5*
142-PUC5		61	2226	Me	Formalin		5*
146-Mega1	Whittard		3872	Me, Env	Formalin/ -20°C	sub-sampled large diam core	12
146-Mega2	Whittard		3872	Me, Env	Formalin/ -20°C	sub-sampled large diam core	12
147-PUC4	Whittard	63	3945	Me	Formalin		5*
147-PUC6	Whittard	63	3742	Me	Formalin		5*
147-PUC12	Whittard	63	3742	Me	Formalin		5*

Jeroen Ingels and Wouter Willems

Benthic Incubation Chambers (Legs 2 and 3)

The Benthic Incubation Chamber System 2 (BICS2) is a respirometer system used to measure the respiration rate of deep-sea megafauna. It was deployed 5 times during cruise JC10 (Table 17). BICS2 is comprised of two water-tight respirometry chambers (~14 L each) housed within an external protective frame. One Aanderaa Oxygen Optode 3975 is present inside both chambers, and measures the oxygen concentration and temperature of the enclosed water. The optodes are rated to 6000 m, the maximum depth of deployment of BICS2. The O_2 measurements are logged via an RS232 link through a custom built TT8 controller to a flash card and recorded in text file format. The chambers' frame is composed of glass reinforced plastic (GRP) with dimensions 1000 mm x 580 mm x 642 mm. In air, BICS2 weighs 78 kg with empty chambers and 113 kg when full; in water it weighs 33 kg. BICS2 is deployed by ROV elevator and remains attached to the elevator throughout the deployment. When at the seafloor the ROV searches for suitable animals for use in BICS2, which are picked up by collection scoop and deposited into the chambers. The lids are closed by the ROV turning the t-handles in an anticlockwise direction. The chamber is activated when the push switch is pressed and is confirmed as activated by an LED flashing.

During JC10 Leg 2, BICS2 was deployed 4 times. At the start of Leg 2 it was discovered that one of the optodes (#551) had leaked during its deployment on the trials cruise (JC09T) and was unusable. During deployment 1 optodes #552 and #734 (on loan from Oceanlab) were used. For deployments 2-4 only one optode (#552), and hence one chamber, was used.

During Leg 3 BICS2 was deployed for a fifth time, with an optode in both chambers (#552 and #582 (Oceanlab)). A holothurian was collected and placed in each chamber. Upon recovery it was discovered that the titanium chamber housing the electronic equipment had leaked. Initial inspections revealed that one of the end cap o-rings had been forced up into the chamber. The data recorded from optode #552 was corrupt, but was rescued. No data was recorded from optode #582. No further deployments of BICS2 were made. Shore based investigations revealed that the end caps to the titanium pressure housing were too narrow for the housing cylinder; it is presumed that this fault caused the failure of the pressure housing during JC09T.

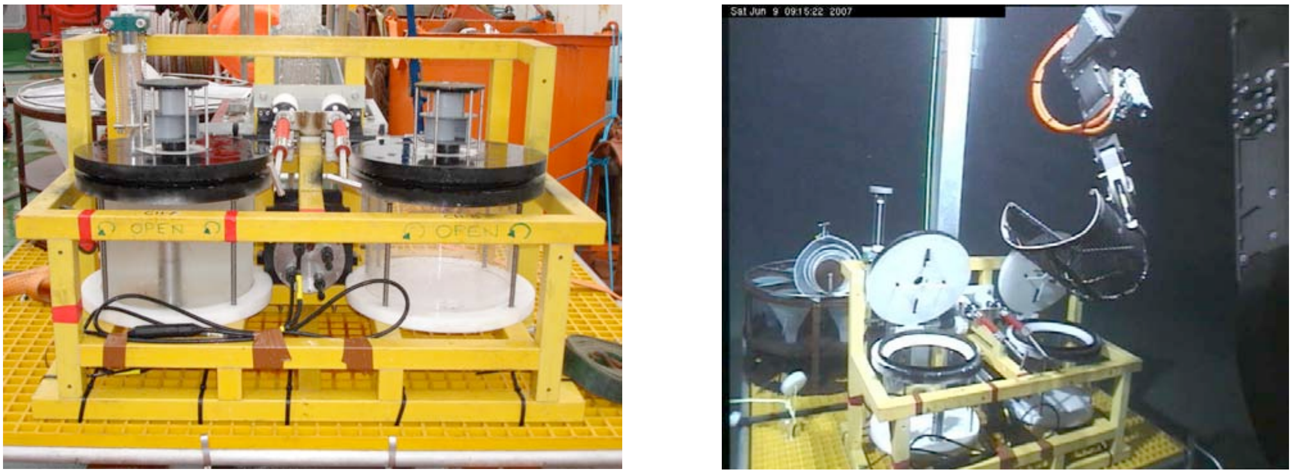


Figure 16. Left: BICS2 on deck after deployment, attached to the elevator by cable ties and jubilee clips. The titanium pressure housing is flanked either side by a respiration chamber, only the left chamber contains an optode and is in use. Right: BICS 2 at the seabed during deployment 1; it is deployed on the elevator with the chamber lids open. The right hand ROV manipulator is in view; the collection scoop being held contains a starfish ready for placement in a respiration chamber.

Table 17. Summary of BICS2 deployments

BICS2	Date / Power on Start time	Elevator Station No.	ROV Dive No.	Location of BICS2	Depth (m)	Deployment length (h)	Species Targeted
1	06/06/07 07:43	JC10_083	44	38º 16.017 09º 09.936	1451	12	Control / Starfish
2	09/06/07 09:25	JC10_090	46	39º 29.821 09º 55.984	3534	103	Brittlestar *Ophiura* sp.
3	15/06/07 10:21	JC10_106	51	39º 29.809 09º 55.753	3497	58	Brittlestar *Ophiura* sp.
4	19/06/07 22:33	JC10_119	56	39º 29.831 09º 55.820	3507	140	Brittlestar *Ophiura* sp.
5	28/06/07 13:31*	JC10_143	61	38º 14.362 09º 23.629	2226	17	Holothurian *Zygothuria lactea*

* BICS was powered up prior to entry to the water during deployment 5.

BICS2 was a second design following the original Oceanlab BICS design (see Jamieson et al., 2005 Cruise Report TN-187). The second design was carried out in order to correct the sealing of the lid and to include a stirring mechanism. During JC10, however, it became apparent that the new mechanism for closing the lids was somewhat "over engineered". It is recommended that any future in-situ ROV deployed equipment is designed by personnel who have research based sea-going experience of working with a scientific ROV, and that a simple construction is best (i.e. bungee cords and a counter weight system for closing lids on chambers).

Sarah Murty and Ben Boorman

Suspended Organic Particles and Sediment Organic Biogeochemistry (Legs 2 and 3)

Sampling of Suspended Particulate Organic Matter (sPOM)

Suspended particles were collected on large (293mm diameter) precombusted (400ºC; 4 h) GF/F filters along the Lisbon, Setubal and Nazare Canyons on the Portuguese Margin (Legs 2 and 3) and the Whittard Canyon on the Irish Margin (Leg 3) using stand alone pumping systems (SAPS; Challenger Oceanic, NOCS; Table 18). Each SAPS carried two stacked filters, the bottom one being used as a DOM adsorption blank. Two SAPS were used on the same deployment; the first was deployed at the BBL (i.e. 10-20 m above bottom (ab)) and the other at selected depths. The choice of the depths was based on the water structure of CTD profiles (Figure 17) that were carried out immediately or soon before the SAPS deployments at the same or nearby stations. The pumps were operated for 1-2 hours depending on depth and particle loading as estimated by the BBRTD sensors of the CTD (purple or brown traces; Figure 17). On recovery, both SAPS filters were folded, wrapped in separate pre-combusted (400ºC; 4 h) foil and stored in -80ºC for the duration of the cruise. Elemental, chlorophyll, lipid and isotopic analyses will be carried out after freeze drying of the filters in the laboratory

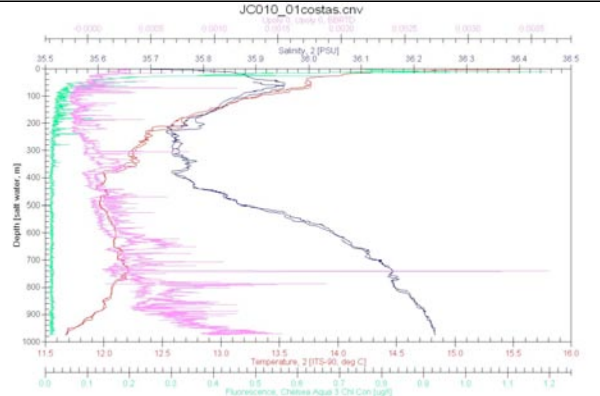
Sediment sampling

Sediment cores were collected using the ISIS ROV from various depths of the Lisbon, Setubal and Nazare canyons. Some of the cores were frozen upon recovery, extruded when still frozen, wrapped in pre-combusted (400ºC; 4 h) foil and stored in -80ºC for the duration of the cruise. Others were sliced at 4ºC soon after recovery and then frozen at -80ºC for the rest of the cruise. The slices were every 0.5 cm down to 1 cm, every 1 cm down to 6 cm and every 2 cm down to 10 cm. On return to the laboratory the cores will be analysed for organic carbon, nitrogen, lipids and chlorophyll.

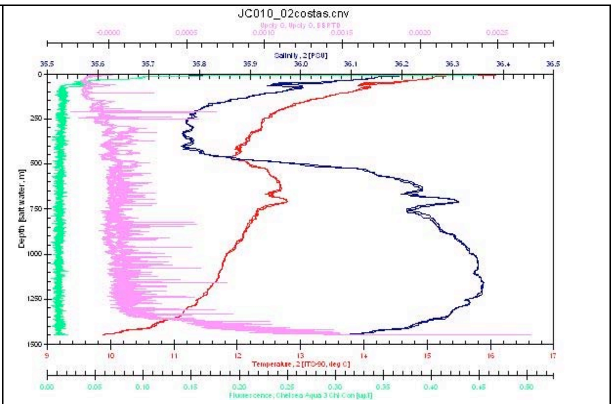
Table 18. Sampling of suspended particulate material (SAPS SPM) and sediment cores (ROV and Megacorer) for organic analyses during JC 10. The CTD stations relating to the SAPS deployments are also presented (for more details on CTD deployments see appropriate section in the report).

Date	Station JC10	Position and depth (m)	Gear/ sample	Longitude	Latitude	Water depth (m)	Pump depth (SAPS) m	Volume (l)
LEG 2								
04/06/07	77	Lisbon 1000	ROV Core	38°26.365	09°19.221	996		
05/06/07	78	Lisbon 1000	CTD	38°26.84	09°19.23	989		
05/06/07	79	Lisbon 1000	SAPS SPM	38°26.838	09°19.235	984	10 above bottom (ab)	682
05/06/07	79	Lisbon 1000	SAPS SPM	38°26.838	09°19.235	984	50	650
05/06/07	80	Setubal 1400	ROV Core	38°15.951	09°10.152	1455		
05/06/07	81	Setubal 1400	CTD	38°16.045	09°10.152	1437		
05/06/07	82	Setubal 1400	SAPS SPM	38°16.056	09°10.152	1440	10ab	770

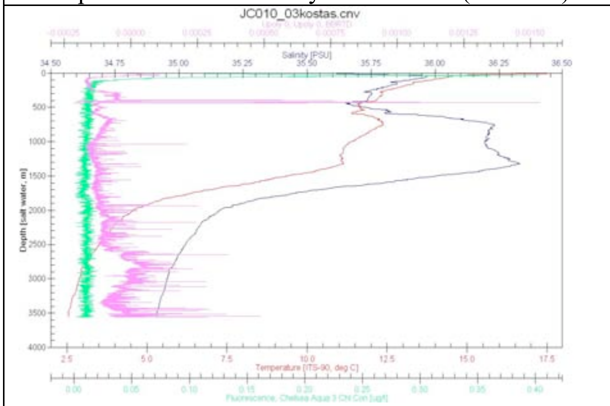
05/06/07	82	Setubal 1400	SAPS SPM	38°16.053	09°10.154	1440	20	726
10/06/07	91	Nazare 3400	ROV Core	39°29.822	09°55.985	3535		
11/06/07	92	Nazare 4300	ROV Core	39°34.197	10°18.199	4369		
11/06/07	92	Nazare 4300	ROV Core	39°34.157	10°18.234	4357		
12/06/07	96	Nazare 3400	CTD	39°29.485	09°56.05	3664		
13/06/07	97	Nazare 3400	SAPS SPM	39°29.486	09°56.047	3640	10ab	1433
13/06/07	97	Nazare 3400	SAPS SPM	39°29.487	09°56.047	3640	30	465
15/06/07	107	Nazare 1800	CTD	39°31.266	09°33.917	1751		
16/06/07	108	Nazare 1400	ROV Core	39°30.997	09°33.413	1415		
16/06/07	109	Nazare 1800	SAPS SPM	39°31.263	09°33.915	1822	10ab	426
16/06/07	109	Nazare 1800	SAPS SPM	39°31.263	09°33.915	1822	1550	683
16/06/07	110	Nazare 2200	CTD	39°30.253	09°39.353	2214		
17/06/07	111	Nazare 2000	ROV Core	39°30.485	09°39.427	2195		
18/06/07	113	Nazare 2500	SAPS SPM	39°30.251	09°39.354	2470	10ab	112
18/06/07	113	Nazare 2500	SAPS SPM	39°30.251	09°39.354	2470	2070	635
18/06/07	114	Nazare 700	CTD	39°35.082	09°24.136	729		
18/06/07	115	Nazare 1100	SAPS SPM	39°36.062	09°24.087	1140	10ab	366
18/06/07	115	Nazare 1100	SAPS SPM	39°36.069	09°24.087	1140	30	408
19/06/07	116	Nazare 700	ROV Core	36°36.672	09°23.943	661		
19/06/07	117	Nazare 3000	CTD	39°31.334	09°46.131	2953		
19/06/07	118	Nazare 3000	SAPS SPM	39°31.331	09°46.130	2953	10ab	1442
19/06/07	118	Nazare 3000	SAPS SPM	39°31.331	09°46.132	2953	1700	1588
20/06/07	121	Nazare 3400	ROV Core	39°29.949	09°56.189	3535		
20/06/07	119	Nazare 3400	ROV Core	39°29.611	09°55.858	3400		
20/06/07	123	Open slope	CTD	39°10.369	10°11.636	898		
20/06/07	124	Open slope	Mega Core	39°10.369	10°11.636	898		
20/06/07	125	Open slope	SAPS SPM	39°10.367	10°11.636	898	10ab	1715
20/06/07	125	Open slope	SAPS SPM	39°10.367	10°11.636	898	55	645
LEG 3								
24/06/07	128	Nazare 4300	Mega Core	39° 34.711	10°18.113	4369		
24/06/07	129	Nazare 4300	Mega Core	39° 34.712	10°18.115	4363		
26/06/07	132	Open Slope	Mega Core	39°38.80	09°58.12	1968		
26/06/07	133	Open Slope	Mega Core	39°39.33	09°43.65	1426		
26/06/07	134	Open Slope	CTD	39°43.367	09°37.534	671		
26/06/07	135	Open Slope	SAPS SPM	39°43.367	09°37.534	671	666	1147
26/06/07	135	Open Slope	SAPS SPM	39°43.367	09°37.534	671	45	658
26/06/07	136	Open Slope	Mega Core	39°43.08	09°37.57	670		
27/06/07	138	Cascais	Mega Core	38° 19.97	09°49.28	3634		
27/06/07	139	Lisbon	ROV Core	38°22.438	09°20.706	1664		
28/06/07	140	Cascais	CTD	38°22.492	09°20.587	1685		
28/06/07	141	Cascais	SAPS SPM	38°22.496	09°20.584	1684	1680	513
28/06/07	141	Cascais	SAPS SPM	38°22.496	09°20.584	1684	1380	1116
28/06/07	142	Cascais	ROV Core	38°14.313	09°23.475	2226		
03/07/07	146	Whittard	Mega Core	47°50.477	10°12.956	3872		
03/07/07	147	Whittard	ROV Core	47°55.399	10°13.327	3742		
05/07/07	149	Whittard	ROV Core	48°25.903	09°56.446	2595		
05/07/07	149	Whittard	ROV Core	48°26.438	09°51.734	466		



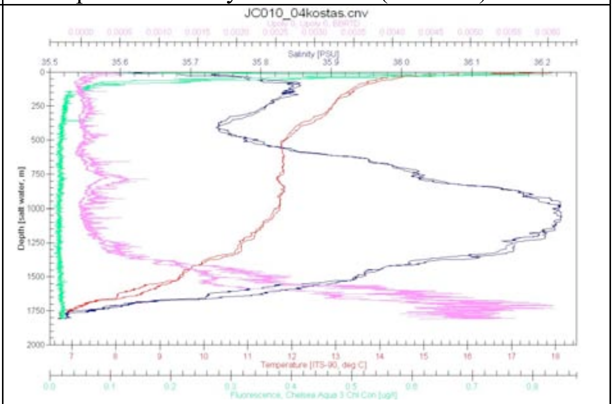
CTD profile of Lisbon Canyon at 1000m (JC10-78)



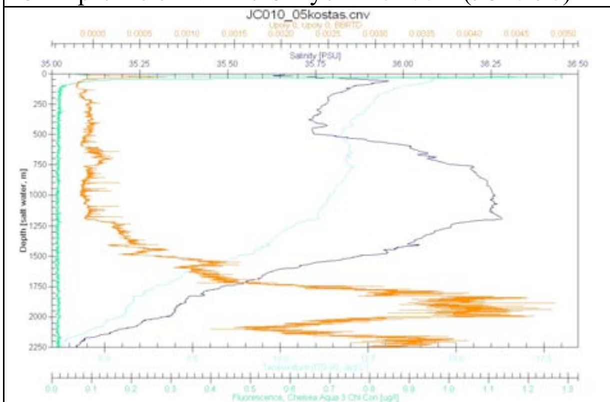
CTD profile of Canyon at 1400m (JC10-81)



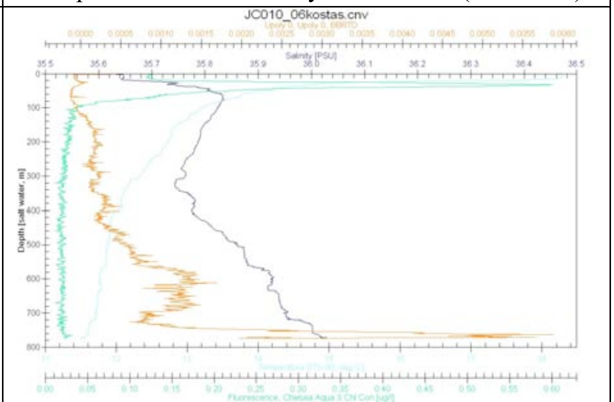
CTD profile of Nazare Canyon at 3400m (JC10-96)



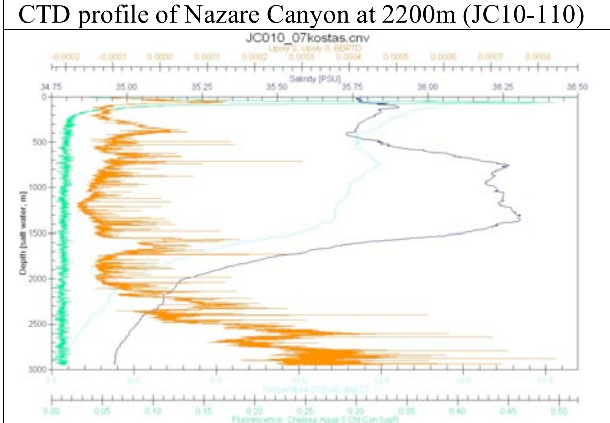
CTD profile of Nazare Canyon at 1800m (JC10-107)



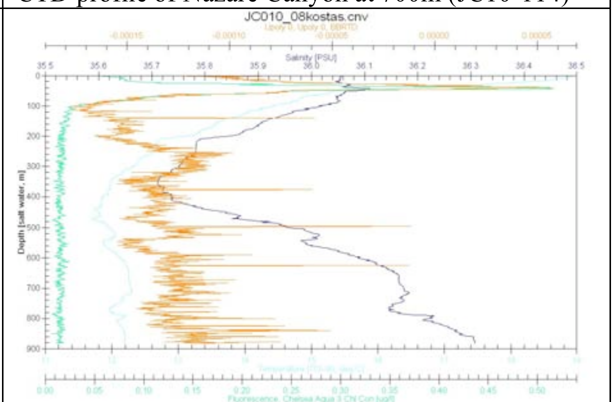
CTD profile of Nazare Canyon at 2200m (JC10-110)



CTD profile of Nazare Canyon at 700m (JC10-114)



CTD profile of Nazare Canyon at 3000m (JC10-117)



CTD profile of open slope at 900m (JC10-123)

Figure 17. CTD profiles, demonstrating water structure, at the same location or near SAPS deployments

Kostas Kiriakoulakis and George Wolff, University of Liverpool.

Piston Coring (Legs 2 and 3)

Two successful piston cores were obtained from Nazare Canyon during Leg 2. The sites were chosen in an area of pre-established anomalously high sedimentation rates in the middle section of Nazare Canyon, in order to further determine the nature and extent of these rates in this area. A single core was also collected from Whittard Canyon during Leg 3.

The first core (JC10-102) was shot using a 12 m barrel in the inner terrace of a large bend at 3552 m water depth. 7.7 m of sediment were recovered as well as 50 cm in the trigger core. They are both composed of dark grey organic-rich mud with occasional silty or fine sandy turbidite bases. These bases are 1-2 cm thick and very micaceous and organic-rich. The second core (JC10-103) was shot using a 21 m-long barrel on the downslope outer flank of the same bend, at a water depth of 3643 m. 14.5 m of sediment was recovered, very similar in character to that of JC10-102, with organic-rich grey mud and some thin silty-sandy turbidite bases, some of which had undergone pull-apart distortion. A 50 cm-long trigger core was also recovered with this piston core.

A third piston core was recovered from the levee adjacent to the lower Whittard Canyon at a water depth of 3873 m. A 10 m core, consisting of a thin Holocene hemipelagic sediment layer overlying a thick sequence of thin, fine-grained turbidites, was recovered.

Table 19. Piston cores collected during JC10.

Station	Area	Latitude	Longitude	Water depth (m)	Length (m)
JC10-102	Nazare	39°29.72N	09°56.07W	3552	7.69
JC10-103	Nazare	39°29.92N	09°57.50W	3646	14.50
JC10-145	Whittard	47°50.47N	10°12.95W	3873	10.01

Raquel Arzola

Agassiz Trawling (Leg 3)

Two Agassiz trawls at depth of ca. 3400 m in Cascais Canyon were attempted during the cruise. The first catch was very small and only contained 10 red midwater shrimps and 1 ophiuroid, suggesting only a very short period on the bottom. In the second Agassiz trawl, the pennant caught around the frame of the Agassiz Trawl that caused the trawl to be dragged at 90^{o} so that the mouth was effectively closed. Therefore there was no catch. The objective of both catches was to study the feeding adaptations of *Molpadia musculus*.

Table 20 – List of the stations for the Agassiz trawl

Station	Area	Date	Latitude	Longitude	Depth (m)
JC10-126	Cascais Canyon	22.06.07	39°18.616N	09°47.58W	3302
JC10-137	Cascais Canyon	27.06.07	39°18.971N	09°47.842W	3590

Teresa Amaro

Pixelfly camera

Pixelfly is a high-contrast, 11 bit monochrome megapixel camera, developed at WHOI (Howland & Lerner 1999 and Howland 1999). The high contrast aids picture mosaicking rather than high resolution. It is controlled over an Ethernet connection from the ROV by a computer located in the ROV cabin. The camera is mounted vertically on the forward drawer ("tool tray") of the ROV, in a downwards looking direction. It is combined with a 600 joule twin headed flash unit mounted at the rear of the ROV in order to provide camera to light separation to reduce backscatter. Trials showed that a 5 m altitude (important: with reference Doppler altitude measurement) provided an optimum survey altitude, giving a photographic area coverage of 763 cm wide x 610 cm high.

Settings / Usage:

1) On bright sand exposure should be 500-750 ms, rising to up to 1250 ms on muddy sediment. Take a test photograph at the start of the transect, and adjust the exposure.
2) Settings in the software = Manual and Truncate.
3) Whilst transiting in the ROV, maintain the same heading at all times, i.e. ROV has to go up one transect line forwards, and return along the next transect line backwards. This is to ensure that the flashguns are always facing the same direction relative to the seabed, so that the shadows cast by seabed features can be patched together during subsequent mosaic processing.
4) Maintain the same height above the seabed at all times. This is to ensure that the area of each photograph is the same, and continuous coverage is obtained. At 5 m height, with a flat seabed the area the photograph covers is 763 x 610 cm, and each step forward should be 3 m, each lateral step should be 4 m.
5) On a slope, the distance covered during each step will need to be reduced, to an size to be determined by taking test shots before commencing the transect.

Two Pixelfly deployments were carried out during JC10 Leg 3. Both were carried out in the Nazare Canyon at 4300 m.

The first photographic transect was carried out over the sand dune region. A heading of 020º and an altitude of 5 m was maintained throughout this transect. This transect was carried out over a slope, and it was discovered that incremental forward/backward steps should be 1.5 m to ensure photographic overlap. Images taken are summarised below (missing photos were test photos);

1st line, photographs 0005 – 0017, 3m steps backwards. At end 4 m step starboard
2nd line, photographs 0018 – 0026, 3 m steps forward;
2nd line, photographs 0029 – 0034, 1.5m steps forward. At end 4m step starboard
3rd line, photographs 0037 – 0061, 1.5m steps backwards. At end 4 m step starboard
4th line, photographs 0062 – 0086, 1.5m steps forward.

Figure 18. Image showing 4 images mosaiced together from the slope transect. An outline of where the ROV touched the sea bed during a previous dive is located in the picture centre.

The second photographic transect was carried out over a Xenophyophore field. 5 m altitude and 3 m steps forward /backward and 4 m steps starboard were maintained. Images taken are summarised below;

1st line, photographs 0088-0093, 3 m steps forward. At end 4 m step starboard
2nd line, photographs 0095-0098, 3 m steps backward. At end 4 m step starboard
3rd line, photographs 0099-0102, 3 m steps forward. At end 4 m step starboard
4th line, photographs 0103-0106, 3 m steps backward. At end 4 m step starboard
5th line, photographs 0107-0110, 3 m steps forward.

Table 21. Pixelfly camera deployments on Leg 3.

Deployment	**ISIS Depth (m)**	**Location Start**	**Location End**	**Photographs**
JC10-130PX01	4361-4372	39º34.351 10º18.105	39º34.363 10º18.105	81 images #005 - #0086
JC10-130PX02	4347	39º34.737 10º18.116	39º34.733 10º18.132	23 images #0088 - #0110

Sarah Murty

Macrofauna and megafauna sampling for stable isotope analysis (Leg 3)

Our initial aims were to determine rates and pathways of carbon cycling in canyon systems using *in situ* pulse chase experiments carried out with ROV deployed benthic chambers. Two chambers were deployed at the end of leg 2 at 3400 m in the Nazare canyon. The experiments were successful and the chambers were recovered by the ROV and placed on an elevator. Unfortunately during recovery the elevator became caught in the ship's propeller and the chambers were lost.

Having no chambers to work with during leg 3, I decided to take cores to obtain macrofauna and megafauna for stable isotope analyses. The aim is to determine if there are differences in food sources and trophic pathways in macro and megafauna between the Cascais, Lisbon and Sebutal canyons. Samples were also taken from three stations within the Whittard canyon, near the head of the canyon, in the middle and near the mouth of the canyon. I hope to determine if there are differences in the food source and trophic pathways along the Whittard canyon.

The samples taken for stable isotope analyse are outlined in Table 22 and examples of the megafauna obtained are shown in Figure 19. Briefly cores were pooled for stable isotope analyses and sieved for macrofauna on a 250 µm screen, these samples were then frozen. For identification of macrofauna a core from each station was sieved and preserved in 10 % formalin. Megafauna were dissected for muscle tissue and this was then frozen. A separate core was sliced and frozen in order to obtain sedimentary food sources. Cores were sliced into 0-2 cm, 2-5 cm, 5-10 cm and 10-15 cm intervals.

Table 22. Samples taken for stable isotope analysis at Aberdeen University

Station	**Canyon**	**Depth (m)**	**Equipment**	**Sample**	**Preservation**
JC10-127	Nazare	3536	Pushcores	3 cores - macrofauna	10% formalin
JC10-127	Nazare	3536		1 core - sediment isotopes	frozen
JC10-138	Cascais	3634	Megacores	1 core - sediment isotopes; 4 cores - macrofaunal isotopes	frozen
JC10-138	Cascais	3634		1 core - macrofauna id	10% formalin

JC10-139	Lisbon	1664	Pushcores	1 core - sediment isotopes; 4 cores - macrofaunal isotopes	frozen
JC10-139	Lisbon	1664		1 core - macrofauna id	10% formalin
JC10-139	Lisbon	1424	Biobox	2 Sponges - isotopes	frozen
JC10-139	Lisbon	1667		4 Brachiopods - isotopes	frozen
JC10-142	Sebutal	2226	Pushcores	1 core - sediment isotopes; 4 cores - macrofaunal isotopes	frozen
JC10-142	Sebutal	2226		1 core - macrofauna id	10% formalin
JC10-142	Sebutal	2053	Biobox	2 crinoids - isotopes	frozen
JC10-142	Sebutal	1933		2 ophiuroids - isotopes	frozen
JC10-146	Whittard	3872	Megacores	3 cores - macrofaunal isotopes; ½ core - sediment isotopes	frozen
JC10-146	Whittard			½ core - macrofauna id	10 % formalin
JC10-148	Whittard	3134	Pushcores	1 core - sediment isotopes; 4 cores - macrofaunal isotopes	frozen
JC10-148	Whittard	3134		1 core - macrofauna id	10% formalin
JC10-148	Whittard	2750	Biobox	2 regular echinoids - isotopes	frozen
JC10-148	Whittard	2750		1 crab - isotopes	frozen
JC10-148	Whittard	1231	Pushcores	1 core - sediment isotopes; 4 cores - macrofaunal isotopes	frozen
JC10-148	Whittard			1 core - macrofauna id	10% formalin
JC10-148	Whittard	2612	Biobox	2 anemones - isotopes	frozen
JC10-148	Whittard	1230		2 gorgonians - isotopes	frozen
JC10-148	Whittard	1654		1 sponge	frozen

Figure 19: Examples of megafauna collected for stable isotope analyses.

Rachel Jeffreys

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TRACK CHARTS AND STATION MAPS

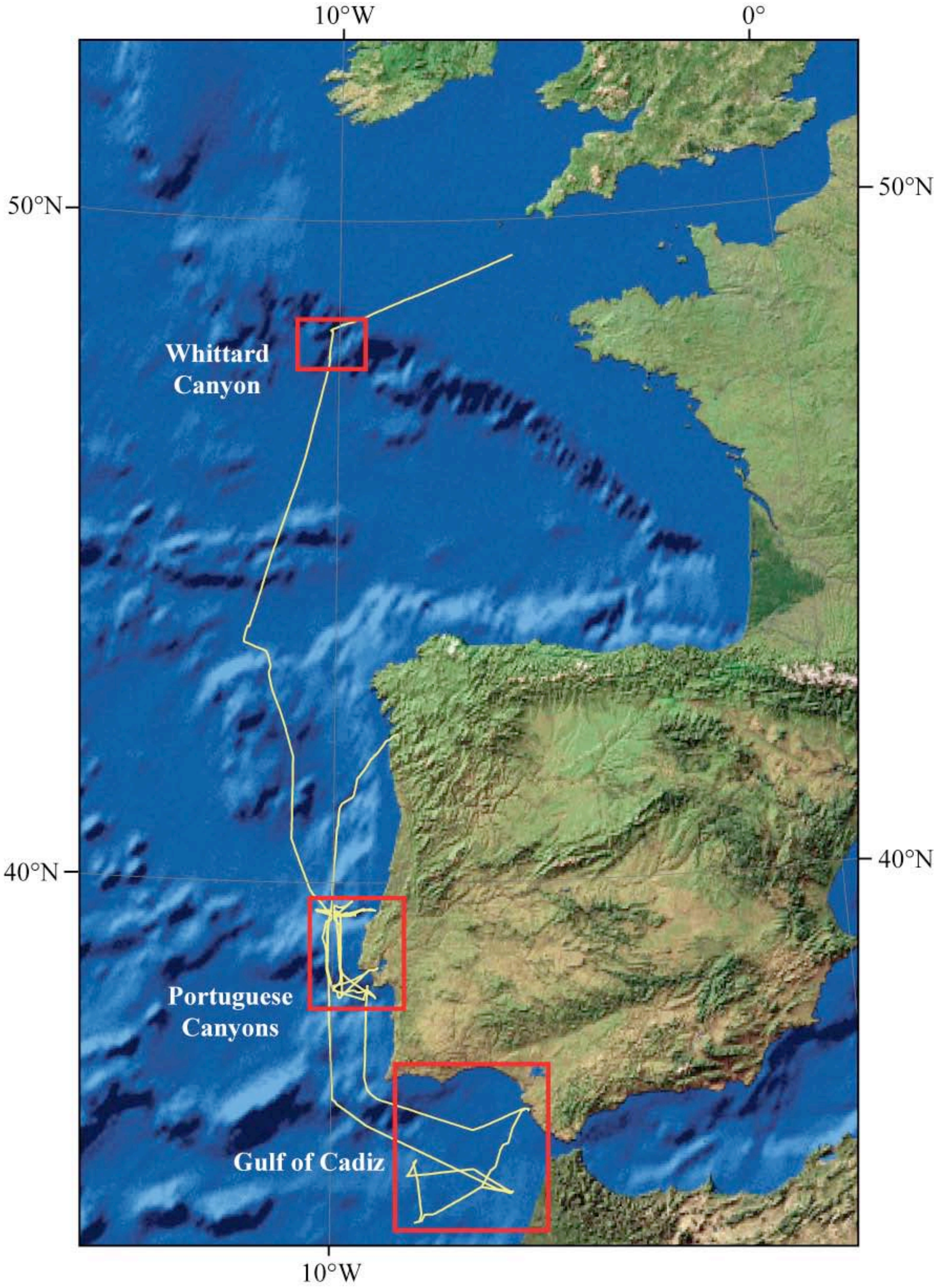

Figure 20. Overview track chart for RRS James Cook cruise 10 showing the three main study areas in the Gulf of Cadiz (Leg 1), Portuguese Canyons (Legs 2 and 3) and Whittard Canyon (Leg 3)

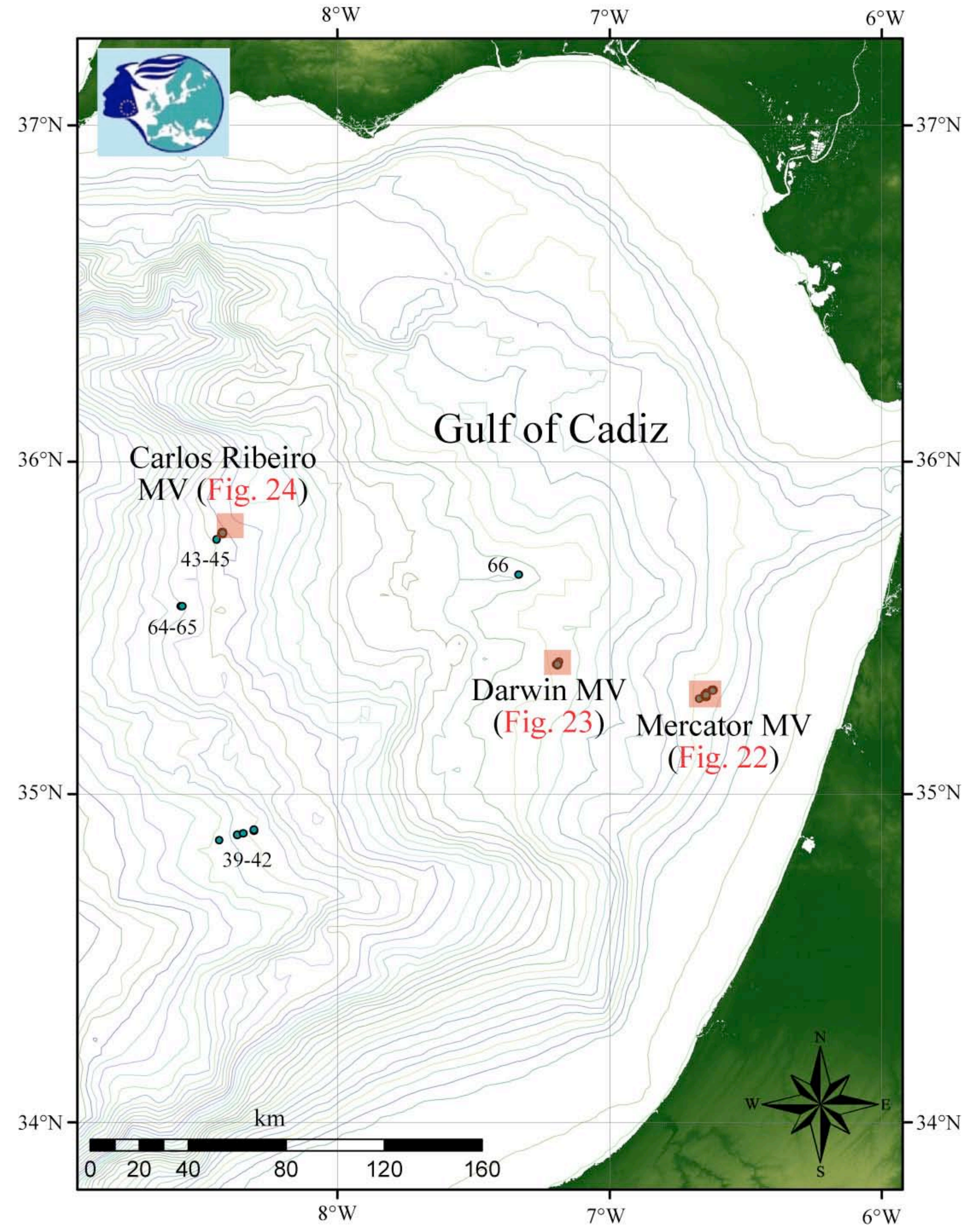

Figure 21. Station map for the Gulf of Cadiz. Most stations are located at Mercator, Darwin or Carlos Ribiero mud volcanoes (see detailed figures 22-24).

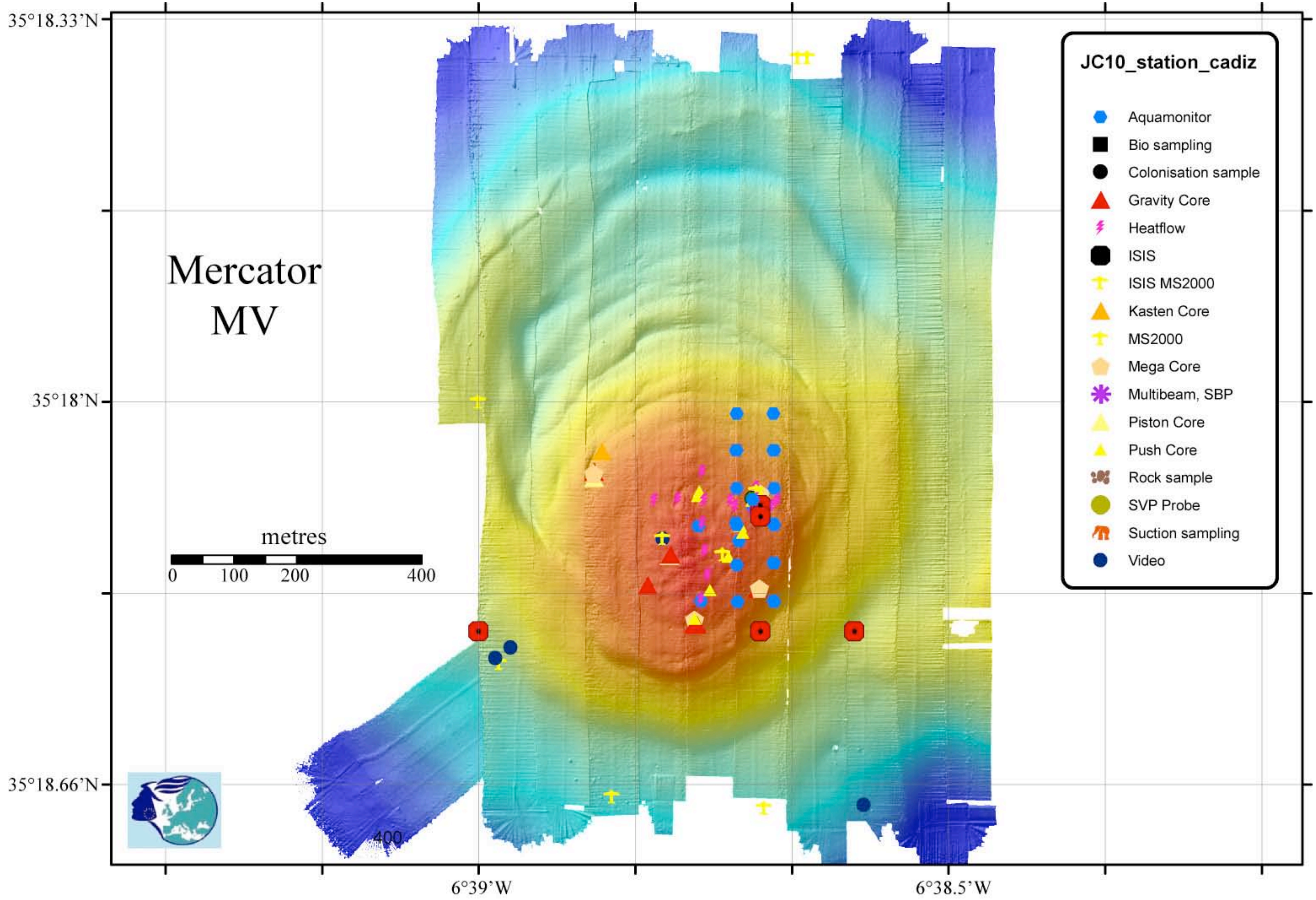

Figure 22. ROV swath bathymetry map of Mercator mud volcano with locations of stations superimposed. Station labels have been omitted because of overlap. Details of individual stations can be found in the station list at the end of this report.

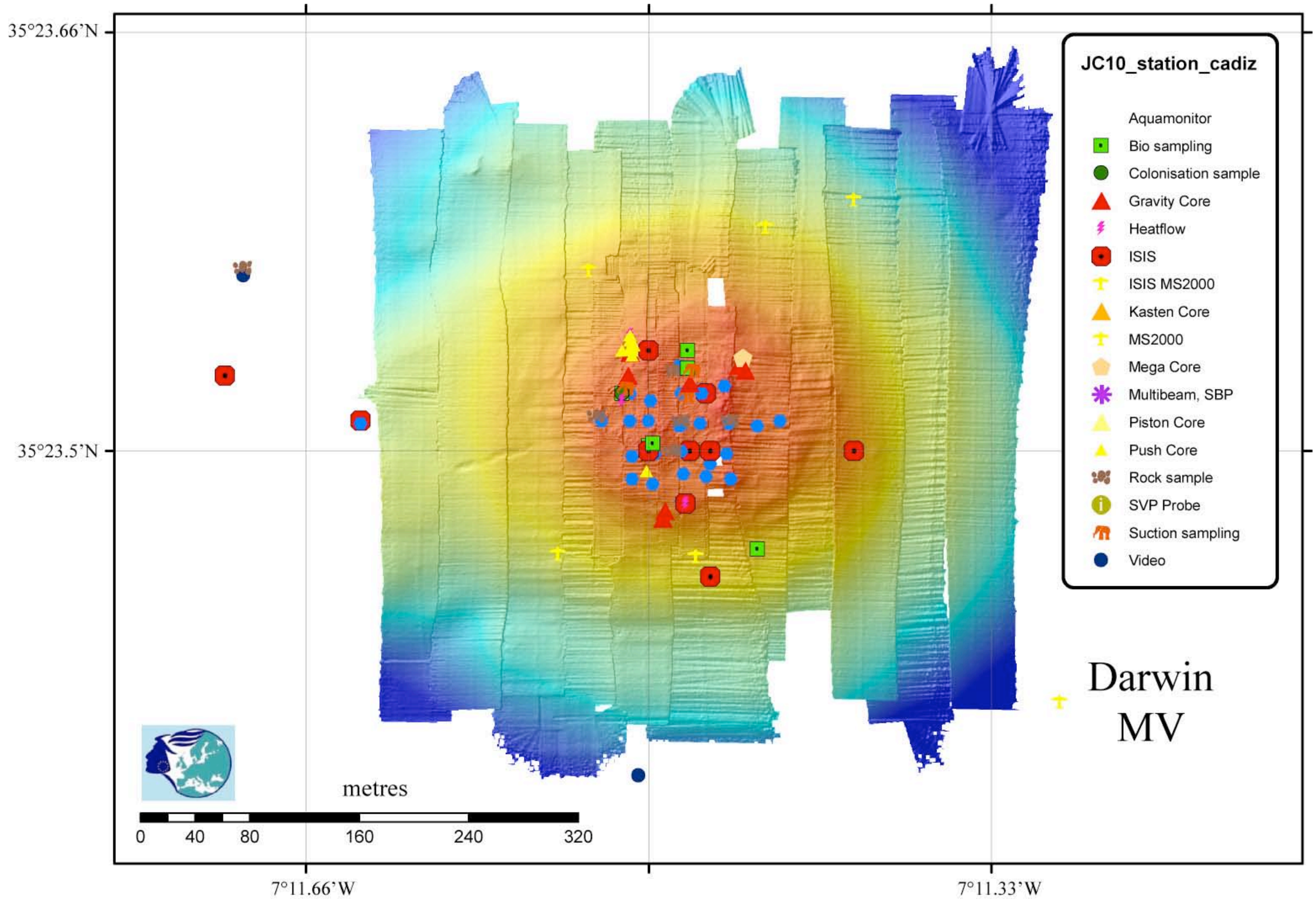

Figure 23. ROV swath bathymetry map of Darwin mud volcano with locations of stations superimposed. Station labels have been omitted because of overlap. Details of individual stations can be found in the station list at the end of this report.

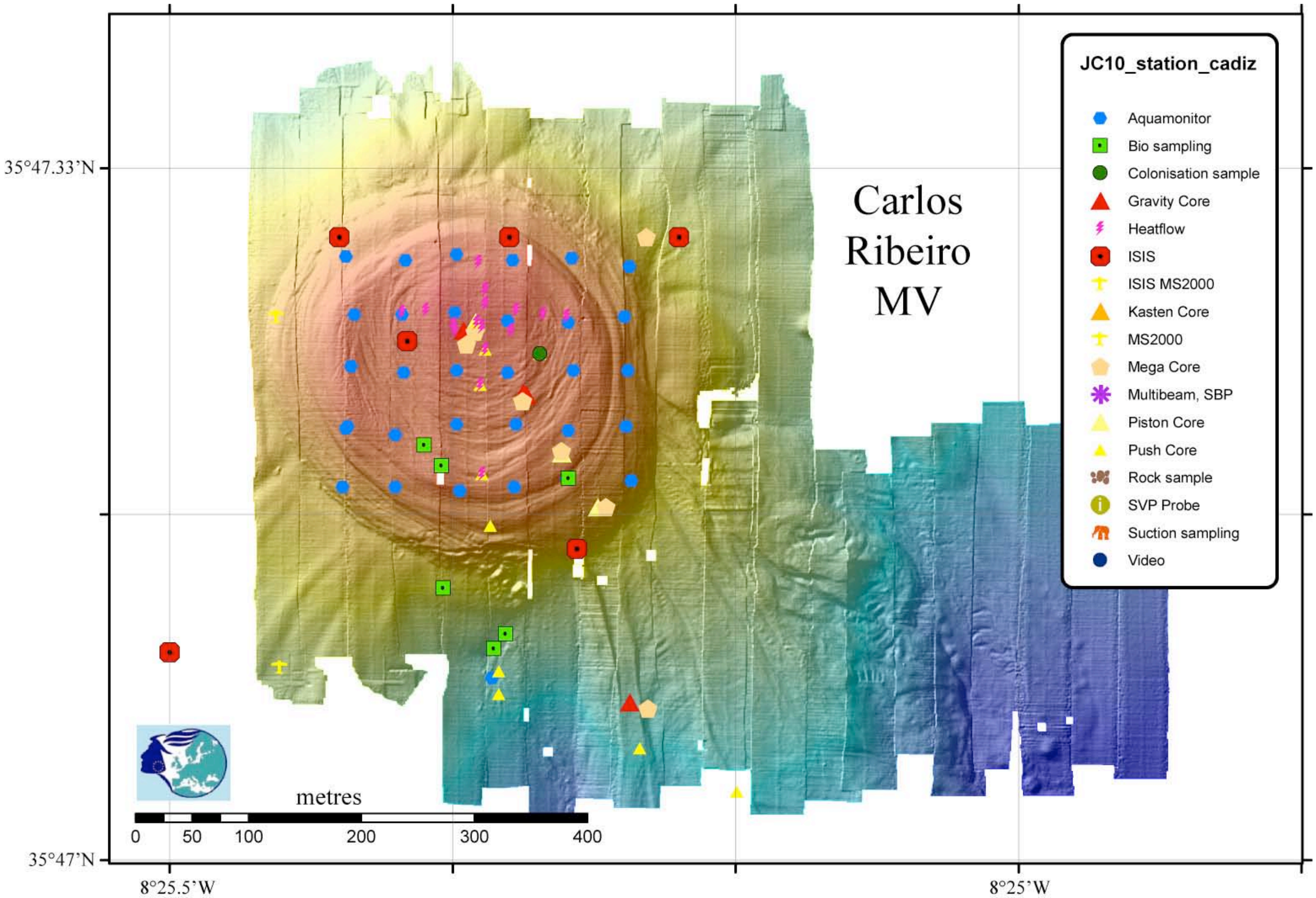

Figure 24. ROV swath bathymetry map of Carlos Ribeiro mud volcano with locations of stations superimposed. Station labels have been omitted because of overlap. Details of individual stations can be found in the station list at the end of this report.

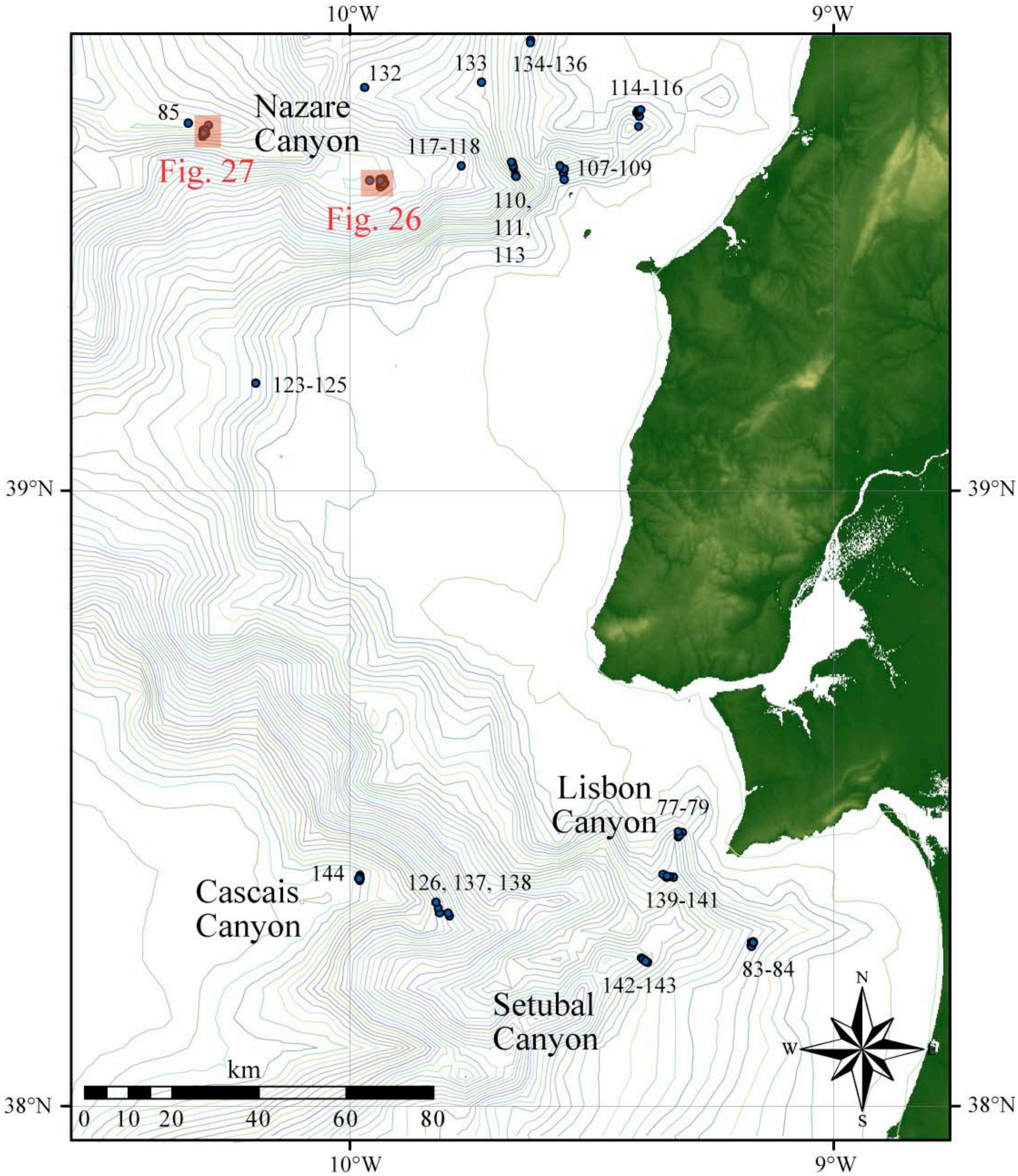

Figure 25. Location of stations in Nazare, Cascais, Lisbon and Setubal Canyon on the Portuguese margin. Locations of figures 26-27 are also shown. Figure 26 corresponds to the 3400 m site in Nazare Canyon where stations 90, 91, 93-95, 98-102-104-106, 112, 119-122, 127, 131 are located.Figure 27 corresponds to the 4300 m site in Nazare Canyon where stations 86-88, 92, 128-130 are located.

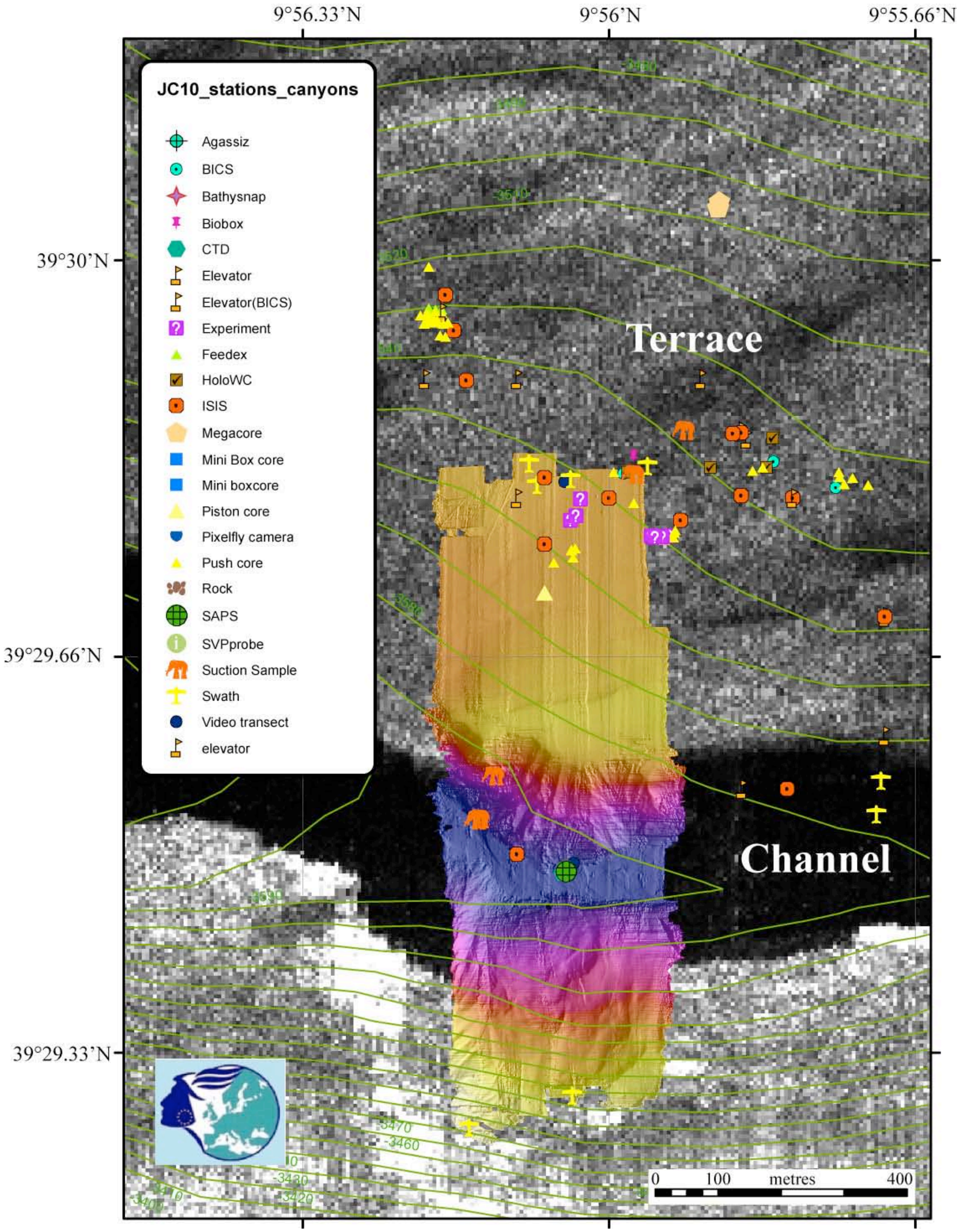

Figure 26. Location map for the Nazare Canyon 3400 m site showing TOBI sidescan sonar data (grey background), 10 m contours (green lines), ROV swath bathymetry (coloured inset panel) and station locations (see key). See figure 25 for location. Station labels have been omitted because of overlap. Details of individual stations can be found in the station list at the end of this report.

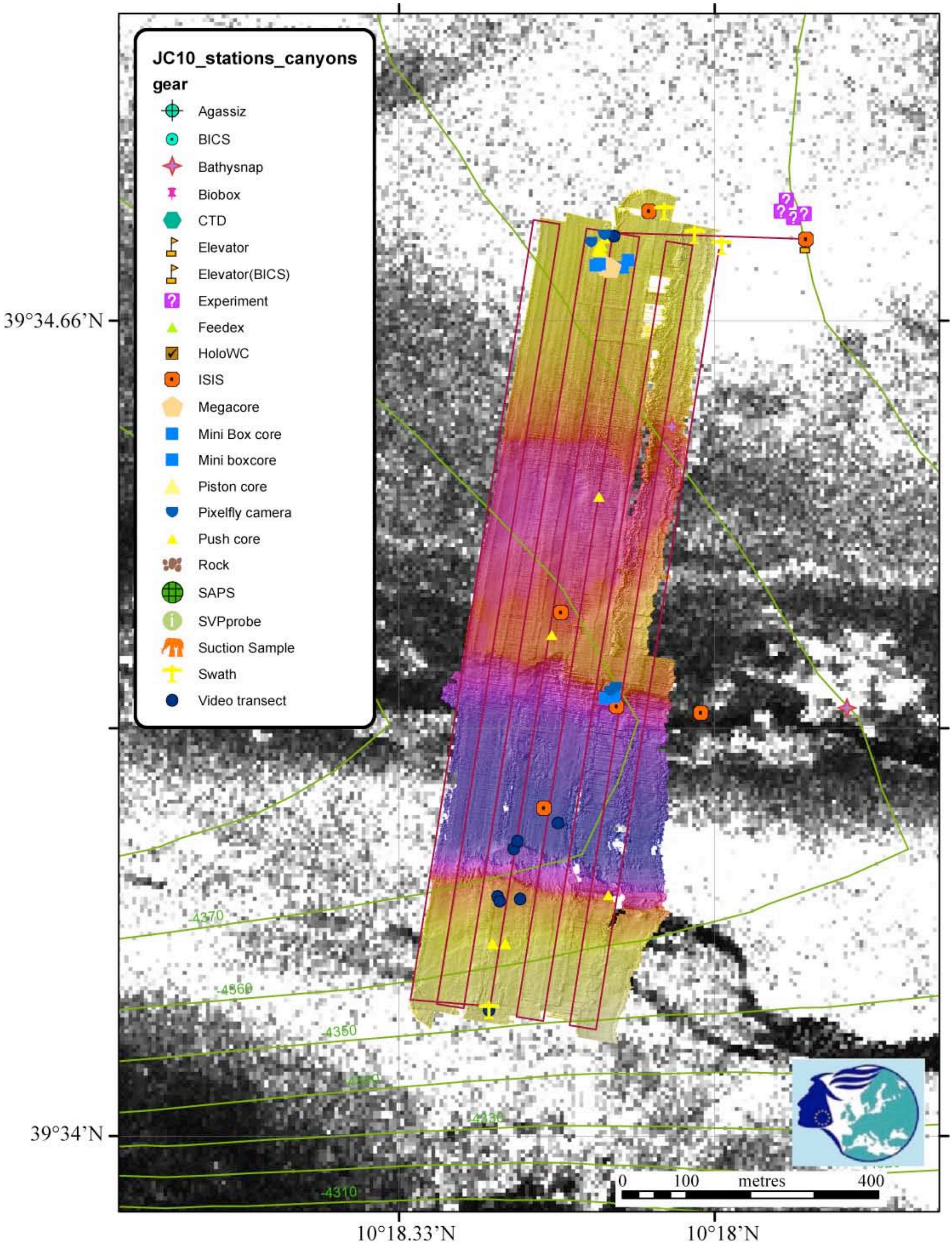

Figure 27. Location map for the Nazare Canyon 4300 m site showing TOBI sidescan sonar data (grey background), 10 m contours (green lines), ROV swath bathymetry (coloured inset panel) and station locations (see key). See figure 25 for location. Station labels have been omitted because of overlap. Details of individual stations can be found in the station list at the end of this report.

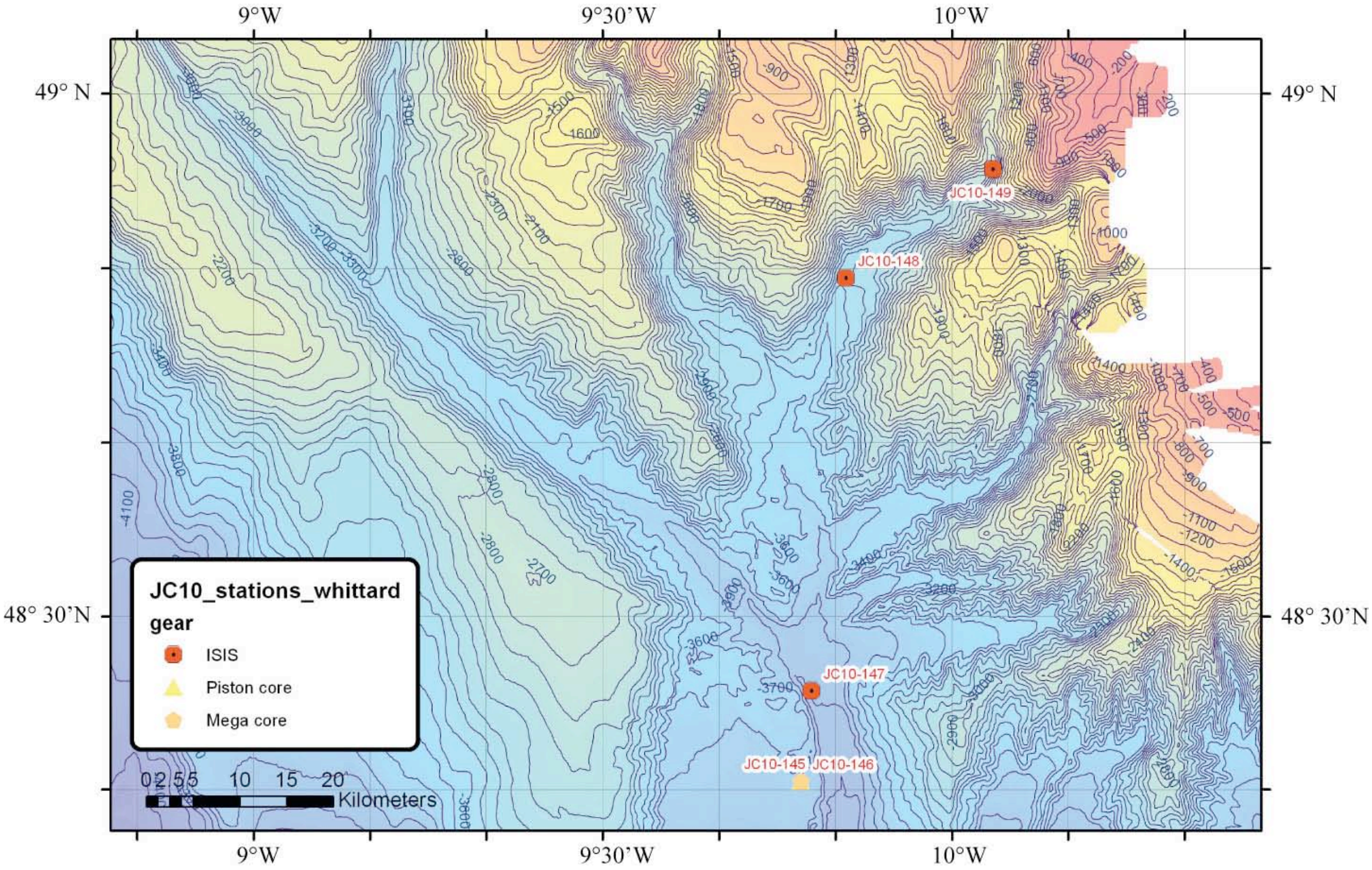

Figure 28. Location of stations in Whittard Canyon

STATION LISTS

<u>Key to station list</u>

AL	Aquamonitor
HTF	Heatflow
CS	Colonisation sample
PUC	Pushcore
VT	Video transect
PX	Pixelfly photomosaic
SW	ROV swath bathymetry
Rock	ROV rock sample
Bibo	Biobox sample
BF	‘Butterfly’ net
SUS	Suction sample
Mbox	ROV mini boxcore
FX	Feedex experiment
EX	Aberdeen ROV Benthic Incubation Chambers
Bics	NOCS Benthic Incubation Chamber
HWC	Molpadiid holothurian experiment
NR	Core sieved for biology; length not recorded
5*	Upper 5 cm of core sieved for biology; total length not recorded
SVP	Sound velocity probe
SBP	Sub-bottom profiler

For stations where only a start position is given, then all activity took place exactly on that point

Station List: JC10 Leg 1.

Station no JC10-	ISIS Dive no	Area	Gear	Start Date	Start Time	End Date	End Time	Start Latitude	Start Longitude	Depth (m)	End Latitude	End Longitude	Core Recovery (cm)	Remarks
001		Mercator	Piston Core	15.05.07	1143			35°17.254N	6°40.248W	473			241	
002		Mercator	Mega Core	15.05.07	1335			35°17.260N	6°40.240W	470			42	6 out of 6
003		Mercator	SVP	15.05.07	1440	15.05.07	1508	35°17.257N	6°40.244W	471				
004		Mercator	Piston Core	15.05.07	1601			35°17.244N	6°40.251W	470			375	
005	23	Mercator	ISIS MS2000	15.05.07	1901	16.05.07	0508	35°18.300N	6°38.660W	412	35°18.30N	6°38.66W		
006	24	Mercator	ISIS MS2000	16.05.07	0818	16.05.07	1826	35°18.300N	6°38.650W	470	35°18.0N	6°39.0W		
007		Mercator	Piston Core	16.05.07	2014			35°17.915N	6°38.696W	349			70	
008		Mercator	Piston Core	16.05.07	2317			35°17.917N	6°38.700W	351			0	failed
009		Mercator	Gravity Core	17.05.07	0245			35°17.840N	6°38.820W	349			80	
010		Mercator	Gravity Core	17.05.07	0423			35°17.920N	6°38.700W	351			150	
011		Mercator	Mega Core	17.05.07	0536			35°17.920N	6°38.700W	351			40	5 out of 6
012	25	Mercator	ISIS	17.05.07	0642	17.05.07	1651	35°17.8N	6°38.6W	392	35°17.8N	6°39.0W		
012-VT01	25	Mercator	Video	17.05.07	0713	17.05.07	1402	35°17.649N	6°38.590W	397	35°17.881N	6°38.804W		
012-SW01	25	Mercator	MS2000	17.05.07	1403	17.05.07	1536	35°17.881N	6°38.804W	377	35°17.772N	6°38.978W		
012-VT02	25	Mercator	Video	17.05.07	1537	17.05.07	1551	35°17.777N	6°38.982W	373	35°17.786N	6°38.966W		
013		Mercator	Mega Core	17.05.07	1817			35°17.810N	6°38.770W	348			28	5 out of 6
014		Mercator	Gravity Core	17.05.07	1918			35°17.806N	6°38.768W	346			53	
015		Mercator	Gravity Core	17.05.07	2058			35°17.806N	6°38.771W	346			93	
016	26	Mercator	ISIS	17.05.07	2257	18.05.07	0753	35°17.8N	6°38.7W	350	35°17.9N	6°38.7W		
016-AL01	26	Mercator	Aquamonitor	17.05.07	2358	18.05.07	0019	35°17.827N	6°38.886W	NR	35°17.860N	6°38.686W		Bag 2
016-AL02	26	Mercator	Aquamonitor	18.05.07	0020	18.05.07	0041	35°17.827N	6°38.886W	NR	35°17.860N	6°38.686W		Bag 3
016-AL03	26	Mercator	Aquamonitor	18.05.07	0041	18.05.07	0102	35°17.860N	6°38.686W	NR	35°17.893N	6°38.685W		Bag 4
016-AL04	26	Mercator	Aquamonitor	18.05.07	0102	18.05.07	0124	35°17.893N	6°38.685W	NR	35°17.925N	6°38.685W		Bag 5
016-AL05	26	Mercator	Aquamonitor	18.05.07	0124	18.05.07	0146	35°17.925N	6°38.685W	NR	35°17.990N	6°38.686W		Bag 6
016-AL06	26	Mercator	Aquamonitor	18.05.07	0146	18.05.07	0209	35°17.958N	6°38.685W	NR	35°17.990N	6°38.725W		Bag 7
016-AL07	26	Mercator	Aquamonitor	18.05.07	0209	18.05.07	0232	35°17.990N	6°38.686W	NR	35°17.958N	6°38.725W		Bag 8
016-AL08	26	Mercator	Aquamonitor	18.05.07	0232	18.05.07	0257	35°17.990N	6°38.725W	NR	35°17.925N	6°38.725W		Bag 9
016-AL09	26	Mercator	Aquamonitor	18.05.07	0257	18.05.07	0320	35°17.958N	6°38.725W	351	35°17.893N	6°38.725W		Bag 10
016-AL10	26	Mercator	Aquamonitor	18.05.07	0320	18.05.07	0344	35°17.895N	6°38.726W	354	35°17.909N	6°38.706W		Bag 11
016-AL11	26	Mercator	Aquamonitor	18.05.07	0344	18.05.07	0409	35°17.909N	6°38.706W	354				Bag 12

016-AL12	26	Mercator	Aquamonitor	18.05.07	0409	18.05.07	0438	35°17.908N	6°38.706W	354				Bag 13
016-AL13	26	Mercator	Aquamonitor	18.05.07	0440	18.05.07	0505	35°17.909N	6°38.708W	350				Bag 14
016-AL14	26	Mercator	Aquamonitor	18.05.07	0520	18.05.07	0546	35°17.879N	6°38.723W	350	35°17.843N	6°38.725W		Bag 15
016-AL15	26	Mercator	Aquamonitor	18.05.07	0552	18.05.07	0621	35°17.827N	6°38.763W	350	35°17.860N	6°38.765W		Bag 16
016-AL16	26	Mercator	Aquamonitor	18.05.07	0626	18.05.07	0653	35°17.892N	6°38.766W	350	35°17.925N	6°38.765W		Bag 17
016-PUC01	26	Mercator	Push Core	18.05.07	0654			35°17.922N	6°38.765W	352				
016-PUC02	26	Mercator	Push Core	18.05.07	0656			35°17.918N	6°38.767W	352				
017		Mercator	Kasten Core	18.05.07	0832			35°17.957N	6°38.869W	354			106	
018	27	Mercator	ISIS	18.05.07	1037	18.05.07	1650	38°18.8N	6°37.4W	423	38°18.7N	6°37.1W		
018-Rock1	27	Mercator	Rock sample	18.05.07	1147			35°18.755N	6°37.422W	428				
018-Rock2	27	Mercator	Rock sample	18.05.07	1227			35°18.823N	6°37.377W	432				
018-Rock3	27	Mercator	Rock sample	18.05.07	1259			35°18.839N	6°37.354W	426				
018-Rock4	27	Mercator	Rock sample	18.05.07	1335			35°18.846N	6°37.282W	387				
018-Rock5	27	Mercator	Rock sample	18.05.07	1444			35°18.825N	6°37.154W	373				
018-Rock6	27	Mercator	Rock sample	18.05.07	1515			35°18.827N	6°37.058W	376				
018-Rock7	27	Mercator	Rock sample	18.05.07	1600			35°18.840N	6°37.039W	381				
019		Mercator	Piston Core	18.05.07	1829			35°17.866N	6°38.797W	346			272	
020		Mercator	Gravity Core	18.05.07	2033			35°17.867N	6°38.796W	345			79	+ temp probe
021	28	Mercator	ISIS	18.05.07	2210	19.05.07	0710	35°17.9N	6°38.7W	430	35°17.8N	6°38.7W		
021-HTF01	28	Mercator	Heatflow	18.05.07	2316	18.05.07	2336	35°17.906N	6°38.709W	353				
021-HTF02	28	Mercator	Heatflow	19.05.07	0001	19.05.07	0012	35°17.909N	6°38.688W	354				
021-HTF03	28	Mercator	Heatflow	19.05.07	0030	19.05.07	0042	35°17.925N	6°38.705W	355				
021-HTF04	28	Mercator	Heatflow	19.05.07	0122	19.05.07	0130	35°17.909N	6°38.727W	352				
021-CS01	28	Mercator	Colonisation sample	19.05.07	0212	19.05.07	0216	35°17.916N	6°38.709W	354				9 samples deployed
021-PUC01	28	Mercator	Push Core	19.05.07	0200			35°17.914N	6°38.709W	355			14	
021-PUC02	28	Mercator	Push Core	19.05.07	0232			35°17.914N	6°38.709W	354			10	
021-PUC03	28	Mercator	Push Core	19.05.07	0235			35°17.914N	6°38.709W	354			10	
021-PUC04	28	Mercator	Push Core	19.05.07	0240			35°17.914N	6°38.709W	354			15	
021-PUC05	28	Mercator	Push Core	19.05.07	0344			35°17.181N	6°38.770W	400			19	
021-PUC06	28	Mercator	Push Core	19.05.07	0354			35°17.836N	6°38.754W	365			16.5	
021-PUC07	28	Mercator	Push Core	19.05.07	0412			35°17.865N	6°38.734W	364			13	
021-PUC08	28	Mercator	Push Core	19.05.07	0443			35°17.892N	6°38.721W	361			7	
021-PUC09	28	Mercator	Push Core	19.05.07	0508			35°17.886N	6°38.719W	366			0	failed
021-PUC10	28	Mercator	Push Core	19.05.07	0517			35°17.921N	6°38.701W	365			18	

021-SW01	28	Mercator	ISIS MS2000	19.05.07	0534	19.05.07	0610	35°17.922N	6°38.704W	365	35°17.867N	6°38.74W		2 swath lines
022	29	Darwin	ISIS MS2000	19.05.07	1202	19.05.07	2036	35°23.4N	7°11.3W	1147	35°23.6N	7°11.4W		11 swath lines
023		Darwin	Piston Core	19.05.07	2325			35°23.962N	7°11.120W	1145			505	+ temp. probe
024	30	Darwin	ISIS	20.05.07	0129	20.05.07	1228	35°23.325N	7°11.463W	1169	35°23.53N	7°11.706W		
024-VT01	30	Darwin	Video	20.05.07	0224	20.05.07	1108	35°23.371N	7°11.505W	1151	35°23.57N	7°11.697W		
024-Rock1	30	Darwin	Rock sample	20.05.07	1057			35°23.573N	7°11.697W	1151				
025		Darwin	Piston Core	20.05.07	1400			35°23.965N	7°11.120W	1145			507	
026		Darwin	Mega Core	20.05.07	1558			35°23.965N	7°11.121W	1145			36	8 out of 8
027	31	Darwin	ISIS	20.05.07	1913	21.05.07	0427	35°23.512N	7°11.640W	1134	35°23.5N	7°11.48W		
027-AL01	31	Darwin	Aquamonitor	20.05.07	1924	20.05.07	1937	35°23.511N	7°11.640W	1140				Bag 2
027-AL02	31	Darwin	Aquamonitor	20.05.07	2012	20.05.07	2027	35°23.512N	7°11.523W	1111				Bag 3
027-AL03	31	Darwin	Aquamonitor	20.05.07	2035	20.05.07	2048	35°23.512N	7°11.509W	1109				Bag 4
027-AL04	31	Darwin	Aquamonitor	20.05.07	2059	20.05.07	2111	35°23.512N	7°11.500W	1118				Bag 5
027-AL05	31	Darwin	Aquamonitor	20.05.07	2117	20.05.07	2131	35°23.511N	7°11.483W	1118				Bag 6
027-AL06	31	Darwin	Aquamonitor	20.05.07	2133	20.05.07	2148	35°23.510N	7°11.485W	1113				Bag 7
027-AL07	31	Darwin	Aquamonitor	20.05.07	2149	20.05.07	2206	35°23.510N	7°11.485W	1108				Bag 8
027-AL08	31	Darwin	Aquamonitor	20.05.07	2211	20.05.07	2226	35°23.511N	7°11.475W	1117				Bag 9
027-AL09	31	Darwin	Aquamonitor	20.05.07	2230	20.05.07	2245	35°23.511N	7°11.461W	1117				Bag 10
027-AL10	31	Darwin	Aquamonitor	20.05.07	2250	20.05.07	2305	35°23.510N	7°11.447W	1117				Bag 11
027-AL11	31	Darwin	Aquamonitor	20.05.07	2310	20.05.07	2326	35°23.512N	7°11.436W	1117				Bag 12
027-AL12	31	Darwin	Aquamonitor	20.05.07	2343	21.05.07	0000	35°23.480N	7°11.484W	1120				Bag 13
027-AL13	31	Darwin	Aquamonitor	21.05.07	0005	21.05.07	0022	35°23.491N	7°11.483W	1118				Bag 14
027-AL14	31	Darwin	Aquamonitor	21.05.07	0028	21.05.07	0045	35°23.500N	7°11.484W	1117				Bag 15
027-AL15	31	Darwin	Aquamonitor	21.05.07	0053	21.05.07	0110	35°23.523N	7°11.484W	1117				Bag 16
027-AL16	31	Darwin	Aquamonitor	21.05.07	0116	21.05.07	0134	35°23.534N	7°11.485W	1117				Bag 17
027-AL17	31	Darwin	Aquamonitor	21.05.07	0142	21.05.07	0200	35°23.520N	7°11.499W	1117				Bag 18
027-AL18	31	Darwin	Aquamonitor	21.05.07	0207	21.05.07	0225	35°23.498N	7°11.508W	1119				Bag 19
027-AL19	31	Darwin	Aquamonitor	21.05.07	0230	21.05.07	0248	35°23.499N	7°11.497W	1119				Bag 20
027-AL20	31	Darwin	Aquamonitor	21.05.07	0256	21.05.07	0315	35°23.495N	7°11.470W	1119				Bag 21
028	32	Darwin	ISIS	21.05.07	0532	21.05.07	1259	35°23.523N	7°11.472W	1110	35°23.5N	7°11.47W		
028-AL01	32	Darwin	Aquamonitor	21.05.07	0635	21.05.07	0655	35°23.500N	7°11.463W	1109				Bag 22
028-AL02	32	Darwin	Aquamonitor	21.05.07	0705	21.05.07	0725	35°23.526N	7°11.463W	1109				Bag 23
028-AL03	32	Darwin	Aquamonitor	21.05.07	0730	21.05.07	0752	35°23.523N	7°11.474W	1108				Bag 24
028-AL04	32	Darwin	Aquamonitor	21.05.07	0803	21.05.07	0823	35°23.523N	7°11.509W	1110				Bag 25
028-AL05	32	Darwin	Aquamonitor	21.05.07	0836	21.05.07	0858	35°23.489N	7°11.508W	1119				Bag 26

028-AL06	32	Darwin	Aquamonitor	21.05.07	0903	21.05.07	0923	35°23.487N	7°11.498W	1119				Bag 27
028-AL07	32	Darwin	Aquamonitor	21.05.07	0935	21.05.07	0956	35°23.490N	7°11.472W	1118				Bag 28
028-AL08	32	Darwin	Aquamonitor	21.05.07	1001	21.05.07	1024	35°23.489N	7°11.460W	1119				Bag 29
028-Rock1	32	Darwin	Rock sample	21.05.07	1032			35°23.500N	7°11.488W	1118				
028-Rock2	32	Darwin	Rock sample	21.05.07	1045			35°23.502N	7°11.498W	1118				
028-Rock3	32	Darwin	Rock sample	21.05.07	1048			35°23.502N	7°11.498W	1118				
028-Rock4	32	Darwin	Rock sample	21.05.07	1101			35°23.514N	7°11.525W	1119				
028-Rock5	32	Darwin	Rock sample	21.05.07	1105			35°23.514N	7°11.525W	1119				
028-Rock6	32	Darwin	Rock sample	21.05.07	1122			35°23.512N	7°11.484W	1118				
028-Rock7	32	Darwin	Rock sample	21.05.07	1142			35°23.532N	7°11.487W	1118				
028-Rock8	32	Darwin	Rock sample	21.05.07	1157			35°23.512N	7°11.460W	1118				
029		Darwin	Gravity Core	21.05.07	1415			35°23.534N	7°11.456W	1104			43	
030		Darwin	Mega Core	21.05.07	1547			35°23.537N	7°11.454W	1104			22	6 out of 6
031		Darwin	Gravity Core	21.05.07	1711			35°23.532N	7°11.453W	1104			49	
032	33	Darwin	ISIS	21.05.07	1938	22.05.07	0516	35°23.479N	7°11.482W	1113	35°23.5N	7°11.4W		
032-Bibo01	33	Darwin	Scoop/Biobox	22.05.07	0111	22.05.07	0125	35°23.523N	7°11.513W	1109				
032-Bibo02	33	Darwin	Scoop/Biobox	22.05.07	0211	22.05.07	0250	35°23.491N	7°11.447W	1103				*Lophelia*
032-Bibo03	33	Darwin	Scoop/Biobox	22.05.07	0350	22.05.07	0400	35°23.502N	7°11.500W	1102				Coral fragment
032-SUS01	33	Darwin	Suction sample	21.05.07	2155	21.05.07	2159	35°23.523N	7°11.513W	1109				250 µm mesh
032-SUS02	33	Darwin	Suction sample	22.05.07	0016	22.05.07	0049	35°23.523N	7°11.513W	1110				250 µm mesh
032-CS01	33	Darwin	Colonisation sample	21.05.07	2350			35°23.523N	7°11.513W	1110				3 samples deployed
033		Darwin	Gravity Core	22.05.07	0710			35°23.539N	7°11.509W	1105			40	
034		Darwin	Gravity Core	22.05.07	0834			35°23.530N	7°11.510W	1104			36	
035		Darwin	Gravity Core	22.05.07	1006			35°23.527N	7°11.480W	1103			1	mussel shells & fragments
036	34	Darwin	ISIS	22.05.07	1124	22.05.07	2138	35°23.54N	7°11.50W	1100	35°23.5N	7°11.4W		
036-HTF01	34	Darwin	Heatflow	22.05.07	1244	22.05.07	1253	35°23.546N	7°11.509W	1111				
036-HTF02	34	Darwin	Heatflow	22.05.07	1335	22.05.07	1345	35°23.538N	7°11.508W	1111				
036-HTF03	34	Darwin	Heatflow	22.05.07	1424	22.05.07	1433	35°23.540N	7°11.508W	1120				
036-HTF04	34	Darwin	Heatflow	22.05.07	1655	22.05.07	1704	35°23.479N	7°11.482W	1112				failed
036-HTF05	34	Darwin	Heatflow	22.05.07	1729	22.05.07	1735	35°23.520N	7°11.513W	1112				failed
036-PUC01	34	Darwin	Push Core	22.05.07	1304			35°23.546N	7°11.509W	1111			14	
036-PUC02	34	Darwin	Push Core	22.05.07	1311			35°23.546N	7°11.509W	1111			17	
036-PUC03	34	Darwin	Push Core	22.05.07	1354			35°23.540N	7°11.508W	1112			20	
036-PUC04	34	Darwin	Push Core	22.05.07	1401			35°23.541N	7°11.509W	1112			17	

036-PUC05	34	Darwin	Push Core	22.05.07	1415			35°23.541N	7°11.509W	1112			20	
036-PUC06	34	Darwin	Push Core	22.05.07	1419			35°23.540N	7°11.508W	1112			15	
036-PUC07	34	Darwin	Push Core	22.05.07	1711			35°23.542N	7°11.508W	1112			18	
036-PUC08	34	Darwin	Push Core	22.05.07	1717			35°23.542N	7°11.508W	1112			16	
036-PUC09	34	Darwin	Push Core	22.05.07	1721			35°23.541N	7°11.508W	1112			12	bubble site
036-PUC10	34	Darwin	Push Core	22.05.07	1746			35°23.542N	7°11.507W	1112			19	
036-PUC11	34	Darwin	Push Core	22.05.07	1755			35°23.544N	7°11.509W	1112			17	
036-PUC12	34	Darwin	Push Core	22.05.07	1814			35°23.541N	7°11.509W	1112			11	
036-SW01	34	Darwin	MS2000	22.05.07	1836	22.05.07	2032	35°23.572N	7°11.529W	1092	35°23.589N	7°11.443W		Swath logging failure
037		Darwin	Gravity Core	22.05.07	2236			35°23.476N	7°11.492W	1105			24	
038		Darwin	Gravity Core	22.05.07	2359			35°23.473N	7°11.493W	1105			100	
039		Western	SVP	23.05.07	0815	23.05.07	0955	34°53.285N	8°18.397W	2876				Max. 2600 m
040		Western	Multibeam, SBP	23.05.07	1029	23.05.07	1148	34°53.512N	8°18.415W	2881	34°51.570N	8°25.968W		MBES files 23-25
041		Western	Gravity Core	23.05.07	1341			34°52.557N	8°22.091W	2771			464	
042		Western	Piston Core	23.05.07	1659			34°52.836N	8°20.706W	2762			470	
043		Carlos Rib.	Piston Core	24.05.07	0130			35°46.040N	8°26.551W	2344			546	
044		Carlos Rib.	Mega Core	24.05.07	0543			35°46.042N	8°26.554W	2344			18	8 out of 8
045		Carlos Rib.	Piston Core	24.05.07	0811			35°46.044N	8°26.556W	2345			NR	
046		Carlos Rib.	Multibeam, SBP	24.05.07	0950	24.05.07	1110	35°46.12N	8°26.69W	2354	35°47.53N	8°24.73W		
047	35	Carlos Rib.	ISIS	24.05.07	1145	25.05.07	1938	35°47.1N	8°25.5W	2200	35°47.3N	8°25.4W		
047-SW01	35	Carlos Rib.	MS2000	24.05.07	1443	25.05.07	1508	35°47.093N	8°25.435W	2189	35°47.262N	8°25.437W		
047-AL01	35	Carlos Rib.	Aquamonitor	25.05.07	1547	25.05.07	1600	35°47.286N	8°25.229W	2211				Bag 2
047-AL02	35	Carlos Rib.	Aquamonitor	25.05.07	1613	25.05.07	1626	35°47.290N	8°25.263W	2203				Bag 3
047-AL03	35	Carlos Rib.	Aquamonitor	25.05.07	1640	25.05.07	1655	35°47.289N	8°25.298W	2197				Bag 4
047-AL04	35	Carlos Rib.	Aquamonitor	25.05.07	1709	25.05.07	1723	35°47.292N	8°25.331W	2196				Bag 5
047-AL05	35	Carlos Rib.	Aquamonitor	25.05.07	1737	25.05.07	1753	35°47.289N	8°25.361W	2197				Bag 6
047-AL06	35	Carlos Rib.	Aquamonitor	25.05.07	1805	25.05.07	1820	35°47.291N	8°25.396W	2202				Bag 7
047-AL07	35	Carlos Rib.	Aquamonitor	25.05.07	1833	25.05.07	1848	35°47.263N	8°25.391W	2197				Bag 8
047-AL08	35	Carlos Rib.	Aquamonitor	25.05.07	1855	25.05.07	1910	35°47.263N	8°25.363W	2197				Bag 9
047-AL09	35	Carlos Rib.	Aquamonitor	25.05.07	1921	25.05.07	1936	35°47.264N	8°25.332W	2195				Bag 10
048		Carlos Rib.	Gravity Core	25.05.07	2250			35°47.225N	8°25.292W	2177			161	
049		Carlos Rib.	Gravity Core	26.05.07	0021			35°47.224N	8°25.290W	2177			124	
050		Carlos Rib.	Mega Core	26.05.07	0215			35°47.221N	8°25.292W	2176			20	8 out of 8

051	36	Carlos Rib.	ISIS	26.06.07	0328	26.05.07	1632	35°47.3N	8°25.3W	2200	35°47.15N	8°25.26W		
051-AL01	36	Carlos Rib.	Aquamonitor	26.05.07	0519	26.05.07	0536	35°47.260N	8°25.301W	2196				Bag 11
051-AL02	36	Carlos Rib.	Aquamonitor	26.05.07	0542	26.05.07	0559	35°47.259N	8°25.265W	2198				Bag 12
051-AL03	36	Carlos Rib.	Aquamonitor	26.05.07	0606	26.05.07	0624	35°47.262N	8°25.232W	2204				Bag 13
051-AL04	36	Carlos Rib.	Aquamonitor	26.05.07	0632	26.05.07	0648	35°47.236N	8°25.230W	2205				Bag 14
051-AL05	36	Carlos Rib.	Aquamonitor	26.05.07	0656	26.05.07	0714	35°47.236N	8°25.262W	2199				Bag 15
051-AL06	36	Carlos Rib.	Aquamonitor	26.05.07	0722	26.05.07	0739	35°47.235N	8°25.301W	2197				Bag 16
051-AL07	36	Carlos Rib.	Aquamonitor	26.05.07	0746	26.05.07	0803	35°47.237N	8°25.327W	2198				Bag 17
051-AL08	36	Carlos Rib.	Aquamonitor	26.05.07	0809	26.05.07	0828	35°47.235N	8°25.362W	2197				Bag 18
051-AL09	36	Carlos Rib.	Aquamonitor	26.05.07	0834	26.05.07	0853	35°47.238N	8°25.393W	2199				Bag 19
051-AL10	36	Carlos Rib.	Aquamonitor	26.05.07	0900	26.05.07	0918	35°47.209N	8°25.395W	2199				Bag 20
051-AL11	36	Carlos Rib.	Aquamonitor	26.05.07	0929	26.05.07	0948	35°47.205N	8°25.367W	2198				Bag 21
051-AL12	36	Carlos Rib.	Aquamonitor	26.05.07	0959	26.05.07	1019	35°47.210N	8°25.331W	2199				Bag 22
051-AL13	36	Carlos Rib.	Aquamonitor	26.05.07	1027	26.05.07	1046	35°47.210N	8°25.296W	2199				Bag 23
051-AL14	36	Carlos Rib.	Aquamonitor	26.05.07	1053	26.05.07	1113	35°47.207N	8°25.265W	2200				Bag 24
051-AL15	36	Carlos Rib.	Aquamonitor	26.05.07	1121	26.05.07	1141	35°47.209N	8°25.231W	2205				Bag 25
051-AL16	36	Carlos Rib.	Aquamonitor	26.05.07	1150	26.05.07	1211	35°47.183N	8°25.228W	2210				Bag 26
051-AL17	36	Carlos Rib.	Aquamonitor	26.05.07	1222	26.05.07	1242	35°47.184N	8°25.266W	2203				Bag 27
051-AL18	36	Carlos Rib.	Aquamonitor	26.05.07	1251	26.05.07	1313	35°47.180N	8°25.297W	2200				Bag 28
051-AL19	36	Carlos Rib.	Aquamonitor	26.05.07	1321	26.05.07	1342	35°47.178N	8°25.329W	2200				Bag 29
051-AL20	36	Carlos Rib.	Aquamonitor	26.05.07	1349	26.05.07	1411	35°47.180N	8°25.367W	2202				Bag 30
051-AL21	36	Carlos Rib.	Aquamonitor	26.05.07	1419	26.05.07	1441	35°47.180N	8°25.398W	2208				Bag 31
051-AL22	36	Carlos Rib.	Aquamonitor	26.05.07	1449	26.05.07	1512	35°47.208N	8°25.396W	2199				Bag 32
051-AL23	36	Carlos Rib.	Aquamonitor	26.05.07	1539	26.05.07	1602	35°47.088N	8°25.310W	2241				Bag 33
051-PUC01	36	Carlos Rib.	Push Core	27.05.07	0733			35°47.244N	8°25.282W	2197			20	
051-PUC02	36	Carlos Rib.	Push Core	27.05.07	0745			35°47.244N	8°25.282W	2197			18	
051-PUC03	36	Carlos Rib.	Push Core	27.05.07	0753			35°47.244N	8°25.282W	2197			18	
051-PUC04	36	Carlos Rib.	Push Core	27.05.07	1130			35°47.091N	8°25.306W	2240			14	
051-PUC05	36	Carlos Rib.	Push Core	27.05.07	1200			35°47.091N	8°25.306W	2240			14	
051-PUC06	36	Carlos Rib.	Push Core	27.05.07	1234			35°47.091N	8°25.306W	2240			16	
051-CS01	36	Carlos Rib.	Colonisation sample	27.05.07	0700			35°47.244N	8°25.282W	2197				3 samples deployed
051-Bibo4	36	Carlos Rib.	Claw/Biobox	27.05.07	1105	27.05.07	1115	35°47.109N	8°25.302W	2228				Sample lost
051-Bibo2	36	Carlos Rib.	Claw/Biobox	27.05.07	1225	27.05.07	1234	35°47.102N	8°25.309W	2230				*Acanella*
051-Bibo3	36	Carlos Rib.	Claw/Biobox	27.05.07	1302	27.05.07	1314	35°47.131N	8°25.339W	2213				Wood

051-Bibo4	36	Carlos Rib.	Claw/Biobox	27.05.07	1334	27.05.07	1340	35°47.19N	8°25.34W	2194				Seawhip
051-Bibo5	36	Carlos Rib.	Claw/Biobox	27.05.07	1346	27.05.07	1355	35°47.20N	8°25.35W	2193				*Bathypathes*
052		Carlos Rib.	Gravity Core	27.05.07	1752			35°47.255N	8°25.327W	2173			200	
053		Carlos Rib.	Piston Core	27.05.07	2021			35°47.259N	8°25.320W	2174			548	
054		Carlos Rib.	Mega Core	27.05.07	2306			35°47.300N	8°25.219W	2179			66	8 out of 8
055		Carlos Rib.	Mega Core	28.05.07	0119			35°47.256N	8°25.320W	2176			0	failed
056	37	Carlos Rib.	ISIS	28.05.07	0240	28.05.07	2127	35°47.25N	8°25.36W	2200	35°47.3N	8°25.2W		
056-PUC01	37	Carlos Rib.	Push Core	28.05.07	0445			35°47.259N	8°25.319W	2227			12	
056-PUC02	37	Carlos Rib.	Push Core	28.05.07	0449			35°47.259N	8°25.319W	2227			37	
056-PUC03	37	Carlos Rib.	Push Core	28.05.07	0455			35°47.259N	8°25.319W	2227			17	
056-PUC04	37	Carlos Rib.	Push Core	28.05.07	1100			35°47.246N	8°25.314W	2195			0	failed
056-PUC05	37	Carlos Rib.	Push Core	28.05.07	1109			35°47.246N	8°25.314W	2195			15	
056-PUC06	37	Carlos Rib.	Push Core	28.05.07	1115			35°47.246N	8°25.314W	2195			14	
056-PUC07	37	Carlos Rib.	Push Core	28.05.07	1133			35°47.229N	8°25.317W	2197			23	
056-PUC08	37	Carlos Rib.	Push Core	28.05.07	1136			35°47.229N	8°25.317W	2197			18	
056-PUC09	37	Carlos Rib.	Push Core	28.05.07	1145			35°47.229N	8°25.317W	2197			22	
056-PUC10	37	Carlos Rib.	Push Core	28.05.07	1157			35°47.186N	8°25.316W	2199			17	
056-PUC11	37	Carlos Rib.	Push Core	28.05.07	1225			35°47.161N	8°25.311W	2204			33	
056-PUC12	37	Carlos Rib.	Push Core	28.05.07	1232			35°47.161N	8°25.311W	2204			12	
056-PUC13	37	Carlos Rib.	Push Core	28.05.07	1237			35°47.161N	8°25.311W	2204			22	
056-PUC14	37	Carlos Rib.	Push Core	28.05.07	1318			35°47.080N	8°25.306W	2242			15	
056-PUC15	37	Carlos Rib.	Push Core	28.05.07	1323			35°47.080N	8°25.306W	2242			24	
056-PUC16	37	Carlos Rib.	Push Core	28.05.07	1400			35°47.054N	8°25.223W	2243			31	
056-PUC17	37	Carlos Rib.	Push Core	28.05.07	1409			35°47.054N	8°25.223W	2243			17	
056-PUC18	37	Carlos Rib.	Push Core	28.05.07	1415			35°47.054N	8°25.223W	2243			15	
056-PUC19	37	Carlos Rib.	Push Core	28.05.07	1435			35°47.033N	8°25.166W	2228			14	
056-HTF01	37	Carlos Rib.	Heatflow	28.05.07	0507	28.05.07	0524	35°47.259N	8°25.319W	2195				
056-HTF02	37	Carlos Rib.	Heatflow	28.05.07	0549	28.05.07	0559	35°47.258N	8°25.333W	2195				
056-HTF03	37	Carlos Rib.	Heatflow	28.05.07	0612	28.05.07	0624	35°47.265N	8°25.349W	2227				
056-HTF04	37	Carlos Rib.	Heatflow	28.05.07	0636	28.05.07	0648	35°47.264N	8°25.363W	2228				
056-HTF05	37	Carlos Rib.	Heatflow	28.05.07	0708	28.05.07	0720	35°47.288N	8°25.318W	2228				
056-HTF06	37	Carlos Rib.	Heatflow	28.05.07	0738	28.05.07	0750	35°47.275N	8°25.314W	2227				
056-HTF07	37	Carlos Rib.	Heatflow	28.05.07	0759	28.05.07	0812	35°47.268N	8°25.314W	2227				
056-HTF08	37	Carlos Rib.	Heatflow	28.05.07	0833	28.05.07	0844	35°47.265N	8°25.296W	2227				
056-HTF09	37	Carlos Rib.	Heatflow	28.05.07	0904	28.05.07	0917	35°47.263N	8°25.280W	2229				

056-HTF10	37	Carlos Rib.	Heatflow	28.05.07	0923	28.05.07	0936	35°47.262N	8°25.266W	2230				
056-HTF11	37	Carlos Rib.	Heatflow	28.05.07	0941	28.05.07	0956	35°47.255N	8°25.299W	2228				
056-HTF12	37	Carlos Rib.	Heatflow	28.05.07	1010	28.05.07	1024	35°47.257N	8°25.316W	2195				
056-HTF13	37	Carlos Rib.	Heatflow	28.05.07	1029	28.05.07	1039	35°47.255N	8°25.332W	2195				
056-HTF14	37	Carlos Rib.	Heatflow	28.05.07	1051	28.05.07	1101	35°47.246N	8°25.314W	2196				
056-HTF15	37	Carlos Rib.	Heatflow	28.05.07	1129	28.05.07	1141	35°47.229N	8°25.317W	2197				
056-HTF16	37	Carlos Rib.	Heatflow	28.05.07	1151	28.05.07	1203	35°47.186N	8°25.316W	2199				
056-Bibo1	37	Carlos Rib.	Claw/Biobox	28.05.07	1750	27.05.07	1803	35°47.184N	8°25.265W	2194				hydroid
057		Carlos Rib.	Mega Core	28.05.07	2321			35°47.250N	8°25.324W	2175			32	8 out of 12
058		Carlos Rib.	Piston Core	29.05.07	0146			35°47.196N	8°25.269W	2177			231	
059		Carlos Rib.	Piston Core	29.05.07	0442			35°47.170N	8°25.248W	2179			133	
060		Carlos Rib.	Gravity Core	29.05.07	0716			35°47.076N	8°25.229W	2189			197	
061		Carlos Rib.	Mega Core	29.05.07	0913			35°47.073N	8°25.218W	2190			22	
062		Carlos Rib.	Mega Core	29.05.07	1336			35°47.170N	8°25.246W	2180			20	
063		Carlos Rib.	Mega Core	29.05.07	1558			35°47.197N	8°25.269W	2177			36	
064		Shipwreck	Multibeam, SBP	29.05.07		29.05.07		confidential	confidential	2585				
065	38	Shipwreck	Isis Video	29.05.07	2037	30.05.07	0530	35°33.95N	8°34.45W	2580	35°33.97N	8°34.18W		
066		Captain Arutyunov	Piston Core	30.05.07	1241			35°39.637N	7°20.046W	1311			408	
067		Mercator	Piston Core	30.05.07	1833			35°17.934N	6°38.877W	358			0	failed
068		Mercator	Gravity Core	30.05.07	1938			35°17.837N	6°38.703W	350			0	failed
069		Mercator	Gravity Core	30.05.07	2035			35°17.939N	6°38.877W	357			101	
070		Mercator	Mega Core	30.05.07	2136			35°17.937N	6°38.877W	357			38	3 out of 4
071		Mercator	Mega Core	30.05.07	2217			35°17.837N	6°38.701W	351			37	3 out of 4
072		Mercator	Gravity Core	30.05.07	2336			35°18.813N	6°37.169W	374			0	failed
073		Mercator	Gravity Core	31.05.07	0035			35°18.717N	6°37.217W	380			454	
074	39	Mercator	ISIS	31.05.07	0340	31.06.07	2112	35°17.91N	6°38.7W	355	35°17.9N	6°38.7W		
074-HTF01	39	Mercator	Heatflow	31.05.07	0424	31.05.07	0436	35°17.914N	6°38.682W	355				
074-HTF02	39	Mercator	Heatflow	31.05.07	0452	31.05.07	0504	35°17.915N	6°38.705W	355				
074-HTF03	39	Mercator	Heatflow	31.05.07	0543	31.05.07	0556	35°17.914N	6°38.732W	353				
074-HTF04	39	Mercator	Heatflow	31.05.07	0606	31.05.07	0617	35°17.914N	6°38.760W	352				
074-HTF05	39	Mercator	Heatflow	31.05.07	0626	31.05.07	0637	35°17.915N	6°38.788W	350				
074-HTF06	39	Mercator	Heatflow	31.05.07	0644	31.05.07	0655	35°17.914N	6°38.813W	349				
074-HTF07	39	Mercator	Heatflow	31.05.07	0703	31.05.07	0714	35°17.939N	6°38.762W	352				
074-HTF08	39	Mercator	Heatflow	31.05.07	0720	31.05.07	0732	35°17.894N	6°38.762W	396				

074-HTF09	39	Mercator	Heatflow	31.05.07	0736	31.05.07	0748	35°17.870N	6°38.759W	396				
074-HTF10	39	Mercator	Heatflow	31.05.07	0753	31.05.07	0804	35°17.849N	6°38.756W	348				
074-HTF11	39	Mercator	Heatflow	31.05.07	0811	31.05.07	0823	35°17.828N	6°38.763W	347				
074-SW01	39	Mercator	MS2000	31.05.07	0908	31.05.07	1635	35°17.656N	6°38.858W	389	35°17.646N	6°38.696W		
074-AL01	39	Mercator	Aquamonitor	31.05.07	1751	31.05.07	1804	35°17.826N	6°38.685W	360				Bag 2
074-AL02	39	Mercator	Aquamonitor	31.05.07	1811	31.05.07	1824	35°17.860N	6°38.685W	355				Bag 3
074-AL03	39	Mercator	Aquamonitor	31.05.07	1831	31.05.07	1844	35°17.894N	6°38.686W	351				Bag 4
074-AL04	39	Mercator	Aquamonitor	31.05.07	1849	31.05.07	1903	35°17.925N	6°38.685W	342				Bag 5
074-AL05	39	Mercator	Aquamonitor	31.05.07	1907	31.05.07	1921	35°17.958N	6°38.686W	355				Bag 6
074-AL06	39	Mercator	Aquamonitor	31.05.07	1927	31.05.07	1942	35°17.958N	6°38.726W	354				Bag 7
074-AL07	39	Mercator	Aquamonitor	31.05.07	1947	31.05.07	2003	35°17.925N	6°38.725W	351				Bag 8
074-AL08	39	Mercator	Aquamonitor	31.05.07	2008	31.05.07	2023	35°17.893N	6°38.725W	350				Bag 9
074-AL09	39	Mercator	Aquamonitor	31.05.07	2026	31.05.07	2043	35°17.858N	6°38.725W	348				Bag 10
075	40	Mercator	ISIS	31.05.07	2148	01.06.07	0719	35°17.9N	6°38.7W	355	35°17.9N	6°38.7W		
075-AL01	40	Mercator	Aquamonitor	31.05.07	2228	01.06.07	0543	35°17.826N	6°38.724W	351	35°17.915N	6°38.708W		Failed
076	41	Darwin	ISIS	01.06.07	1133	01.06.07	2103	35°23.5N	7°11.5W	1110	35°23.45N	7°11.47W		
076-SW01	41	Darwin	MS2000	01.06.07	1733	01.06.07	2008	35°23.459N	7°11.544W	1109	35°23.458N	7°11.477W		
076-PUC01	41	Darwin	Push Core	01.06.07	1256			35°23.538N	7°11.508W	1111			22	
076-PUC02	41	Darwin	Push Core	01.06.07	1257			35°23.538N	7°11.508W	1111			20	
076-PUC03	41	Darwin	Push Core	01.06.07	1356			35°23.540N	7°11.513W	1106			24	
076-PUC04	41	Darwin	Push Core	01.06.07	1701			35°23.492N	7°11.501W	1112			22	
076-SUS1	41	Darwin	Suction sample	01.06.07	1425	01.06.07	1441	35°23.525N	7°11.511W	1109				Meiofauna
076-Bibo1	41	Darwin	Scoop/Biobox	01.06.07	1452	01.06.07	1508	35°23.503N	7°11.498W	1109				Mussels
076-Bibo2	41	Darwin	Scoop/Biobox	01.06.07	1600	01.06.07	1610	35°23.540N	7°11.481W	1109				Mussels
076-Bibo3	41	Darwin	Scoop/Biobox	01.06.07	1610	01.06.07	1627	35°23.533N	7°11.481W	1109				Mussels
076-SUS2	41	Darwin	Suction sample	01.06.07	1627	01.06.07	1636	35°23.532N	7°11.479W	1109				Mussels

Station List: JC10 Leg 2.

Station no JC10-	ISIS Dive no	Area	Gear	Start Date	Start Time	End Date	End Time	Start Latitude	Start Longitude	Depth (m)	End Latitude	End Longitude	Core Recovery (cm)	Remarks
077	42	Lisbon	ISIS	04.06.07	0827	04.06.07	2242	38°26.75N	9°18.74W	964	38°26.6N	9°19.1W		
077-PUC01	42	Lisbon	Push Core	04.06.07	1444			38°26.365N	9°19.221W	996			NR	
077-PUC02	42	Lisbon	Push Core	04.06.07	1456			38°26.365N	9°19.221W	996			NR	
077-Bibo01	42	Lisbon	Biobox	04.06.07	1704			38°26.645N	9°19.116W	894				Brisingid
077-SUS01	42	Lisbon	Suction Sample	04.06.07	1801			38°26.634N	9°19.133W	844				
077-Bibo02	42	Lisbon	Biobox	04.06.07	1832			38°26.622N	9°19.101W	785				Cidaris
077-PUC03	42	Lisbon	Push Core	04.06.07	2101			38°26.492N	9°19.085W	568			NR	
077-PUC04	42	Lisbon	Push Core	04.06.07	2106			38°26.492N	9°19.085W	568			21.5	
077-PUC05	42	Lisbon	Push Core	04.06.07	2121			38°26.492N	9°19.085W	568			15	
078		Lisbon	CTD	04.06.07	2352			38°26.841N	9°19.232W	989				
079		Lisbon	SAPS	05.06.07	0207	05.06.07	0307	38°26.838N	9°19.234W	984	38°26.838N	9°19.23W		SAPS at 50 and 974 m
080	43	Setubal	ISIS	05.06.07	0555	05.06.07	1806	38°16.102N	9°10.003W	1416	38°15.67N	9°10.17W		
080-PUC01	43	Setubal	Push Core	05.06.07	1119			38°15.951N	9°10.152W	1455			NR	
080-PUC02	43	Setubal	Push Core	05.06.07	1124			38°15.951N	9°10.152W	1455			NR	
080-PUC03	43	Setubal	Push Core	05.06.07	1136			38°15.951N	9°10.152W	1455			NR	
080-SUS01	43	Setubal	Suction Sample	05.06.07	1212			38°15.923N	9°10.135W	1396				Oysters & Hydroids
080-Bibo1	43	Setubal	Biobox	05.06.07	1222			38°15.923N	9°10.135W	1396				oyster?
080-Bibo2	43	Setubal	Biobox	05.06.07	1257			38°15.926N	9°10.154W	1393				2 sponges + bryzoa
080-Rock	43	Setubal	Rock	05.06.07	1408			38°15.855N	9°10.188W	1289				rock
080-SUS02	43	Setubal	Suction Sample	05.06.07	1431			38°15.829N	9°10.189W	1259				sea urchin
080-PUC04	43	Setubal	Push Core	05.06.07	1440			38°15.826N	9°10.187W	1259			NR	
080-PUC05	43	Setubal	Push Core	05.06.07	1444			38°15.826N	9°10.187W	1259			NR	
080-Bibo3	43	Setubal	Biobox	05.06.07	1523			38°15.750N	9°10.195W	1157				starfish
080-PUC06	43	Setubal	Push Core	05.06.07	1636			38°15.676N	9°10.180W	1050			NR	
081		Setubal	CTD	05.06.07	1911			38°16.045N	9°10.152W	1437				
082		Setubal	SAPS	05.06.07	2100	05.06.07	2200	38°16.056N	9°10.152W	1440	38°16.056N	9°10.15W		SAPS at 20 and 1430 m
083		Setubal	Elevator(BICS)	05.06.07	2331	06.06.07	1928	38°16.044N	9°10.006W	1400	38°15.999N	9°9.865W		starfish
084	44	Setubal	ISIS	06.06.07	0105	06.06.07	1718	38°16.045N	9°10.006W	1400	38°15.996N	9°9.891W		

084-Bibo1	44	Setubal	Biobox	06.06.07	0630			38°16.018N	9°10.045W	1451				starfish
084-SW01	44	Setubal	Swath	06.06.07	0830	06.06.07	1436	38°16.053N	9°09.892W	1378	38°16.008N	9°09.957W		
084-PUC01	44	Setubal	Push Core	06.06.07	1531			38°16.021N	9°09.925W	1440			NR	
084-PUC02	44	Setubal	Push Core	06.06.07	1534			38°16.022N	9°09.925W	1440			NR	
084-PUC03	44	Setubal	Push Core	06.06.07	1536			38°16.022N	9°09.925W	1440			NR	
085		Nazare	SVProbe	07.06.07	0843			39°35.396N	10°20.001W	4351				
086		Nazare	Bathysnap deployment	07.06.07	1144			39°34.35N	10°17.86W	4353				
087	45	Nazare	ISIS	07.06.07	1348	08.06.07	2141	39°34.756N	10°18.069W	4350	39°34.428N	10°18.162W		
087-VT01	45	Nazare	Video transect	07.06.07	1639	07.06.07	1949	39°34.736N	10°18.106W	4352	39°34.103N	10°18.238W		
087-SW01	45	Nazare	Swath	07.06.07	1956	07.06.07	2206	39°34.103N	10°18.238W	4335	39°34.728N	10°17.992W		
087-EX01	45	Nazare	Experiment	08.06.07	0259			39°34.751N	10°17.916W	4349				Chamber B switched on
087-EX02	45	Nazare	Experiment	08.06.07	0340			39°34.765N	10°17.924W	4350				Chamber A switched on
087-SW02	45	Nazare	Swath	08.06.07	0407	08.06.07	1606	39°34.737N	10°18.021W	4331	39°34.756N	10°18.053W		
087-PUC1	45	Nazare	Push Core	08.06.07	1640			39°34.734N	10°18.116W	4355			20	
087-PUC2	45	Nazare	Push Core	08.06.07	1649			39°34.723N	10°18.122W	4356			21	
087-PUC3	45	Nazare	Push Core	08.06.07	1650			39°34.724N	10°18.124W	4356			18	
087-PUC4	45	Nazare	Push Core	08.06.07	1653			39°34.728N	10°18.119W	4357			22.5	
087-PUC5	45	Nazare	Push Core	08.06.07	1658			39°34.723N	10°18.119W	4357			22	
087-PUC6	45	Nazare	Push Core	08.06.07	1707			39°34.728N	10°18.122W	4357			23.5	
087-PUC7	45	Nazare	Push Core	08.06.07	1806			39°34.728N	10°18.122W	4357			17	
087-PUC8	45	Nazare	Push Core	08.06.07	1824			39°34.523N	10°18.122W	4374			14	
087-PUC9	45	Nazare	Push Core	08.06.07	1830			39°34.523N	10°18.122W	4374			15.5	
087-PUC10	45	Nazare	Push Core	08.06.07	1905			39°34.410N	10°18.172W	4368			0	
088		Nazare	elevator	07.06.07	2230	10.06.07	0908	39°34.730N	10°17.903W	4347	39°35.2N	10°17.5W		
089		Nazare	Megacore	09.06.07	0035			39°34.71N	10°18.11W	4355			18-45	
090		Nazare	Elevator	09.06.07	0445	13.06.07	1645	39°29.856N	9°55.857W	3511	39°29.9N	9°55.9W		
091	46	Nazare	ISIS	09.06.07	0540	10.06.07	0228	39°29.802N	9°55.856W	3525	39°29.781N	9°55.922W		
091-Bics01	46	Nazare	Bics	09.06.07	0925			39°29.821N	9°55.984W	3534				BICS on
091-HWC	46	Nazare	Holothurian chambers	09.06.07	1221			39°29.826N	9°55.890W	3534				Cover closed
091-Bibo01	46	Nazare	Bibo	09.06.07	1339			39°29.835N	9°55.973W	3533				Holothurians
091-VT01	46	Nazare	Video transect	09.06.07	1500	09.06.07	1629	39°29.493N	9°56.038W	3642	39°29.814N	9°56.048W		
091-SW01	46	Nazare	Swath	09.06.07	1648	09.06.07	2207	39°29.827N	9°55.958W	3511	39°29.297N	9°56.040W		

091-PUC01	46	Nazare	Push Core	09.06.07	2327			39°29.822N	9°55.995W	3535			NR	
091-PUC02	46	Nazare	Push Core	09.06.07	2333			39°29.822N	9°55.995W	3535			NR	
091-PUC03	46	Nazare	Push Core	09.06.07	2339			39°29.822N	9°55.995W	3535			NR	
091-PUC04	46	Nazare	Push Core	09.06.07	2346			39°29.822N	9°55.995W	3535			NR	
091-PUC05	46	Nazare	Push Core	09.06.07	2352			39°29.822N	9°55.995W	3535			NR	
091-PUC06	46	Nazare	Push Core	09.06.07	2355			39°29.822N	9°55.995W	3535			NR	
92	47	Nazare	ISIS	10.06.07	0526	11.06.07	0305	39°34.733N	10°17.903W	4348	39°34.268N	10°18.180W		
92-EX01	47	Nazare	Experiment	10.06.07	0908			39°34.756N	10°17.929W	4350				
92-EX02	47	Nazare	Experiment	10.06.07	1038			39°34.754N	10°17.905W	4347				
92-MBox01	47	Nazare	Mini Box core	10.06.07	1744			39°34.716N	10°18.091W	4356			NR	
92-MBox02	47	Nazare	Mini Box core	10.06.07	1807			39°34.710N	10°18.097W	4357			NR	
92-MBox03	47	Nazare	Mini Box core	10.06.07	1854			39°34.710N	10°18.097W	4357			NR	
92-PUC01	47	Nazare	Push Core	10.06.07	1903			39°34.711N	10°18.112W	4356			NR	
92-PUC02	47	Nazare	Push Core	10.06.07	2206			39°34.197N	10°18.112W	4369			11.5	
92-PUC03	47	Nazare	Push Core	10.06.07	2226			39°34.158N	10°18.235W	4357			13.5	
92-PUC04	47	Nazare	Push Core	10.06.07	2229			39°34.157N	10°18.234W	4357			NR	
92-PUC05	47	Nazare	Push Core	10.06.07	2234			39°34.158N	10°18.221W	4358			15	
92-PUC06	47	Nazare	Push Core	10.06.07	2243			39°34.157N	10°18.221W	4358			13	
92-VT01	47	Nazare	Video transect	10.06.07	2301	10.06.07	2315	39°34.235N	10°18.212W	4391	39°34.196N	10°18.229W		
92-VT02	47	Nazare	Video transect	10.06.07	2323	10.06.07	2342	39°34.241N	10°18.208W	4395	39°34.192N	10°18.227W		
92-VT03	47	Nazare	Video transect	10.06.07	2351	11.06.07	0007	39°34.256N	10°18.165W	4394	39°34.194N	10°18.205W		
93		Nazare	Megacore	11.06.07	1308			39°30.045N	9°55.882W	3447			38-40	
94		Nazare	elevator	11.06.07	1528	13.06.07	1044	39°29.9N	9°56.2W	3500	39°29.9N	9°56.1W		
95	48	Nazare	ISIS	11.06.07	1605	12.06.07	1854	39°29.941N	09°56.169W	3500	39°29.8N	09°56.0W		
95-PUC01	48	Nazare	Push Core	11.06.07	1850			39°29.948N	09°56.187W	3519			NR	
95-FX1	48	Nazare	Feedex	11.06.07	1958			39°29.959N	09°56.196W	3507				Exp. Unit 7
95-FX2	48	Nazare	Feedex	11.06.07	2037			39°29.960N	09°56.196W	3509				Exp. Unit 8
95-FX3	48	Nazare	Feedex	11.06.07	2104			39°29.956N	09°56.197W	3510				Exp. Unit 4
95-FX4	48	Nazare	Feedex	11.06.07	2134			39°29.959N	09°56.182W	3513				Exp. Unit 9
95-FX5	48	Nazare	Feedex	11.06.07	2212			39°29.959N	09°56.189W	3516				Exp. Unit 1
95-FX6	48	Nazare	Feedex	11.06.07	2258			39°29.952N	09°56.193W	3519				Exp. Unit 2
95-FX7	48	Nazare	Feedex	12.06.07	2358			39°29.950N	09°56.189W	3520				Exp. Unit 3
95-FX8	48	Nazare	Feedex	12.06.07	0034			39°29.954N	09°56.187W	3515				Exp. Unit 6
95-FX9	48	Nazare	Feedex	12.06.07	0114			39°29.948N	09°56.186W	3522				Exp. Unit 5
95-SW01	48	Nazare	Swath	12.06.07	0202	12.06.07	0908	39°29.816N	09°56.042W	3511	39°29.829N	09°56.087W		Start 52-59

095-HWC	48	Nazare	Holothurian chambers	12.06.07	0940			39°29.822N	09°55.980W	3534				Cover closed
095-SUS	48	Nazare	Suction Sample	12.06.07	1000			39°29.820N	09°55.974W	3534				squat lobster
95-PUC02	48	Nazare	Push Core	12.06.07	1120			39°29.954N	09°56.205W	3512			19	
95-PUC03	48	Nazare	Push Core	12.06.07	1126			39°29.952N	09°56.198W	3512			21.5	
95-PUC04	48	Nazare	Push Core	12.06.07	1141			39°29.952N	09°56.194W	3512			10	
95-PUC05	48	Nazare	Push Core	12.06.07	1144			39°29.948N	09°56.193W	3512			18	
95-PUC06	48	Nazare	Push Core	12.06.07	1150			39°29.948N	09°56.194W	3512			20	
95-PUC07	48	Nazare	Push Core	12.06.07	1153			39°29.953N	09°56.197W	3512			NR	
95-PUC08	48	Nazare	Push Core	12.06.07	1156			39°29.955N	09°56.199W	3512			22.5	
95-PUC09	48	Nazare	Push Core	12.06.07	1202			39°29.955N	09°56.199W	3512			17.5	
95-PUC10	48	Nazare	Push Core	12.06.07	1220			39°29.949N	09°56.187W	3514			11.5	FX 7a
95-PUC11	48	Nazare	Push Core	12.06.07	1230			39°29.955N	09°56.197W	3514			0	FX 7c failed
95-PUC12	48	Nazare	Push Core	12.06.07	1236			39°29.955N	09°56.190W	3514			16	FX7b
95-PUC11-repeat	48	Nazare	Push Core	12.06.07	1239			39°29.955N	09°56.190W	3514			21	FX 7c repeat
95-PUC13	48	Nazare	Push Core	12.06.07	1255			39°29.995N	09°56.196W	3514			0	FX 8a failed
95-PUC14	48	Nazare	Push Core	12.06.07	1259			39°29.995N	09°56.196W	3514			14	FX 8b
95-PUC15	48	Nazare	Push Core	12.06.07	1304			39°29.956N	09°56.189W	3514			3	FX 8c
95-PUC16	48	Nazare	Push Core	12.06.07	1321			39°29.955N	09°56.188W	3515			0	FX 4b failed
95-PUC17	48	Nazare	Push Core	12.06.07	1326			39°29.955N	09°56.188W	3515			3	FX 4c
95-PUC18	48	Nazare	Push Core	12.06.07	1330			39°29.956N	09°56.182W	3515			20.5	FX 4a
96		Nazare	CTD	12.06.07	2317			39°29.485N	09°56.050W	3664				
97		Nazare	SAPS	13.06.07	0330	13.06.07	0530	39°29.486N	09°56.047W	3640	39°29.486N	09°56.047W		SAPS at 30 m depth and 10 m ab
98	49	Nazare	ISIS	13.06.07	0814	13.06.07	0933	39°29.971N	09°56.178W	3507	39°29.971N	09°56.178W		Failed
99	50	Nazare	ISIS	13.06.07	1150	14.06.07	0643	39°29.8N	09°56.0W	3500	39°29.5N	09°56.1W		
99-SUS01	50	Nazare	Suction Sample	13.06.07	1543			39°29.857N	09°55.919W	3525				
99-SW01	50	Nazare	Swath	13.06.07	1714	13.06.07	2327	39°29.811N	09°56.078W	3508	39°29.270N	09°56.152W		
99-SUS02	50	Nazare	Suction Sample	14.06.07	0205			39°29.530N	09°56.142W	3651				gorgonian
99-SUS03	50	Nazare	Suction Sample	14.06.07	0226			39°29.530N	09°56.142W	3649				crinoid
99-SUS04	50	Nazare	Suction Sample	14.06.07	0245			39°29.529N	09°56.145W	3648				octocoral
99-SUS05	50	Nazare	Suction Sample	14.06.07	0327			39°29.566N	09°56.126W	3576				
100		Nazare	Megacore	14.06.07	0934			39°30.045N	09°55.881W	3462			30-42	
101		Nazare	Megacore	14.06.07	1322			39°30.05N	09°55.88W	3466			30-39	

102		Nazare	Piston core	14.06.07	1734			39°29.72N	09°56.07W	3552				
103		Nazare	Piston core	14.06.07	2124			39°29.924N	09°57.501W	3646				
104		Nazare	elevator	14.06.07	2328	17.06.07	1051	39°29.956N	09°56.182W	3554	39°29.6N	09°55.7W		
105		Nazare	elevator	14.06.07	2352	17.06.07	2009	39°29.85N	09°55.85W	3554	39°29.7N	09°55.7W		
106	51	Nazare	ISIS	15.06.07	0307	15.06.07	1728	39°29.8N	09°56.0W	3500	39°29.8N	09°55.8W		
106-EX01	51	Nazare	Experiment	15.06.07	0551			39°29.768N	09°55.954W	3534				Arobics started
106-EX02	51	Nazare	Experiment	15.06.07	0622			39°29.768N	09°55.935W	3530				Arobics started
106-PUC01	51	Nazare	Push Core	15.06.07	0636			39°29.766N	09°55.943W	3529			NR	
106-PUC02	51	Nazare	Push Core	15.06.07	0640			39°29.765N	09°55.940W	3529			NR	
106-PUC03	51	Nazare	Push Core	15.06.07	0641			39°29.767N	09°55.930W	3529			NR	
106-PUC04	51	Nazare	Push Core	15.06.07	0646			39°29.773N	09°55.928W	3529			NR	
106-PUC05	51	Nazare	Push Core	15.06.07	0649			39°29.767N	09°55.936W	3529			NR	
106-PUC06	51	Nazare	Push Core	15.06.07	0651			39°29.771N	09°55.929W	3530			NR	
106-Bics01	51	Nazare	Bics	15.06.07	1010			39°29.809N	09°55.753W	3497				Brittlestar
106-PUC07	51	Nazare	Push Core	15.06.07	1345			39°29.822N	09°55.750W	3496			NR	
106-PUC08	51	Nazare	Push Core	15.06.07	1354			39°29.818N	09°55.749W	3496			NR	
106-PUC09	51	Nazare	Push Core	15.06.07	1359			39°29.811N	09°55.718W	3496			NR	
106-PUC10	51	Nazare	Push Core	15.06.07	1401			39°29.812N	09°55.744W	3496			NR	
106-PUC11	51	Nazare	Push Core	15.06.07	1414			39°29.817N	09°55.735W	3495			NR	
107		Nazare	CTD	15.06.07	2026			39°31.266N	09°33.917W	1751				
108	52	Nazare	ISIS	15.06.07	2126	16.06.07	0745	39°31.3N	09°33.9W	1400	39°30.6N	09°33.5W		
108-PUC01	52	Nazare	Push Core	16.06.07	0036			39°30.997N	09°33.413W	1415			NR	
108-PUC02	52	Nazare	Push Core	16.06.07	0038			39°29.997N	09°33.413W	1415			NR	
108-PUC03	52	Nazare	Push Core	16.06.07	0041			39°30.997N	09°33.413W	1415			NR	
108-PUC04	52	Nazare	Push Core	16.06.07	0043			39°29.997N	09°33.413W	1415			20	
108-PUC05	52	Nazare	Push Core	16.06.07	0046			39°30.997N	09°33.413W	1415			NR	
108-PUC06	52	Nazare	Push Core	16.06.07	0048			39°29.997N	09°33.413W	1415			NR	
108-SUS01	52	Nazare	Suction Sample	16.06.07	0100			39°30.979N	09°33.417W	1390				
109		Nazare	SAPS	16.06.07	1000	16.06.07	1100	39°31.263N	09°33.915W	1822	39°31.263N	09°33.915W		SAPS at 1550 m and 10 m ab
110		Nazare	CTD	16.06.07	1338			39°30.253N	09°39.353W	2214				
111	53	Nazare	ISIS	16.06.07	1440	17.06.07	0153	39°30.3N	09°39.4W	2000	39°31.6N	09°39.9W		
111-PUC01	53	Nazare	Push Core	16.06.07	1700			39°30.485N	09°39.427W	2195			NR	

111-PUC02	53	Nazare	Push Core	16.06.07	1704			39°30.486N	09°39.426W	2195			30	
111-PUC03	53	Nazare	Push Core	16.06.07	1712			39°30.485N	09°39.426W	2195			18	
111-PUC04	53	Nazare	Push Core	16.06.07	1716			39°30.485N	09°39.424W	2195			17	
111-PUC05	53	Nazare	Push Core	16.06.07	2008			39°31.116N	09°39.629W	1685			19.5	
111-Bibo01	53	Nazare	Biobox	16.06.07	2144			39°31.297N	09°39.707W	1555				Xeno
111-Bibo02	53	Nazare	Biobox	16.06.07	2211			39°31.313N	09°39.712W	1522				Gorgonian
111-PUC06	53	Nazare	Push Core	17.06.07	0040			39°31.647N	09°39.909W	1003			17	
112	54	Nazare	ISIS	17.06.07	0357	17.06.07	2046	39°29.817N	09°56.070W	3546	39°29.7N	09°55.7W		
112-EX01	54	Nazare	Experiment	17.06.07	0713			39°29.767N	09°55.942W	3531				Chamber 1 on elevator
112-EX02	54	Nazare	Experiment	17.06.07	0809			39°29.767N	09°55.950W	3532				Chamber 2 on elevator
112-PUC01	54	Nazare	Push Core	17.06.07	0906			39°29.796N	09°55.973W	3533			NR	
112-PUC02	54	Nazare	Push Core	17.06.07	0907			39°29.796N	09°55.973W	3533			NR	
112-PUC03	54	Nazare	Push Core	17.06.07	0909			39°29.796N	09°55.973W	3533			NR	
112-PUC04	54	Nazare	Push Core	17.06.07	0914			39°29.796N	09°55.973W	3533			NR	
112-PUC05	54	Nazare	Push Core	17.06.07	0918			39°29.796N	09°55.973W	3533			NR	
112-PUC06	54	Nazare	Push Core	17.06.07	1332			39°29.947N	09°56.201W	3514			21	FX 9b
112-PUC07	54	Nazare	Push Core	17.06.07	1351			39°29.947N	09°56.201W	3514			18	FX 9c
112-PUC08	54	Nazare	Push Core	17.06.07	1401			39°29.951N	09°56.193W	3514			16.5	FX 9a
112-PUC09	54	Nazare	Push Core	17.06.07	1415			39°29.951N	09°56193W	3514			0	FX 1c failed
112-PUC10	54	Nazare	Push Core	17.06.07	1427			39°29.951N	09°56.193W	3514			19	FX 1b
112-PUC11	54	Nazare	Push Core	17.06.07	1434			39°29.950N	09°56.187W	3517			15	FX 1a
112-PUC12	54	Nazare	Push Core	17.06.07	1448			39°29.948N	09°56.175W	3518			0	FX 2c failed
112-PUC13	54	Nazare	Push Core	17.06.07	1502			39°29.948N	09°56.186W	3519			0	FX 2a failed
112-PUC14	54	Nazare	Push Core	17.06.07	1526			39°29.949N	09°56.189W	3520			0	FX 2b failed
113		Nazare	SAPS	18.06.07	0000	18.06.07	0100	39°30.251N	09°39.354W	2470	39°30.251N	09°39.354W		SAPS at 2070 m and 10 m ab
114		Nazare	CTD	18.06.07	0444			39°35.082N	09°24.136W	729				
115		Nazare	SAPS	18.06.07	1700	18.06.07	1800	39°36.062N	09°24.087W	1140	39°36.062N	09°24.087W		SAPS at 30 m and 10 m ab
116	55	Nazare	ISIS	18.06.07	1832	19.06.07	0741	39°36.071N	09°24.087W	1142	39°36.7N	09°23.9W		
116-Bibo01	55	Nazare	Biobox	18.06.07	2214			39°36.424N	09°24.386W	980				Brisingid
116-SUS01	55	Nazare	Suction Sample	18.06.07	2235			39°36.426N	09°24.384W	973				Brisingid
116-SUS02	55	Nazare	Suction Sample	19.06.07	0225			39°36.614N	09°24.237W	709				Gorgonian

116-Bibo02	55	Nazare	Biobox	19.06.07	0348			39°36.607N	09°24.062W	717				Brisingid
116-SUS03	55	Nazare	Suction Sample	19.06.07	0348			39°36.607N	09°24.062W	717				Anemone
116-Bibo03	55	Nazare	Biobox	19.06.07	0511			39°36.672N	09°23.943W	661				Starfish
116-PUC01	55	Nazare	Push Core	19.06.07	0522			39°36.672N	09°23.943W	661			27	
116-PUC02	55	Nazare	Push Core	19.06.07	0528			39°36.672N	09°23.943W	661			NR	
116-PUC03	55	Nazare	Push Core	19.06.07	0529			39°36.672N	09°23.943W	661			NR	
116-PUC04	55	Nazare	Push Core	19.06.07	0530			39°36.672N	09°23.943W	661			NR	
116-PUC05	55	Nazare	Push Core	19.06.07	0532			39°36.672N	09°23.943W	661			NR	
116-PUC06	55	Nazare	Push Core	19.06.07	0534			39°36.672N	09°23.943W	661			NR	
117		Nazare	CTD	19.06.07	0910			39°31.331N	09°46.131W	3044				
118		Nazare	SAPS	19.06.07	1400	19.06.07	1600	39°31.331N	09°46.130W	2953	39°31.331N	09°46.130W		SAPS at 1700 m and 10 m ab
119		Nazare	elevator	19.06.07	1822			39°29.8N	09°55.8W	3527				
120		Nazare	elevator	19.06.07	1843			39°29.8N	09°56.1W	3500				
121	56	Nazare	ISIS	19.06.07	1928	20.06.07	0608	39°29.855N	09°55.856W	3498	39°29.8N	09°56.0W		
121-Bics01	56	Nazare	BICS	19.06.07	2233			39°29.831N	09°55.821W	3507				brittle star
121-HWC	56	Nazare	HoloWC	20.06.07	0106			39°29.851N	09°55.822W	3508				experiment secured
121-EX01	56	Nazare	Experiment	20.06.07	0251			39°29.799N	09°56.031W	3535				Chamber A activated
121-Ex02	56	Nazare	Experiment	20.06.07	0306			39°29.799N	09°56.031W	3535				ChamberB activated
121-PUC01	56	Nazare	Push Core	20.06.07	0312			39°29.949N	09°56.189W	3535			NR	
121-PUC02	56	Nazare	Push Core	20.06.07	0312			39°29.949N	09°56.189W	3535			NR	
121-PUC03	56	Nazare	Push Core	20.06.07	0316			39°29.949N	09°56.189W	3535			NR	
121-PUC04	56	Nazare	Push Core	20.06.07	0318			39°29.949N	09°56.189W	3535			NR	
121-PUC05	56	Nazare	Push Core	20.06.07	0321			39°29.949N	09°56.189W	3535			NR	
121-PUC06	56	Nazare	Push Core	20.06.07	0326			39°29.949N	09°56.189W	3535			26	
122		Nazare	Megacore	20.06.07	0854			39°30.05N	09°55.88W	3461			29-42	
123		Iberian slope	CTD	20.06.07	1407			39°10.369N	10°11.636W	896				
124		Iberian slope	Megacore	20.06.07	1525			39°10.37N	10°11.64W	896			6-15	
125		Iberian slope	SAPS	20.06.07	1625	20.06.07	1945	39°10.367N	10°11.636W	898	39°10.367N	10°11.636W		

Station List: JC10 Leg 3.

Station no JC10-	ISIS Dive no	Area	Gear	Start Date	Start Time	End Date	End Time	Start Latitude	Start Longitude	Depth (m)	End Latitude	End Longitude	Core Recovery (cm)	Remarks
126		Cascais	Agassiz	22.06.07	1923	22.06.07	1958	38°18.620N	9°47.580W	3186	38°18.930N	9°47.76W		
127	57	Nazare	ISIS	23.06.07	0735	24.06.07	0210	39°29.761N	9°56.070W	3477	39°29.555N	9°55.806W		
127-EX01	57	Nazare	Experiment	23.06.07	1006			39°29.781N	9°56.042W	3536				Exp. recovery
127-EX02	57	Nazare	Experiment	23.06.07	1237			39°29.785N	9°56.036W	3536				Exp. recovery
127-PUC01	57	Nazare	Push core	23.06.07	1341			39°29.750N	9°56.039W	3536			15	
127-PUC02	57	Nazare	Push core	23.06.07	1347			39°29.758N	9°56.037W	3536			15	
127-PUC03	57	Nazare	Push core	23.06.07	1352			39°29.756N	9°56.041W	3536			15	
127-PUC04	57	Nazare	Push core	23.06.07	1400			39°29.757N	9°56.041W	3536			15	bathysiphon present
127-PUC05	57	Nazare	Push core	23.06.07	1405			39°29.746N	9°56.060W	3536			15	bathysiphon present
127-SW01	57	Nazare	ISIS MS2000	23.06.07	1820	23.06.07	2021	39°29.562N	9°55.704W	3555	39°29.534N	9°55.709W		failed
120		Nazare	Elevator	23.06.07	1848			39°29.590N	9°55.620W					elevator lost during recovery
128		Nazare	Megacore	24.06.07	0824			39°34.710N	10°18.110W	4365			7.5 - 22.5	
86		Nazare	Bathysnap	24.06.07	1338			39°34.580N	10°18.045W	4267				recovery
129		Nazare	Megacore	24.06.07	1609			39°34.712N	10°18.115W	4363			11.5 - 29	
130	58	Nazare	ISIS	24.06.07	1908	25.06.07	1103	39°34.351N	10°18.103W	4372	39°34.346N	10°18.014W		
130-Mbox01	58	Nazare	Mini boxcore	24.06.07	2208			39°34.359N	10°18.106W	4376			0	box didn't close
130-Mbox02	58	Nazare	Mini boxcore	24.06.07	2223			39°34.358N	10°18.115W	4376			0	box didn't close
130-PX01	58	Nazare	Pixelfly camera	24.06.07	2308	25.06.07	0130	39°34.364N	10°18.110W	4363	39°34.367N	10°18.104W		
130-Mbox03	58	Nazare	Mini boxcore	25.06.07	0309			39°34.713N	10°18.121W	4356			NR	boxcore with xenophyophore
130-Mbox04	58	Nazare	Mini boxcore	25.06.07	0347			39°34.712N	10°18.125W	4356			NR	boxcore with xenophyophore
130-PX02	58	Nazare	Pixelfly camera	25.06.07	0400	25.06.07	0400	39°34.737N	10°18.116W	4347	39°34.731N	10°18.13W		
131	59	Nazare	ISIS	25.06.07	1348	26.06.07	0009	39°29.854N	9°55.865W	3515	39°29.899N	9°56.155W		
131-HWC01	59	Nazare	Holothurian Experiment	25.06.07	1618			39°29.826N	9°55.829W	3507				exp closed
131-PUC01	59	Nazare	Push core	25.06.07	1648			39°29.823N	9°55.844W	3510			NR	
131-PUC02	59	Nazare	Push core	25.06.07	1651			39°29.826N	9°55.833W	3510			NR	
119		Nazare	Elevator	25.06.07	1839			39°29.555N	9°55.855W	3475				recovered
131-PUC03	59	Nazare	Push core	25.06.07	2033			39°29.947N	9°56.180W	3522			5*	FX 5C

131-PUC04	59	Nazare	Push core	25.06.07	2044			39°29.947N	9°56.180W	3522			5*	FX 5B
131-PUC05	59	Nazare	Push core	25.06.07	2048			39°29.947N	9°56.180W	3522			5*	FX 5A
131-PUC06	59	Nazare	Push core	25.06.07	2102			39°29.936N	9°56.178W	3520			5*	FX 6C
131-PUC07	59	Nazare	Push core	25.06.07	2106			39°29.936N	9°56.178W	3520			5*	FX 6B
131-PUC08	59	Nazare	Push core	25.06.07	2115			39°29.936N	9°56.178W	3520			0	FX 6A
131-PUC09	59	Nazare	Push core	25.06.07	2127			39°29.937N	9°56.184W	3520			0	FX 3B
131-PUC10	59	Nazare	Push core	25.06.07	2134			39°29.937N	9°56.184W	3520			0	FX 3C
131-PUC11	59	Nazare	Push core	25.06.07	2139			39°29.937N	9°56.184W	3520			0	FX 3A
132		Iberian slope	Megacore	26.06.07	0331			39°38.798N	9°58.123W	1968			21 - 39.5	
133		Iberian slope	Megacore	26.06.07	0719			39°39.330N	9°43.650W	1445			5 - 14.5	
134		Iberian slope	CTD	26.06.07	0954			39°43.360N	9°37.530W	670				
135		Iberian slope	SAPS	26.06.07	1128	26.06.07	1245	39°43.367N	9°37.533W	671	39°43.368N	9°37.536W		
136		Iberian slope	Megacore	26.06.07	1145			39°43.080N	9°37.570W	670			23 - 38	
137		Cascais	Agassiz	27.06.07	0357	27.06.07	0438	38°18.970N	9°48.840W	3540	38°19.410N	9°49.03W		empty
138		Cascais	Megacore	27.06.07	0657			38°19.970N	9°49.280W	3634			11 - 32	
139	60	Lisbon	ISIS	27.06.07	1410	28.06.07	0337	38°22.500N	9°20.590W	1690	38°22.431N	9°19.777W		
139-PUC01	60	Lisbon	Push core	27.06.07	1635			38°22.438N	9°20.706W	1664			NR	
139-PUC02	60	Lisbon	Push core	27.06.07	1637			38°22.438N	9°20.706W	1664			NR	
139-PUC03	60	Lisbon	Push core	27.06.07	1643			38°22.438N	9°20.706W	1664			NR	
139-PUC04	60	Lisbon	Push core	27.06.07	1646			38°22.438N	9°20.706W	1664			NR	
139-PUC05	60	Lisbon	Push core	27.06.07	1651			38°22.438N	9°20.706W	1664			NR	
139-PUC06	60	Lisbon	Push core	27.06.07	1653			38°22.438N	9°20.706W	1664			NR	
139-PUC07	60	Lisbon	Push core	27.06.07	1656			38°22.438N	9°20.706W	1664			22	
139-PUC08	60	Lisbon	Push core	27.06.07	1657			38°22.438N	9°20.706W	1664			24	
139-PUC09	60	Lisbon	Push core	27.06.07	1700			38°22.438N	9°20.706W	1664			5*	
139-Bibo01	60	Lisbon	Biobox sample	27.06.07	1843			38°22.598N	9°21.014W	1424				
139-PUC10	60	Lisbon	Push core	27.06.07	2015			38°22.673N	9°21.164W	1187			21	
139-PUC11	60	Lisbon	Push core	27.06.07	2020			38°22.671N	9°21.161W	1187			20	
139-Bibo02	60	Lisbon	Biobox sample	28.06.07	0030			38°22.473N	9°20.289W	1667				brachiopods
140		Lisbon	CTD	28.06.07	0526	28.06.07	0645	38°22.490N	9°20.580W	1683				
141		Lisbon	SAPS	28.06.07	0655	28.06.07	0750	38°22.500N	9°20.600W	1683				
142	61	Setubal	ISIS	28.06.07	1111	29.06.07	0636	38°14.3N	9°23.4W	2015	38°14.5N	9°23.8W		
142-PUC01	61	Setubal	Push core	28.06.07	1408			38°14.313N	9°23.475W	2226			NR	
142-PUC02	61	Setubal	Push core	28.06.07	1410			38°14.313N	9°23.475W	2226			NR	
142-PUC03	61	Setubal	Push core	28.06.07	1413			38°14.313N	9°23.475W	2226			NR	

142-PUC04	61	Setubal	Push core	28.06.07	1416			38°14.313N	9°23.475W	2226			NR	
142-PUC05	61	Setubal	Push core	28.06.07	1418			38°14.313N	9°23.475W	2226			NR	
142-PUC06	61	Setubal	Push core	28.06.07	1423			38°14.313N	9°23.475W	2226			NR	
142-PUC07	61	Setubal	Push core	28.06.07	1426			38°14.313N	9°23.475W	2226			NR	
142-PUC08	61	Setubal	Push core	28.06.07	1428			38°14.313N	9°23.475W	2226			NR	
142-PUC09	61	Setubal	Push core	28.06.07	1431			38°14.313N	9°23.475W	2226			17	
142-PUC10	61	Setubal	Push core	28.06.07	1435			38°14.313N	9°23.475W	2226			22.5	
143		Setubal	Elevator	28.06.07	1353			38°14.315N	9°23.437W	2240				deployed
142-Bics01	61	Setubal	BICS	28.06.07	1530			38°14.365N	9°23.624W	2226				chamber closed
142-Bics02	61	Setubal	BICS	28.06.07	1532			38°14.365N	9°23.624W	2226				chamber closed
142-Bibo01	61	Setubal	Biobox sample	28.06.07	2232			38°14.097N	9°23.050W	1933				
142-Bibo02	61	Setubal	Biobox sample	29.06.07	0044			38°14.132N	9°23.046W	1978				coral
142-Bibo03	61	Setubal	Biobox sample	29.06.07	0244			38°14.136N	9°23.162W	2053				crinoids
143		Setubal	Elevator	29.06.07	0444			38°14.213N	9°23.284W	2226				recovered
144	62	Cascais	ISIS	29.06.07	0959	30.06.07	0543	38°22.595N	9°58.690W	4536	38°22.290N	9°58.787W		
144-Bibo01	62	Cascais	Biobox sample	29.06.07	1310			38°22.530N	9°58.690W	4571				umbellula
144-PUC01	62	Cascais	Push core	29.06.07	1329			38°22.510N	9°58.700W	4576			12	
144-PUC02	62	Cascais	Push core	29.06.07	1340			38°22.510N	9°58.700W	4576			21.5	
144-PUC03	62	Cascais	Push core	29.06.07	1355			38°22.471N	9°58.691W	4578			20.5	
144-PUC04	62	Cascais	Push core	29.06.07	1358			38°22.471N	9°58.691W	4578			24	
144-Rock01	62	Cascais	Rock	29.06.07	1437			38°22.386N	9°58.683W	4578				
144-Rock02	62	Cascais	Rock	29.06.07	1444			38°22.386N	9°58.683W	4578				
144-PUC05	62	Cascais	Push core	29.06.07	1549			38°22.187N	9°58.690W	4578			17	
144-PUC06	62	Cascais	Push core	29.06.07	1735			38°22.114N	9°58.695W	4567			0	
144-PUC07	62	Cascais	Push core	29.06.07	1834			38°22.280N	9°58.658W	4575			0	
144-PUC08	62	Cascais	Push core	29.06.07	1837			38°22.283N	9°58.654W	4575			14.5	
144-PUC09	62	Cascais	Push core	29.06.07	1844			38°22.287N	9°58.658W	4576			19	
144-PUC10	62	Cascais	Push core	29.06.07	1848			38°22.275N	9°58.661W	4576			14	
144-PUC11	62	Cascais	Push core	29.06.07	1850			38°22.275N	9°58.661W	4576			9	
144-PUC12	62	Cascais	Push core	29.06.07	1853			38°22.275N	9°58.661W	4576			13.5	
144-PUC13	62	Cascais	Push core	29.06.07	1855			38°22.275N	9°58.661W	4576			14.5	
144-SW01	62	Cascais	ISIS MS2000	29.06.07	1903	30.06.07	0309	38°22.280N	9°58.859W	4554	38°22.276N	9°58.794W		
145		Whittard	Piston core	02.07.07	2225			47°50.47N	10°12.95W	3873			1001	
146		Whittard	Megacore	03.07.07	0141			47°50.47N	10°12.95W	3872			11.5 - 17	
147	63	Whittard	ISIS	03.07.07	0411	03.07.07	1540	47°55.708N	10°12.025W	4000	47°55.399N	10°13.327W		

147-Mbox01	63	Whittard	Mini boxcore	03.07.07	0738			47°55.729N	10°12.144W	4003			NR	xenophyophore
147-Bibo01	63	Whittard	Biobox sample	03.07.07	0905			47°55.619N	10°12.550W	4040				umbellula
147-PUC01	63	Whittard	Push core	03.07.07	0943			47°55.642N	10°12.748W	3951			NR	
147-PUC02	63	Whittard	Push core	03.07.07	0949			47°55.626N	10°12.756W	3951			NR	
147-PUC03	63	Whittard	Push core	03.07.07	0954			47°55.626N	10°12.756W	3951			NR	
147-PUC04	63	Whittard	Push core	03.07.07	0959			47°55.625N	10°12.753W	3951			20	
147-PUC05	63	Whittard	Push core	03.07.07	1225			47°55.399N	10°13.327W	3742			15	
147-PUC06	63	Whittard	Push core	03.07.07	1227			47°55.399N	10°13.327W	3742			NR	
147-PUC07	63	Whittard	Push core	03.07.07	1232			47°55.399N	10°13.327W	3742			NR	
147-PUC08	63	Whittard	Push core	03.07.07	1234			47°55.399N	10°13.327W	3742			NR	
147-PUC09	63	Whittard	Push core	03.07.07	1236			47°55.399N	10°13.327W	3742			NR	
147-PUC10	63	Whittard	Push core	03.07.07	1239			47°55.399N	10°13.327W	3742			NR	
147-PUC11	63	Whittard	Push core	03.07.07	1243			47°55.399N	10°13.327W	3742			NR	
147-PUC12	63	Whittard	Push core	03.07.07	1248			47°55.399N	10°13.327W	3742			NR	
148	63	Whittard	ISIS	03.07.07	1920	04.07.07	0839	48°19.457N	10°9.071W	3572	48° 20.5N	10° 10.8W		
148-PUC01	64	Whittard	Push core	03.07.07	2136			48°19.962N	10°9.242W	3396			NR	
148-PUC02	64	Whittard	Push core	03.07.07	2141			48°19.962N	10°9.242W	3396			NR	
148-PUC03	64	Whittard	Push core	03.07.07	2144			48°19.962N	10°9.242W	3396			10	
148-PUC04	64	Whittard	Push core	04.07.07	0108			48°20.141N	10°9.912W	3134			15	
148-PUC05	64	Whittard	Push core	04.07.07	0110			48°20.141N	10°9.912W	3134			15	
148-PUC06	64	Whittard	Push core	04.07.07	0115			48°20.141N	10°9.912W	3134			15	
148-PUC07	64	Whittard	Push core	04.07.07	0127			48°20.141N	10°9.912W	3134			15	
148-PUC08	64	Whittard	Push core	04.07.07	0133			48°20.141N	10°9.912W	3134			15	
148-PUC09	64	Whittard	Push core	04.07.07	0137			48°20.141N	10°9.912W	3134			15	
148-Bibo01	64	Whittard	Biobox sample	04.07.07	0418			48°20.441N	10°10.103W	2750				sea urchin, crab
149	65	Whittard	ISIS	04.07.07	1133	05.07.07	0410	48°25.684N	9°56.421W	2638	48° 26.5N	9°51.8W		
149-PUC01	65	Whittard	Push core	04.07.07	1316			48°25.903N	9°56.446W	2595			NR	
149-PUC02	65	Whittard	Push core	04.07.07	1319			48°25.903N	9°56.446W	2595			NR	
149-PUC03	65	Whittard	Push core	04.07.07	1324			48°25.903N	9°56.446W	2595			NR	
149-Bibo1	65	Whittard	Biobox sample	04.07.07	1405			48°25.932N	9°56.165W	2612				anemones
149-Bibo02	65	Whittard	Biobox sample	04.07.07	1852			48°26.144N	9°54.780W	1654				stalked sponge
149-PUC04	65	Whittard	Push core	04.07.07	2052			48°26.280N	9°53.843W	1231			15	
149-PUC05	65	Whittard	Push core	04.07.07	2054			48°26.280N	9°53.843W	1231			15	
149-PUC06	65	Whittard	Push core	04.07.07	2058			48°26.280N	9°53.843W	1231			15	
149-PUC07	65	Whittard	Push core	04.07.07	2102			48°26.280N	9°53.843W	1231			15	

149-PUC08	65	Whittard	Push core	04.07.07	2106			48°26.280N	9°53.843W	1231			15	
149-PUC09	65	Whittard	Push core	04.07.07	2109			48°26.280N	9°53.843W	1231			15	
149-Bibo03	65	Whittard	Biobox sample	04.07.07	2125			48°26.281N	9°53.839W	1230				gorgonians x2
149-BF01	65	Whittard	Butterfly net	04.07.07	0211			48°26.554N	9°51.869W	561				
149-PUC010	65	Whittard	Push core	05.07.07	0318			48°26.437N	9°51.734W	466			NR	
149-PUC011	65	Whittard	Push core	05.07.07	0321			48°26.438N	9°51.737W	466			NR	
149-PUC012	65	Whittard	Push core	05.07.07	0325			48°26.438N	9°51.737W	466			17	