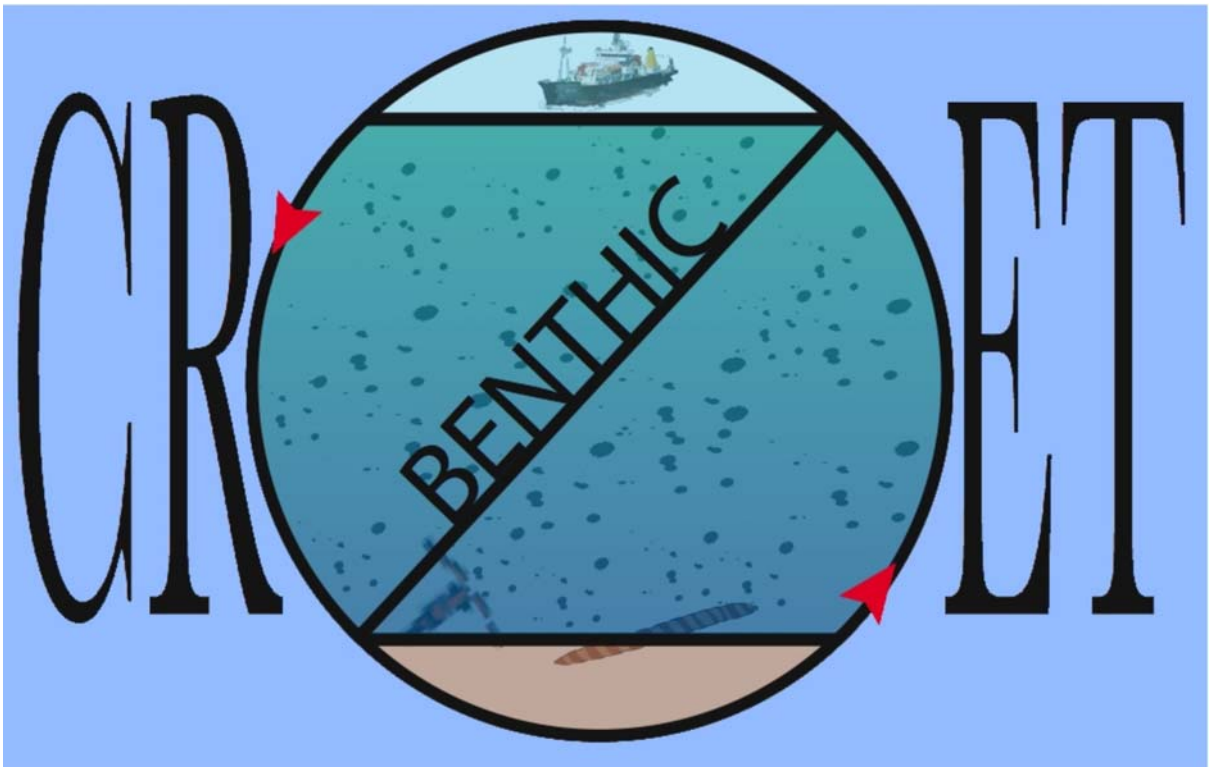
Initial Cruise Report – D300

Benthic CROZET



1st December 2005 – 14th January 2006

RRS Discovery 300

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(University of Liverpool)

Contents

CROZET - Surface water productivity, variability in export flux and deep-sea diversity - how are they linked?

1. Introduction

The supply of food to the ocean floor and benthic community responses to variations in the downward flux of organic matter (OM) over space and time are fundamental issues of biological oceanography. Changes in surface water productivity have been proposed as important drivers for variation in the biodiversity of deep-sea sediments (Snelgrove & Smith, 2002: Lambshead et al., 2002); biogeochemical provinces evident in surface waters (Longhurst, 1998) are mirrored in benthic community structure at the broad scale (Zenkevich & Bogorov, 1966; Sokolova, 2000). Changes in deep-sea community structure in the north eastern Pacific Ocean have been ascribed to reflect changes in carbon flux arising from El Niño/La Niña events (Ruhl and Smith, 2004). However, the relationship is not simple; for instance, recent dramatic changes in species dominance in the abyssal North Atlantic (Billett et al., 2001) do not appear to be related to changes in total export flux (Lampitt et al., 2001), but instead to changes in the "quality" or composition of the OM arriving at the seafloor (Billett and Rice, 2001; Wigham et al., 2003). Understanding patterns of biodiversity in the deep sea and their link to surface water productivity remains a major challenge. How does the connection work and how does it manifest itself?

The principal objective of the cruise was "To assess how biogeochemical composition and flux of OM to the deep-sea floor drives benthic community structure, dynamics and diversity at two sites with contrasting primary production regimes."

Specific hypotheses to be tested:
1. That the variability in biogeochemical composition *as well as* the total flux of OM reaching the abyssal seafloor is dependent on the productivity of overlying surface waters.
2. That the biogeochemical composition of incoming OM is imprinted on the biochemistry of key detritovores.
3. That key nano-nutrients are critical for the reproduction of some deep-sea species and thus variations in OM flux affect sediment community structure and diversity.
4. That variations in total OM flux also influence benthic rate processes (e.g. faunal activity).

The cruise of RRS Discovery (D300) to the Crozet Plateau in the Southern Indian Ocean to the south east of South Africa was the field phase of the NERC project (NER/A/S/2003/00573) tackling this issue. We focused our studies on two contrasting areas of surface productivity around the Crozet Plateau (Southern Indian Ocean). We adopted an integrated, multidisciplinary approach which involves assessment the OM input to the deep-sea floor (export production), the ambient biogeochemistry of the sediment surface, the benthic community structure and diversity (molecular and morphological approaches), the activity of fish (seabed lander experimentation), the

uptake of specific biochemicals by key species and their influence on reproductive processes.

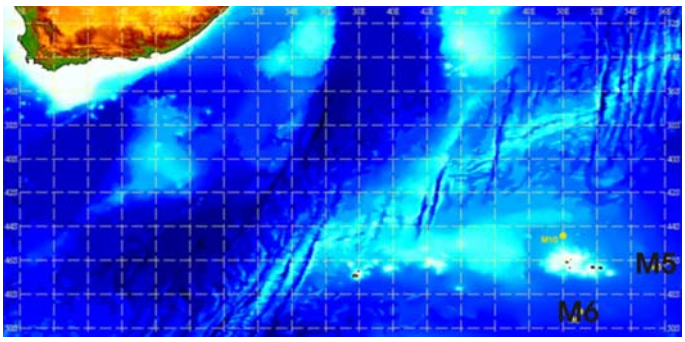


Figure 1.1 Location map showing position of the Crozet Plateau and the main sampling stations, M5 – high productivity and M6 – low productivity.

Eutrophic and oligotrophic conditions occur in well-constrained areas around the Crozet Plateau, but in close proximity to each other. To the south of the plateau is an oligotrophic High Nutrient Low Chlorophyll (HNLC) zone, typical of the Southern Ocean; to the north, however, is an area where annual blooms of primary production occur consistently, over the same area with the same temporal evolution. The bloom reaches its peak in October or November and collapses back close to the Crozet Plateau by December (Pollard et al., 2002). These eutrophic waters cover a large area despite being embedded within the HNLC zone. The study area is ideal for assessing the impact of changing biogeochemical composition of OM on the benthos because we can compare two communities that are:

1. At the same depth,
2. In the same physical (topographic and hydrographic) setting (see below) and
3. Interconnected (there is no physical barrier between them).

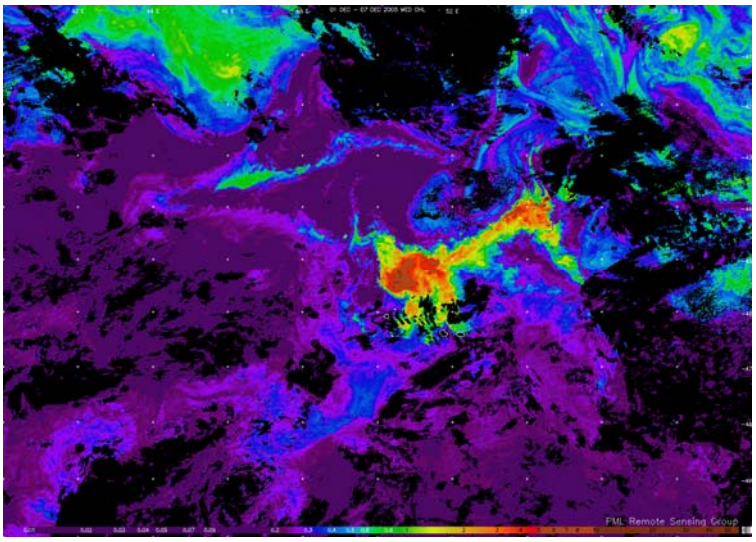


Figure 1.2 Composite sea surface chlorophyll satellite image for 1st – 7th December 2005. Redder colour denotes higher chlorophyll values to the north of the Crozet Islands. (Courtesy of PML Remote Sensing Group).

The Cruise sailed from Port Elizabeth on 1st December 2005 and docked at Capetown on 14th January 2006.

2. Scientific Personnel

Participant	Institute	Interest
George Wolff	University of Liverpool	Biogeochemistry
Frédéric Chaillan	University of Liverpool	Biogeochemistry
Philip Bagley	University of Aberdeen	Fish behaviour/landers
Alan Jamieson	University of Aberdeen	Fish behaviour/landers
Nicola King	University of Aberdeen	Fish/fish behaviour
Ben Wigham	University of Aberdeen	Fish behaviour/landers
David Pearce	BAS	Microbiology/sediments
Robin Floyd	BAS	Nematodes/sediments
Rachel Malinowska	BAS	Microbiology/sediments
Adrian Glover	NHM	Polychaetes
Magaret Packer	NHM	Nematodes
David Billett	NOC	Invertebrate megafuana
Alan Hughes	NOC	Meiofauna
Tania Smith	NOC	Biogeochemistry/holothurians
Ben Boorman	NOC	Scientific Gear/trawling
Brian Bett	NOC	Mega/Macrofauna
Hélène Planquette	NOC	Iron biogeochemistry
Will Homocky	NOC	Redox chemistry/sediments
Hugh Venables	NOC	Physical Oceanography
Sue-Ann Watson	NOC	Invertebrate megafauna
Dave McCarthy	NUIG	Deep-water bacteria
John Patching	NUIG	Deep-water bacteria

BAS	British Antarctic Survey
NHM	Natural History Museum
NOC	National Oceanography Centre
NUIG	National University of Ireland, Galway

3. Cruise Diary

3.1 Background

Prior to joining the ship, scientific activity was discussed and planned by participants in the cruise together with UKORS. It should be noted that the plan on writing the proposal was that the scientific cruise should follow on from D285 and D286, however, there was a delay due to a backlog of cruises caused by on-going problems with the winch systems on *Discovery*. D300 was planned for December/January 2005 on the basis of predicted weather conditions in the Crozet area. The delay in the cruise allowed for longer-term deployment of sediment trap and Bathysnap moorings at M5 and M6, and for long-term deployments of sediment traps at the CROZEX sites of M2 and M10. Additionally, 7 working days were funded during the 2004/2005 CROZEX campaign by NERC and were designated as D287. Originally, it had been agreed that SHRIMP would be available for D300, however ongoing problems with the electro-optical deep-tow winch precluded its availability. This was a very significant blow, but fortunately WASP was available as a back up for bottom photography. The operation of winch systems during D300 was a matter of concern prior to the cruise. For this reason, the Principal Scientists sought assurances from RSU that the problems encountered on previous cruises (D296 – HERMES) could be avoided by provision of adequate spares for D300.

The benthic programme on D300 was augmented by pelagic work following on from D285 and D286, principally determination of iron in surface waters and in particulate material collected in shallow water. Numerous CTD casts also allowed additional data to be accrued from ADCPs mounted on the frame. The cruise work schedule was intense, with principal activities being coring, trawling, photographic transects, deployment and recovery of landers, CTD casts, SAPS deployments and echo sounding to provide bathymetric data for trawl tracks. Sediment trap moorings were recovered from M2, M10, M5 and M6. A bathysnap mooring was also recovered from M6. The details of all scientific activities are given in the daily diary (Section 3.2). Discovery Station numbers were used throughout and span from 15772 to 15778.

The cruise was adversely affected by poor weather conditions. In all, 154.5 hours were lost to weather. While contingency planning had allowed for this, other problems inevitably meant that certain aspects of the planned work were not achieved. The coring winch system proved to be unreliable. There were numerous problems with scrolling and computer systems which were at best, irritating and on several occasions led to poor recovery of cores as systems failed while the corer was sitting on the seafloor. The nature of the sediments, particularly at M6, was such that recovery of good quality cores was very difficult, thus a temperamental winch system was extremely unhelpful. A serious burn out of a key electronic component was fixed early in the cruise; however its later failure while 4000 m of wire was deployed in precisely the same way led to the decision to withdraw it from use. That the system should fail twice, on both occasions creating a fire hazard is clearly a very serious matter. Fortunately, we were able to use the trawl wire for the Megacorer, but gravity coring and box coring were then precluded. The failure and loss of 8000 m of wire trawling together with the net, Otter boards and NOC-

GDD acoustic telemetry system was also a serious blow. We were unable to complete our trawling/faunal sampling programme. The apparent cause was poor spicing of the cable by the manufacturer, and this added to our frustration. Needless to say NOC-GDD, as represented onboard by Dr Brian Bett, would be keen to be informed of any further investigation / liability issues taken up with the manufacturer. The loss of the ROBIO lander through entanglement with the ships propeller at M5 was also extremely unfortunate; fish abundance could be estimated from trawl data at M5, but not at M6 after loss of the trawl! Finally, the Bathysnap mooring at M5 failed to release from the sea floor.

Despite these setbacks, the cruise had notable successes. Scientifically, the area proved to be tremendously interesting and exciting. It is to be hoped that the data that we have managed to gather will justify the cost of the cruise and scientific effort and will allow the original objectives to be met. Throughout, the Master, engineers and crew of the *Discovery* were extremely helpful and professional in their conduct, as were the UKORS technical support team. Their abilities were often tested, however they were able to deal with the difficult situations as they arose. The engineering team is to be commended for their efforts with the winch systems. The deck crew was outstanding and liaison with the deck CPO effective and issues arising during gear deployment and recovery were efficiently dealt with. The enthusiastic support of the ships company ensured that we were able to achieve much, despite the adverse conditions and frustrating failures. Finally, the efforts of the catering staff were appreciated by all on board.

3.2 Cruise Diary for D300

Details of activities at Discovery Stations are listed in Table 3.1. All listed times are given as coordinated Universal Time (UTC)

29th – 30th November 2005 Mobilisation of D300 commenced in Port Elizabeth with unloading of equipment from shipped containers. Scientists first visited the ship on 29th November and began unloading and unpacking of gear. Familiarisation with the ship and first safety briefing was carried out by the Master and 1st Mate. Scientists signed on to ships crew. Following discussions with Colin Day (UKORS) and the Master, it was agreed that all efforts would be made to allow the ship to sail on 1st rather than 2nd December as originally planned in order to make up for the time that would be lost in sailing to Durban for Bunkers. It was also agreed that there would not be a need for a replacement for the Scientific CPO who would have to disembark at Durban for personal reasons.

1st December 2005 Sailing was delayed awaiting arrival of air freighted equipment (from Angola). This arrived in the morning and was craned on board using the ships crane. The Megacorer had been transported on its side and there was some concern that it had sustained damage. The pilot embarked at 12:46 and *Discovery* set course for Durban.

2nd December 2005 Steaming to Durban. Emergency and lifeboat muster for all scientists, technicians and crew with instruction.

3rd December 2005 Passage to Durban ended and *Discovery* docked for bunkers at 07:40. Bunkering was completed by 12:59, pilot embarked at 14:12. Once clear of the port limits *Discovery* set course for the first working station, M10 (44° 30' S 50° 00' W). The ship hove to deploy the trace metal sampling (TMS) fish for testing from 16:18 – 16:56, then resumed passage to M10.

4th December 2005 Continued passage to M10. The ship hove to for deployment of TM fish and testing from 06:15 to 06:20. Problems with the flight of the fish in the water, namely with its breaching were noted and the fish was brought inboard at 06:30. The ship hove to from 11:48 to 12:35 for a trial of the PES fish and passage for M10 resumed thereafter.

5th December 2005 Clocks advanced at midnight, to UTC + 3 hrs. Testing of the TMS fish resumed, the ship hove to at 10:19 for deployment and at 13:05 for recovery. Finally following modification, the TM fish was deployed outboard at 13:57 for further trials. Passage to M10 then resumed.

6th December 2005 Passage continued, the TMS fish was recovered at 16:14. Bad weather was encountered in the late evening and the vessel began to roll considerably. The ship hove to at 12-00 to secure the decks and adjusted course to try to alleviate the rolling. The clocks were advanced at 23:00 to UTC + 4.

7th December 2005 The vessel continued to tack to avoid rolling. The TMS fish was deployed at 14:26 and cleaning of the lines commenced, prior to sampling. At 14:35, the *Discovery* resumed its course to M10.

8th December 2005 *Discovery* arrived at the M10 mooring site at 10:00 and hove to for release of the sediment trap. This was successfully recovered at 11:34. Following this, the Megacorer was deployed and recovered 7/8 slightly disturbed but usable cores. The pressurized sampling system, SPRATS was tested at 400 m water depth on the CTD wire. Communication was successful, but the pumping system failed. Following this, there was a CTD cast, with water collected for salinity, chlorophyll, nutrients and bacterial DNA. 2 SAPS casts followed, with 2 pumps deployed on the first (Fe and particulate organic matter, POM) and 1 on the second (Rachel Mills). All pumps failed!

9th December 2005 On completion of work at M10, a course was set for M5 (46°S 56°E) with the TM fish deployed. This was recovered at 09:19 for repair to tubing and the passage then resumed at full speed.

10th December 2005 *Discovery* commenced an echo sounder survey while continuing toward M5 (see Bathymetry section below). The weather deteriorated during the day and led to a change of course and finally the ship hove to at 12:00 awaiting improvement.

11th December 2005 The poor weather continued through the morning, but the vessel was eventually able to proceed to M5. The first activity was a second SPRATS test, when the pumping system again failed. This was followed by a CTD cast to 4216 m and two

SAPS deployments, the first using two pumps at the chlorophyll maximum for POM and for collection of material for Rachel Mills (NOCS) and the second below the mixed layer for Fe. The pumps performed correctly. Following the SAPS, the echo sounding survey resumed at 23:20.

12th December 2005 The echo sounding was completed at 04:45 and was followed by the deployment of the Aberdeen lander, ROBIO at 05:10. The deployment was aborted at 05:30 just prior to release of the lander when it was noticed that the Dahn Buoy had come adrift. The buoyancy rig was brought inboard and then the Dahn Buoy recovered. In the meanwhile the weather conditions had deteriorated significantly, with wind now gusting up to 70 knots so the ship hove to until 08:30, when *Discovery* returned to the ROBIO deployment site. The Dahn Buoy was reattached with a shackle rather than a clip and the ROBIO lander was successfully deployed at 09:28. After relocating to the proposed coring station, there followed a cast of the Megacorer. This proved unsuccessful, no cores were returned although there was some gravel size residue on the core catching plate on 2 cores, which appeared to be volcanic in origin. A WASP survey was planned prior to further coring. Following the coring, the ship set course for the first trawl cast, which was shot at 17:25. The trawl reached the sea floor at 22:45 and was towed until 00:30. During this time there were several increases in tension on the wire; on the last occasion it was feared that the trawl had become damaged.

13th December 2005 The trawl was recovered by 05:42. There had indeed been damage to the net, which was ripped, but the cod end was intact and a good catch was returned. The ship then proceeded to the lander site and ROBIO was released and successfully recovered at 09:53. The still digital images of the sea floor suggested that there was a layer of green phytodetritus on the sea floor. There followed a WASP cast at the coring site to obtain footage of the seafloor and to assess the possibility of coring. Unfortunately the altimeter failed after 6 minutes flying at 2 m above the sea floor and the deployment was aborted. However, the video returned proved useful and confirmed that the sea floor had a patchy, but extensive covering of phytodetritus. There were no obvious reasons why the Megacorer should have failed. After an unsuccessful test deployment of SPRATS due to traction winch problems, there followed two casts of the Megacorer, which were distinctly unsuccessful, returning only 2/16 very short cores of disturbed mud to 1 – 2 cm. It was decided that a boxcore should be attempted prior to further Megacoring.

14th December 2005 The ship set course for the lander site at 01:00 the ROBIO was deployed at 03:10, prior to returning to the coring site for the deployment of the boxcorer. This proved successful, although the top water was lost. The sediment appeared fine grained, although there were patchy lenses of volcanic gravel and sand. The top 2 cm of the core was removed for sieving for macrofauna by NHM; the rest of the core (apart from two subcores used by BAS for practicing bacterial techniques) was discarded. Following a CTD cast to 4175 m, two SAPS pumps were deployed in the chlorophyll maximum (POM) and below the mixed later (Fe); these were successful, although the top SAPS pumped only ~250 L (cf. ~2500 L bottom pump). The ship then proceeded to the trawl site and shot the net at 19:18.

15th December 2005 The trawl was brought inboard successfully at 07:30. The catch was very good. The ship the proceeded to the coring site for a Megacore cast. The corer was reconfigured with 4 large and 2 small cores and with 100 kg of additional ballast. 5 good cores from six were recovered, one small core failing to fire. Following the Megacoring, there was an emergency muster and drill and the vessel set course for the lander site for the first deployment of FRESP at 14:59. Two amphipod traps were attached to the FRESP frame. There then followed two Megacore casts at the coring site, both of which returned a full compliment of 6 good cores.

16th December 2005 At first light, the ROBIO lander was released from the sea floor at 01:38 and was successfully recovered inboard at 04:02. The vessel returned to the coring site for the second deployment of WASP at 05:30. At 05:33 a strong burning smell became evident through the ship, the winch room being full of smoke due to a catastrophic failure of the coring winch contactor. The incident led to the meltdown of wiring and all operations were ceased while the ship's engineers made repair. This took the best part of 12 hours. In the meanwhile, the ship carried out an echo sounding survey and additionally, redeployed ROBIO at the lander site at 12:03. Due to the valiant efforts of the ships engineers, the core winch wiring was repaired and the winches were back in service by 17:06. The ship then proceeded to the start point of the trawl and this was shot at 18:20.

17th December 2005 The trawl was recovered inboard at 06:15. This time the catch was absolutely outstanding! Dr. David Billett, the lead scientist on the trawl catches was amazed by the sheer number and diversity of invertebrate animals in the haul. 27 species of fish were recovered, some having only been recorded once or twice to date. Processing of the trawl material continued while the ship set course for the lander site and FRESP was released at 08:52. The lander was successfully recovered by 12:00, bring with it 2 fish in its trap. The video footage clearly showed that there was a significant amount of phytodetritus in suspension near the sea floor; at times it obscured the view of the trap less than 1 m below. At 13:18, SPRATS was deployed to 400 m water depth on the CTD wire. Unfortunately, the pump failed again. There then followed a cast of the Megacorer, which returned 4 good cores; one of the small cores had cracked. 3 SAPS pumps were then deployed as close to the sea floor as possible, in the hope of collecting phytodetritus and bacterial biomass. The deployment was successful although one of the SAPS (Fe) failed. The POM filter was green!

18th December 2005 At 02:12, WASP was deployed and towed for 65 minutes at the sea floor. While the stills camera operated successfully, the video camera failed to return any footage, probably due to a poor connection. During the WASP cast, the weather had deteriorated and the vessel hove to at 06:54 until 08:30, then proceeding to the coring station for a Megacore cast. Five of six cores were returned, which were all slightly disturbed, but nonetheless usable. On recovery of the Megacorer, the decks were secured as weather had deteriorated further and operations ceased at 13:24.

19th December 2005 Downtime for weather.

20th December 2005 Weather conditions had improved by 00:42 and the vessel made for and hove to at the lander site and ROBIO was released from the sea floor at 00:59 and was recovered inboard by 03:19. Unfortunately, the camera had failed on this deployment due to a flooded cable. FRESP was then redeployed successfully at 04:47. The weather conditions were reasonable and so it was decided to recover long-term moorings at the M5 moorings site. The sediment trap mooring was released at 05:55 and was inboard by 08:32. The traps had apparently operated successfully. Although contact was made with Bathysnap and releases apparently opened, it refused to move from the sea floor. Repeated attempts to release the mooring unfortunately failed and finally at 09:38, the mooring was abandoned. The vessel then returned to the coring site for a Megacorer cast at 11:10. This returned six good cores. *Discovery* then proceeded to the trawling site and the trawl was shot at 16:00.

21st December 2005 The trawl was recovered inboard by 03:33. This was again a good catch, although smaller than the previous bumper net! Once inboard, the ship set course for the lander site and ROBIO was finally deployed after problems with ballast. On the first occasion, the ballast fell off before the lander was actually in the water. However, the incident was repeated with the ROBIO in the water, which then had to be recovered. The problem arose as the release was cutting through the attachment wire; using a metal eye overcame the problem and ROBIO was finally deployed successfully at 08:10. FRESP was then released from the sea floor at 08:31 and recovered inboard at 11:43. A large fish was lost from the FRESP trap during recovery making a welcome snack for a hungry albatross! The ship then made for the coring site and two deployments of the Megacorer followed. Eight core tubes were now fitted (6 large + 2 small) and 4/8 and 7/8 good cores were obtained from the two casts. The weather had by now deteriorated badly and operations ceased at 20:54.

22nd December 2005 Downtime for weather

23rd December 2005 Poor weather conditions continued until 06:30, when the vessel re-located to the lander site, deploying FRESP by 07:33. ROBIO was then released from the sea floor at 08:06 and recovered inboard by 10:28. On this occasion, the camera had functioned correctly, however, the lander appeared to have been dragged by current on reaching the seafloor and eventually came to rest adjacent to a large rock, which obscured the view of the bait on the sea floor. Some very good photographs of the rock and its epifauna were returned! ROBIO was turned around immediately and redeployed successfully at 12:48. There then followed two Megacorer casts; conditions were now difficult with a considerable swell and in the first deployment no cores were returned, probably due to a poor landing on the sea floor. The second cast was more successful and 8 good but short cores were obtained although one was lost on deck. Following the coring there was a full CTD cast to 4178 m.

24th December 2005 Two SAPS were deployed at 80 m (POM) and 100 m (Fe), both of which pumped successfully for 90 minutes. The vessel then returned to the lander site and ROBIO was released from the sea floor at 06:17. There then followed a series of

unfortunate events. During the first attempt to recover the lander, the recovery line was successfully grappled and the pellet buoy was uncoupled. Shortly after, the Dhan Buoy and glass spheres appeared on the port side of the ship and became entangled on the PES fish. The fish was subsequently brought on board and the mooring began to stream aft but still on the wrong side. Once the mooring was streaming aft of the stern, the rope from the deck winch remained in tension, indicating that there had been entanglement with something on the hull. The rope streaming from the Dhan buoy was grappled, pulled on board, the pellet reattached and uncoupled to the deck winch. At this point the lander moved away from the ship in the correct orientation as if it had just surfaced. No signs of any damage or complications were observed. With the lander removed from the deck winch wire, the wire became slack and fell free of any entanglement. The ship then maneuvered again to make a second attempt at recovery, the mooring line was hauled on board and the Dhan Buoy was uncoupled. At the point where the first set of glass spheres breached the surface, the ship seemingly fell back on the mooring. To correct this, the ship moved forward with the main propeller. At this point at 09:03, the mooring line came under high tension followed by a loud bang coming from the propeller indicating that the spheres were imploding. Shortly after pieces of the spheres plastic hards were seen floating on the surface, heavily damaged. The tension on the line immediately dropped and all that was recovered was the recovery line, the first 10 m of rope, some connecting hardware, half a damaged sphere frame and a section of severed rope. The amount of floating debris indicated that at least two of the glass sphere pairs had been destroyed causing the ROBIO to permanently sink to the seafloor. The loss of the ROBIO was later confirmed by acoustically interrogating it where it had sunk to 1500m.

Following the accidental loss of ROBIO, it was nonetheless decided to go ahead with recovery of FRESP and the lander was released from the seafloor at 09:30. The lander was spotted on the surface at 13:30, the flag having been lost from the Dahn Buoy. The ship then maneuvered to recover FRESP, with the result being fouling of the rudder by the recovery line. This was cleared eventually and the lander was finally recovered inboard at 14:32. The ship then set course for the coring site and WASP was cast to 4283 m, being flown on the seafloor from 17:30 to 18:36, returning 65 minutes of good video. This showed there to be a great deal of phytodetritus in suspension and provided some excellent pictures of the dense population of holothurians at the sea floor. The Megacorer was then deployed at 20:32, but the cast was abandoned at 21:05 due to rapidly worsening weather conditions. At the end of a difficult day, the decision was made to abandon M5 and to make for M6 via M2. The TMS fish was deployed outboard at 21:20 and the *Discovery* set sail for M2 at 21:30.

25th December 2005 Weather conditions deteriorated further and the vessel was forced to hove to at 00:18. Christmas Day dawned with a significant storm and swell for us to deal with. Nevertheless, an excellent lunch, an entertaining speech from the Master and a successful hat competition raised the spirits of crew, technicians and scientists. At 18:00, weather conditions had improved so that course could be set for M2.

26th December 2005 *Discovery* arrived at M2 at 13:00 and the sediment trap mooring was released and recovered successfully by 14:57. The vessel then set course for M6 and commenced an echo sounding survey at 23:06.

27th December 2005 The trace metal fish was recovered for inspection at 00:30 and the echo sounding survey was completed by 06:00. The vessel then made for the proposed lander site at M6 and FRESP was successfully deployed by 06:37. Following this, course was set for the coring site and WASP was cast, being flown above the sea floor from 08:38 to 09:40. Once again the video camera had failed, although the stills camera appeared to have operated successfully. There then followed the first Megacorer deployment at M6; the same configuration of 6 large + 2 small cores was employed, but on this occasion 150 kg of additional ballast was used. 5 good cores (4 large + 1 small) were recovered with one disturbed small core. The sediment was overlain by a layer of colourless material, presumed to be aged or poor quality (with respect to organic matter) phytodetritus. This proved to be a consistent feature at this site. At 15:18, the vessel proceeded to the trawl location and the trawl was shot at 16:16.

28th December 2005 The trawl was successfully landed by 03:46. The catch was smaller than those at M5 and the dominant invertebrate species being very different. Of particular note was the presence of a very small holothurian called *Kolga*. Several hundred specimens, about 1cm long, were picked off the fine mesh liner of the trawl cod end. The ship set course for the coring site, but bad weather again set in and the ship hove to until 07:36. Two megacorer casts followed. These were singularly unsuccessful and only 1 small core was recovered from 16! A full CTD cast to 4175 m was then carried out, followed by two deployments of SAPS, the first with 2 pumps at 60 and 100 m (POM and Fe, respectively), the second with 1 pump only at 60 m to collect material for Rachel Mills (NOCS). The pumps operated successfully, although there was a winch CLAM fault on the first deployment.

29th December 2005 The vessel proceeded to the lander site and FRESP was released from the sea floor at 00:48. The lander was successfully recovered by 03:42, although there were no fish in the trap. Examination of the video sequence showed that fish had visited the bait, but had evaded the trap when it closed. Nevertheless, a beautifully intact ophiuroid was recovered! The ship proceeded to the coring site for a Megacorer cast which did at least return one large and two small cores from 8. WASP was then deployed, but the cast was aborted when the altimeter failed close to the sea floor. There then followed another cast of the Megacorer; the CLAM system again failed, it was unclear whether or not the corer was on the bottom and subsequently no cores were returned. The vessel then set course for the trawling site and the trawl was shot at 18:00.

30th December 2005 The trawl was recovered inboard by 06:00. The catch was again good but small. The weather was deteriorating at this point and operations ceased at 08:00 for 10 hours. It was then decided to proceed with a full CTD cast, followed by a deep SAPS deployment, with two pumps deployed close to the sea floor. It was on this deployment at 23:19 that a fire alarm sounded and an acrid smell pervaded the ship, signaling the second catastrophic failure of the contactor on the core winch. The result

was that there was no way of using the coring winch to get the package clear of the sea bed until the fault was rectified. By holding position or carefully manoeuvring into deepening water steaming slowly, the SAPS were prevented from touching bottom. This strategy was maintained until the coring winch was returned to service.

31st December 2005 The coring winch system was successfully patched up by 00:42 and the SAPS were recovered, but the decision was made that the coring winch was unusable. This meant using the trawl wire for any coring, but effectively precluded any box or gravity coring. Although these activities were not central to the programme, gravity coring had been planned at M6 to service Rachel Mills' (NOCS) request; this was now abandoned. The ship proceeded to the lander site and FRESP was deployed successfully at 05:09. There followed three deployment of the Megacorer, which was reconfigured for 2 large + 2 small cores with 150 kg of extra weight. On the first deployment, 1 small tube was recovered with sediment forced right to the top of the tube. It was decided that the soft sediment substrate was causing problems and that with the additional weight the corer was probably sinking in far too deep. Therefore the ballast was removed and this gave rise to better results on the next two deployments with 2/4 and 3/4 good cores being returned. At 16:30, the vessel set course for the trawling site and the trawl was shot at 18:26.

1st January 2006 The trawl proceeded normally until with 10365 m of wire out and the net on the sea floor, tension dropped rapidly from ~7 to 1 Tonne. Hauling continued, with the wire ending at 8468 m wire out, the outer section of the trawl cable (together with the trawl) being lost seemingly due to the failure of the taper joining splice. The cause of the loss is speculative, but it is possible that the splice may have been 'short', which can make the diameter thicker at the splice thereby giving leading to the sides of the splice wearing away and weakening of the join. Whatever the cause, this event led to the curtailment/end of the trawling programme at M6.

The vessel then proceeded to the Bathysnap mooring site and Bathysnap was released from the sea floor at 04:30. There followed a repeat performance of the hull fouling; on this occasion, the Dahn Buoy became entangled in the rudder; it was cleared eventually and the Bathysnap brought inboard successfully. The vessel then proceeded to the lander site and FRESP was released at 08:44 and recovered successfully by 12:24, although there were no fish in the trap. During recovery, the weather deteriorated significantly and operations ceased at 12:42. At 19:00, the decision was made to resume work, the ship made for the coring site and the Megacorer was deployed at 19:25, returning 3/6 disturbed cores. The weather was again worsening and so all operations ceased at 23:00.

2nd January 2006 Most of the day was lost to weather, although at 19:54, conditions had improved to the extent that a Megacorer cast was made. Only one reasonable core was returned. The vessel then made for the mooring site.

3rd January 2006 As conditions had improved, the decision to recover the sediment trap moorings was taken. These were released at 01:05 and the traps recovered successfully, although the deeper trap was recovered upside down. Once the sediment

traps were secure, the vessel proceeded to the lander site and FRESP was deployed at 06:30. There then followed a cast of the Megacorer and the coring site, three usable cores (2 large, 1 small) were returned. At this point it was decided to deploy WASP, which was first deck-tested. The deployment proved successful and 65 minutes of good quality video was returned. This showed the seafloor to be very different to that at M5, the main features being the covering of colourless phytodetritus type material, many faecal casts, but very few animals. The planned Megacore deployment was delayed for 60 minutes by an alarming sudden increase in air pressure, but this was eventually deployed at 17-30 and returned only one short large core which fell out on deck. The CTD was then deployed to 2000 m together with current meters, which were run for calibration.

4th January 2006 On completion of the CTD cast, 2 SAPS were successfully deployed at 50 and 110 m for POM and Fe, respectively. There then followed an intense session of Megacoring, interspersed by the recovery of FRESP, which again came up with no fish. Once again, they had evaded capture in the trap! The coring proceeded with mixed results, the corer having been reconfigured to 6 large + 2 small tubes. In 4 deployments, 11 cores were recovered. Finally at 21:16, a deep CTD cast was made for helium tritium work.

5th January 2006 The day involved intensive Megacoring in an attempt to finish as far as possible, the coring programme. 4 casts were made and ultimately enough material was returned to provide the minimum sample required by the participating groups. At 15:01, the decision was made to leave M6 and to proceed to the Crozet Islands. The TM fish was deployed at 15:14 and underway sampling for Fe followed. The ship set course for Crozet at 15:30.

6th January 2006 The ship arrived at the first shallow water station between Isle d'Este and Isle de Possesion at 05:06. The CTD was deployed to 300 m and water samples collected before deployment of two SAPS pumps at 70 and 345 m water depth. The pumps operated successfully. The PES fish was then brought inboard and the ship proceeded to Baie Americaine, steaming slowly at 4 – 5 knots during the passage. Once there, the RIB Workboat was launched and a number of scientists were taken to visit the inshore area. In the meantime, science continued and a second CTD/SAPS deployment was made, this time with the two pumps deployed on the CTD frame at 30m depth. On completion of a successful deployment, the ship set course for Port Alfred, but was forced to turn back to pick up the RIB which had developed an engine fault on the way to Port Alfred. The boat was successfully recovered, but following a risk assessment, it was decided that it would not be possible to land a shore party, as no boat was available at Port Alfred, in case of a repeat engine failure. At 14:32, the ship set course for a megacorer deployment in the channel between Isle d'Este and Isle de Possession. The cast was made at 15:30, but no cores were returned due to the nature of the substrate. Some sandy material was present on the core catchers and this was recovered. At 16:12, the ship set course for Capetown.

7th – 14th January 2006

Passage to Capetown. Underway sampling continued (TMS fish) until 8th January at 14-45 (GMT).

Site	Discovery Station Number	Latitude (S)	Longitude (E)	Julian Day	Date	Depth corr m	Time (UTC)	Gear	Comments
M10	15772#1	44 29.95	49 59.92	342	08/12/2005	2898c	10:02 (11:34)	Sediment trap mooring	Successful recovery
M10	15772#2	44 29.67	50 00.91	342	08/12/2005	2908c	13:57	Megacorer	7/8 cores - disturbed
M10	15772#3	44 28.22	50 00.22	342	08/12/2005	2916c	16:00	SPRATS	Tested at 400 m - failed
M10	15772#4	44 28.94	50 00.36	342	08/12/2005	2914c	18:39	CTD	Bottles shot at 15, 30, 45, 60, 75, 130 (x2), 1000, 1800, 2890m (x2)
M10	15772#5	44 28.7	49 58.6	342	08/12/2005	2914c	20:50 (22.45)	SAPS	1 off pump aborted, Fe pump (130 m) failed, POM pump (55 m) 43L only
M10	15772#6	44 28.6	49 58.1	342	08/12/2005	2914c	22:50 (00:20)	SAPS	Pump Failed at 130 m
M5	15773#1	45 59.71	56 15.32	345	11/12/2005	4261c	10:26 (11:35)	SPRATS	Tested at 400 m - failed
M5	15773#2	46 00.45	56 15.56	345	11/12/2005	4204c	13:20	CTD	Bottles shot at 15, 30, 45, 60, 75, 130, 500, 1500, 2500, 4200m (x2)
M5	15773#3	46 00.23	56 16.01	345	11/12/2005	4203c	16:13 (17:15)	SAPS	2 Pumps at 80 m (2463 L) + Rachel Mills (346 L)
M5	15773#4	46 00.17	56 14.95	345	11/12/2005	4203c	19:11 (21:01)	SAPS	1 Fe pump at 140 m (2169 L)
M5	15773#5	45 45.94	56 05.05	346	12/12/2005		05:16 (05:59)	ROBIO	Deployment aborted; down-buoy came adrift; recovered
M5	15773#6	45 50.43	56 06.16	346	12/12/2005	4157c	09:28	ROBIO	Successful deployment
M5	15773#6 (contd)			347	13/12/2005		07:07 (09:53)	ROBIO	Successful recovery
M5	15773#7	45 51.67	56 27.75	346	12/12/2005	4198c	13:15	Megacorer	0/8 Cores recovered - some gravel (volcanic) residue in 2 cores

M5	15773#8	45 43.06	56 32.16	346	12/12/2005	4258 - 4290c	22:45(00:30)	Trawl	Trawl snagged on bottom + ripped Successful recovery + good catch
M5	13773#9	45 50.45	56 24.78	347	13/12/2005	4200c	13:14 (13:20)	WASP	Altimeter failed. 6 minutes good video. Abundant megabenthos + phytodetritus
M5	13773#10	45 50.84	56 25.83	347	13/12/2005		15:35 (16:50)	SPRATS	Aborted - slack turn on winch. Too light.
M5	15773#11	45 50.51	56 24.66	347	13/12/2005	4199c	19:11	Megacorer	0/8 Cores recovered - 2 tubes failed to fire
M5	15773#12	45 52.55	56 24.07	347	13/12/2005	4189c	22:50	Megacorer	1-2 cm disturbed mud in 2 tubes - 3 heads failed to fire
M5	15773#13	45 50.47	56 06.42	348	14/12/2005	4162c	03:00	ROBIO	Deployed
M5	15773#13 (contd)			350	16/12/2005		01:40	ROBIO	Recovered
M5	15773#14	45 52.92	56 23.72	348	14/12/2005	4184c	06:04	Box Corer	Successful core. Top water lost through corner
M5	15773#15	45 53.65	56 23.83	348	14/12/2005	4189c	11:36	CTD	Bottles shot at 15, 30, 45, 60, 75, 130 (x2), 2500 (x2), 4175m (x2)
M5	15773#16	45 55.07	56 25.65	348	14/12/2005	4196c	14:07 (16:50)	SAPS	2 pumps POM at 45 m (231 L) Fe 130 m (2284L)
M5	15773#17	45 43.47	56 36.66	349	15/12/2005	4301 - 4283c	00:25 (02:53)	Trawl	Good trawl + successful recovery
M5	15773#18	45 52.96	56 23.78	349	15/12/2005	4186c	11:28	Megacorer	2UKORS + 2 Deepseas Mega + 2 Deepseas Multi - 4 mega (2 good) + 1 multi (good) 1 multi failed
M5	15773#19	45 50.53	56 08.02	349	15/12/2005	4165c	14:58	FRESP	Successful deployment

M5	15773#19						08:52	FRESP	Successful recovery - 2 fish + 8 amphipods in traps + 7 amphopods in FREP bait
M5	15773#20	45 53.34	56 24.24	349	15/12/2005	4189c	18:04	Megacorer	4 + 2. Six good cores.
M5	15773#21	45 53.67	56 24.40	349	15/12/2005	4193c	21:57	Megacorer	4 + 2. Six good cores.
M5	15773#22	45 50.41	56 06.24	350	16/12/2005	4161c	12:07	ROBIO	Successful deployment
M5	15773#22 (contd)			354	20/12/2005		00:55	ROBIO	Successful recovery - camera failed
M5	15773#23	45 40.05	56 35.27	350	16/12/2005	4269-4275c	00:10 (01:35)	Trawl	Successful trawl - largest catch at M5 to date
M5	15773#24	45 54.19	56 25.25	351	17/12/2005	4202c	13:17 (14:45)	SPRATS	Tested at 400 m - failed
M5	15773#25	45 55.07	56 27.95	351	17/12/2005	4203c	17:09	Megacorer	4 + 2. 4 good cores. 1 multi misfired, cracked tube. UKORS Mega bottom plate smashed
M5	15773#26	45 54.10	56 25.42	351	17/12/2005	4188c	21:31 (23:31)	SAPS	2 Pumps Bacteria (1403L)+ POM (2138L) at 10 mab good. 1 Pump (Fe) failed
M5	15773#27	45 54 44	56 26.91	352	18/12/2005	4204-4210c	04:15 (05:20)	WASP	Good tow but video camera failed
M5	15773#28	45 53.81	56 25.03	352	18/12/2005	4191c	11:39	Megacorer	5/6 Cores. I Mega misfired. All slightly disturbed, but usable.
M5	15773#29	45 50.54	56 07.99	354	20/12/2005	4163c	04:46	FRESP	Successful deployment
M5	15773#29 (contd)			355	21/12/2005		08:31	FRESP	Successful recovery (!) Lost fish as hoisting on board
M5	15773#30	45 00.00	56 05.00	354	20/12/2005		05:51	Sediment trap mooring	Successful recovery - 2 traps
M5	15583#1	46 00.59	56 07.37	354	20/12/2005		08:14	Bathysnap	Communicatig, but failed to release - abandoned

M5	15773#31	45 53.56	56 25.77	354	20/12/2005	4200c	12:50	Megacorer	6/6 Good cores - undisturbed
M5	15773#32	45 40.45	56 33.70	354	20/12/2005	4267-4270c	21:45 (22.40)	Trawl	Good catch
M5	15773#33	45 50.32	56 06.28	355	21/12/2005	4161c	08:07	ROBIO	Successful deployment after ballast problems
M5	15773#33 (contd)			357	23/12/2005		08:03	ROBIO	Successful recovery - dragged and hit rock
M5	15773#34	45 54.44	56 26.67	355	21/12/2005	4204c	14:41	Megacorer	Fitted 8 Megacore units 4/8 good + deep cores
M5	15773#35	45 53.94	56 24.65	355	21/12/2005	4194c	19:05	Megacorer	7/8 Good Cores
M5	15773#36	45 51.36	56 05.72	357	23/12/2005	4161c	07:33	FRESP	Successfully deployed
M5	15773#36 (contd)			357	24/12/2005		09:39	FRESP	Successful recovery (stern over Dahn buoy!)
M5	15773#37	45 50.63	56 06.16	357	23/12/2005	4160c	12:49	ROBIO	Successfully deployed
M5	15773#37 (contd)+B75			358	24/12/2005		09:00	ROBIO	2 attempts to recover - on second, buoyancy became wrapped in propellor. ROBIO lost!
M5	15773#38	45 54.48	56 26.21	357	23/12/2005	4208c	16:05	Megacorer	0/8 cores recovered. Bad swell
M5	15773#39	45 55.57	56 26.06	357	23/12/2005	4198c	19:31	Megacorer	8/8 Good, but short cores. 1 lost on deck.
M5	15773#40	45 55.79	56 25.16	357	23/12/2005	4122c	22:25	CTD	Bottles shot at 30, 85, 800, 1200, 1800, 2100, 3000, 3600, 4052, 4143, 4143 m
M5	15773#41	45 56.41	56 25.49	358	24/12/2005		03:01 (04:31)	SAPS	Pump POM 80 m (267 L) + Fe 100m (2278 L)
M5	15773#42	45 53.88	56 25.38	358	24/12/2005	4194 - 4196c	17:30 (18:36)	WASP	65 minutes of good video
M5	15773#43	45 53.43	56 25.65	358	24/12/2005		20:32 (20:45)	Megacorer	Deployment aborted due to rapidly worsening weather conditions

M2	15774#1			360	26/12/2005	3826c	13:01	Sediment trap mooring	Successfully recovered
M6	15775#1	48 59.87	51 13.78	361	27/12/2005	4182c	06:37	FRESP	Successful deployment
M6	15775#1			363	29/12/2005		03:43	FRESP	Successful recovery - no fish!
M6	15775#2	49 03.88	51 13.77	361	27/12/2005	4182-4192c	08:38 (09:40)	WASP	Video failed - camera OK
M6	15775#3	49 03.65	51 14.21	361	27/12/2005	4202c	13:38	Megacorer	6 + 2 + 150kg 4 good megacores + 1 good multi + 1 disturbed multi
M6	15775#4	48 56.21	51 03.90	361	27/12/2005	4182 - 4195c	21:28 (23:10)	Trawl	Good trawl + successful recovery
M6	15775#5	49 03.95	51 14.18	362	28/12/2005	4202c	09:16	Megacorer	4 + 2 + 150kg Fired but no cores recovered!
M6	15775#6	49 03.55	51 15.73	362	28/12/2005	4202c		Megacorer	4 + 2 +150kg - only one small core - others empty.
M6	15775#7	49 03.40	51 17.40	362	28/12/2005	4199c	16:20 (19:45)	CTD	15, 30, 45, 60, 76, 137, 507, 1503, 2506, 4179 (x2) m
M6	15775#8	49 03.61	51 16.32	362	28/12/2005		20:36 (22:06)	SAPS	2 Pumps POM + Rachel Mills 60 m (428 L + 513 L), Fe 100m (2339 L)
M6	15775#9	49 04.43	51 14.89	362	28/12/2005		22:36 (23:46)	SAPS	1 Pump at 60m (Rachel Mills)
M6	15775#10	49 03.99	51 14.02	363	29/12/2005	4204c	06:24	Megacorer	3/8 Cores 1 Mega + 2 Multi
M6	15775#11	49 03.50	51 13.12	363	29/12/2005		08:45 (10:35)	WASP	Altimeter failed. Aborted.
M6	15775#12			363	29/12/2005	4207c	14:16	Megacorer	Clam reset/alarm, unclear when on/off bottom. No cores returned.
M6	15775#13	49 01.15	51 04.52	363	29/12/2005	4187 - 4191c	23:23 (01:37)	Trawl	Good trawl + successful recovery in difficult conditions

M6	15775#14	49 10.84	51 10.73	364	30/12/2005	4231c	18:00 (20:50)	CTD	Bottles shot at 15, 30, 45, 60, 130 (x2), 2500 (x2), 4210 (x3) m
M6	15775#15	49 11.41	51 09.56	364	30/12/2005	4221c	22:56 (00:56)	SAPS	2 Pumps at 60m from bottom POM + Bacteria(1517 and 1469 L) - Core wire died today!
M6	15775#16	48 59.63	51 13.59	365	31/12/2005	4191c	04:33	FRESP	Successful Deployment
M6	15775#16 (contd)			1	01/01/2006		10:50	FRESP	Successful recovery - no fish!
M6	15775#17	49 03.67	51 13.90	365	31/12/2005	4202c	07:32	Megacorer	4 Cores + 150kg 1/4 Cores - 1 tube with ~ 15cm right at top of tube
M6	15775#18	49 04.01	51 13.19	365	31/12/2005	4197c	11:13	Megacorer	2 + 2 Cores - no extra weight. 2/4 good cores returned
M6	15775#19	49 04.59	51 13.49	365	31/12/2005	4202c	15:01	Megacorer	2 + 2 Cores - no extra weight. 3/4 good cores returned
M6	15775#20	59 00.65	51 06.22	365	31/12/2005		13:56 (01:03)	Trawl	Trawl + 8000 m wire lost!
	15509#1			1	01/01/2006		04:29	Bathysnap	Ship over mooring. Dhan Buoy in Rudder
M6	15775#21	49 03.98	51 12.89	1	01/01/2006	4185c	21:04	Megacorer	4 + 2 Cores 3/6 disturbed cores
M6	15775#22	49 04.32	51 12.95	2	02/01/2006	4204c	21:30	Megacorer	4 + 2 Cores 1/6 cores
M6	15775#23			3	03/01/2006		01:00	Sediment trap mooring	Successful recovery - 2nd trap recovered upside down
M6	15775#24	48 59.71	51 13.55	3	03/01/2006	4192c	06:32	FRESP	Successful deployment
M6	15775#24 (contd)			4	04/01/2006		09:24	FRESP	Successful recovery - no fish!
M6	15775#25	49 04.53	51 13.12	3	03/01/2006	4202c	08:57	Megacorer	4 + 2 Cores 3/6 usable cores 2 Mega, I Multi

M6	15775#26	49 04.63	51 11.48	3	03/01/2006	4169 - 4193c	12:40 (14:02)	WASP	Good Video - full tape
M6	15775#27	49 03.83	51 13.35	3	03/01/2006	4203c	19:34	Megacorer	4 + 2. I short Mega - fell out on deck.
M6	15775#28	49 95.02	51 13.22	3	03/01/2006	4201c	21:51	CTD	Bottles fired at 1975, 1470, 974, 736, 490, 300, 130, 101, 81, 41, 21 m
M6	15775#29	49 06.43	51 12.56	4	04/01/2006		01:22 (02:52)	SAPS	2 Pumps at 110 m (2357 L) and 50 m (798 L) for Fe and POM
M6	15775#30	49 04.29	51 14.11	4	04/01/2006	4203c	05:25	Megacorer	6 + 2 No Cores Again!
M6	15775#31	49 01.92	51 13.88	4	04/01/2006	4192c	08:56	Megacorer	6 + 2 5/8 - 3 disturbed, but usable
M6	15775#32	49 02.50	51 12.85	4	04/01/2006	4197c	15:17	Megacorer	6 + 2 3/8 good cores
M6	15775#33	49 01.98	51 13.98	4	04/01/2006	4192c	18:54	Megacorer	6 + 2 3/8 good cores
M6	15775#34	49 02.05	51 13.06	4	04/01/2006	4147c	22:35	CTD	Bottles fired at 4162, 3978, 3476, 2980, 2480, 1968, 1475, 997, 506, 155, 76 m
M6	15775#35	49 01:90	51 13.13	5	05/01/2006	4195c	02:32	Megacorer	6 + 2 2/8 Cores 1 good
M6	15775#36	49 01.99	51 14.01	5	05/01/2006	4192c	05:58	Megacorer	6 + 2 7/8 Cores 4 good (3 Mega + 1 Multi)
M6	15775#37	49 01.88	51 14.10	5	05/01/2006	4192c	09:42	Megacorer	8 + 2 4/10 usable cores
M6	15775#38	49 01.87	51 14.77	5	05/01/2006	4194c	13:23	Megacorer	8 + 2 6/10 usable cores 4 large + 2 small
Crozet	15776#1	46 26.98	51 55.93	6	06/01/2006	359c	05:26	CTD	Bottles fired at 346, 300, 252, 180, 151, 121, 90, 71, 40, 30, 10 m
Crozet	15776#2	46 29.95	51 54.98	6	06/01/2006	354c	07:03 (08:33)	SAPS	2 Pumps Fe (2434 and 2313 L)
Crozet	15777#1	46 22.84	51 49.76	6	06/01/2006	69	11:32 (12:32)	CTD + SAPS	Bottles fired at 50, 28 (x 4) m, 2 Pumps Fe (601 and 1647 L)
Crozet	15778#1	46 24.79	51 55.56	6	06/01/2006	149	15:40	Megacorer	6 0/6 cores+L104

Table 3.1 Scientific deployments during RRS Discovery Cruise 300

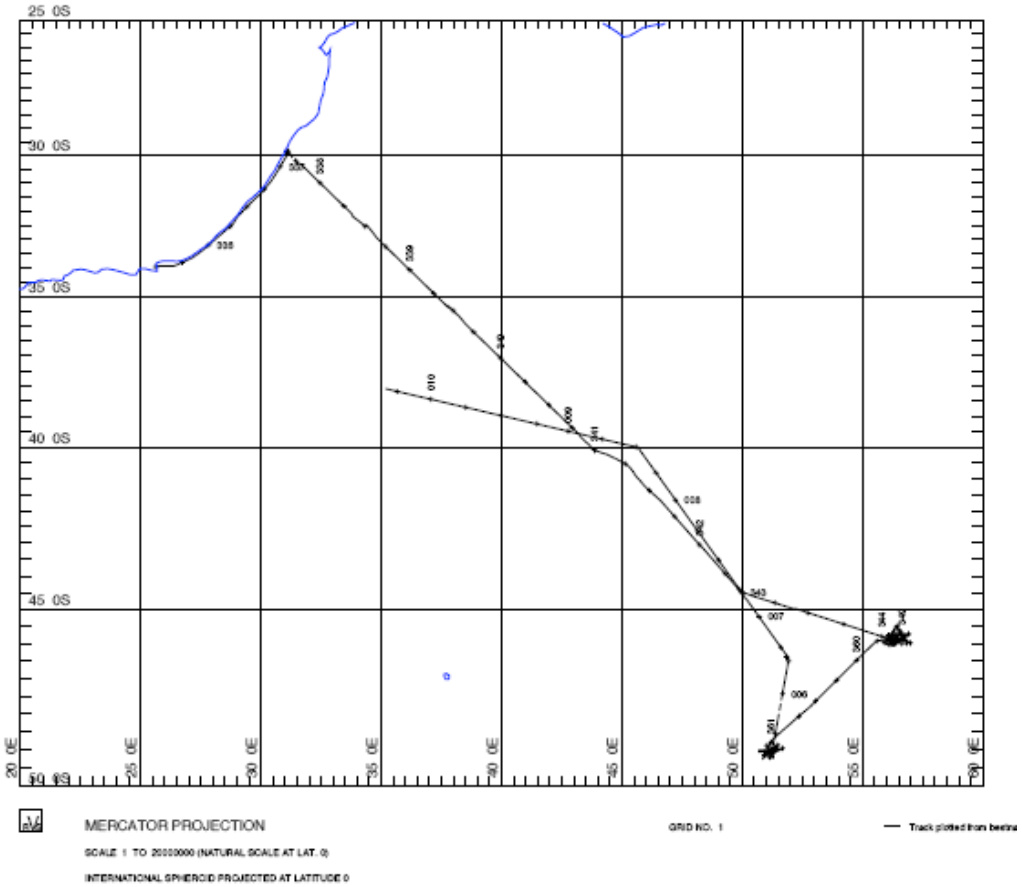


Figure 3.1 RRS Discovery Cruise Track

4. Science Reports

The science reports that follow have been prepared by individual groups responsible for the major activities that were part of D300. These included, trawling, collection of sediments, lander deployments, underway sampling of water for determination of iron, salinity and chlorophyll, CTD cast including sampling for water and deployments of stand-alone pump systems for collection of suspended particulate material. Additionally, long term sediment trap moorings were recovered from M2, M10, M5 and M6 together with a single bathysnap mooring from M6.

5. Otter Trawls

David Billett, Brian Bett, Ben Boorman, Tania Smith, Sue-Ann Watson, Hugh Venables-NOCS (with thanks to the many sorters and net-pickers on deck)

Seven otter trawl deployments were made. On the final deployment the trawl and 8300m of wire were lost for reasons unknown. The wire parted at the splice between the two outboard sections with ~10000m of wire out just as the net was lifting off the seabed.

Of the 6 samples retrieved, 4 were taken at the "eutrophic" M5 site (Station 15773) and 2 at the "oligotrophic" M6 site (Station 15775). Overall the biomass of megafauna was lower at M6 than at M5 by a factor of about 3 (Table 4.1). There were also significant differences in the species composition at the two sites.

Fauna at the M5 "eutrophic" site was particularly rich and varied. Holothurians accounted for an average 90% of the wet weight biomass. In terms of abundance the holothurians were dominated by *Peniagone affinis*, a species with close affinities to other *Peniagone* species found in eutrophic regions of the world's oceans, notably *Peniagone azorica* in the NE Atlantic. In terms of wet weight biomass, however, *P. affinis* was one of three holothurians occurring in more or less the same quantities, the other two species being *Pseudostichopus villosus* and a species of *Psychropotes*. The latter was dark purple and had an unpaired dorsal appendage situated at the posterior end of the body, suggesting a close affinity to *P. longicauda*. However, unlike *P. longicauda* as found in the NE Atlantic, the dorsal appendage was a short stump rather than an elongated structure. It is highly likely that the Crozet holothurian is a new species of *Psychropotes*. Two *Psychropotes* specimens with a long dorsal appendage and resembling *P. longicauda* were also sampled, including one exceptionally large specimen (Figure 5.1). *Pseudostichopus villosus* showed the same wide range of form and colour as found in the NE Atlantic, encompassing the form previously described as *Pseudostichopus atlanticus*.

Other holothurian species of note at the M5 "eutrophic" site were *Oneirophanta mutabilis*, *Ellipinion* sp., *Amperima insignis*, *Abyssocucumis abyssorum*, *Scotoplanes globosa*, several species of *Benthodytes*, possibly two forms of *Molpadia*, several forms of *Pelopatides*, *Paroriza* sp., *Mesothuria* sp., *Laetmogone wyville-thomsoni*, a few *Enypniastes* sp., one or two other species of *Psychropotes* and a multitude of medium and small sized holothurians of various species.

Of the rest of the catch asteroids formed a notable component, especially porcellanasterid mud-swallowing sea stars and several large pterasterid starfish. There was also a large and varied collection of brittle stars and sea anemones. Most phyla were represented, although crustaceans were notable by their scarcity, apart from isopods. Many fragments of a dark purple irregular sea urchin were also collected. The catch was notable for the number of rocks, especially pumice, and the presence of macrophyte detritus, including a kelp holdfast, but it was unclear how much of this had been collected on the seabed. A large and varied fish catch was also obtained and this is reported on separately in the cruise report.

Figure 5.1 Psychropotes – an exceptionally large specimen from M5

The invertebrates at the M5 "eutrophic" site were not only notable for their wide variety, but also for the remarkable similarity of the proportions of the various forms to catches taken at a eutrophic site in the NE Atlantic. There would appear to be some major underlying factor influencing the structure of the megafaunal community in areas subjected to large seasonal pulses of phytodetritus. The similarities between the Crozet M5 "eutrophic" site and the Porcupine Abyssal Plain were quite striking, particularly in the proportions of the main holothurian genera, yet the species were quite distinctive, and In several cases will probably turn out to be new species. Samples of muscle tissue were taken from the common holothurians for molecular characterisation of the species and for comparison with work carried out in the NE Atlantic.

The community structure of the fauna at the M6 "oligotrophic" site was quite different. Several of the species that were common at M5 were also present at M6, but in much

lower abundance. The virtual absence of *Pseudostichopus villosus* at M6 was particularly noticeable and unexpected. In terms of wet weight biomass, the fauna was again dominated by holothurians, but in this area they accounted for only about 70% of the catch. The most abundant holothurian was a species of *Peniagone*, possibly *Peniagone incerta,* an Antarctic species with affinities to *P. affinis* and *P. azorica*.

Proportionally asteroids contributed a greater part of the fauna (about 10%), mainly porcellanasterid mud-swallowing starfish. In one trawl an uncommonly high number of polychaete worm tubes were collected, and in the other a few large cirrate octopods contributed significantly to the wet weight biomass.

The overall wet weight biomass was not as low as one might expect for an apparently oligotrophic region. The wet weight biomass per unit area was similar to some catches from the Porcupine Abyssal Plain (4850m), albeit at a slightly shallower site off Crozet (c. 4250m on the continental rise). Sediment trap data reported on elsewhere in this cruise report indicate that large episodic fluxes of organic matter can occur in this region and therefore it cannot be classed as a permanently oligotrophic site. This is also indicated by the large number of the very small holothurian tentatively identified as *Kolga hyalina* picked from the cod end, particularly on the first trawl from the M6 site. *Kolga* is a known opportunistic species from the NE Atlantic and appears to have a cosmopolitan distribution. It is particularly common in the Norwegian Sea where short, large episodic fluxes of organic matter might be expected. *Kolga* may be particularly successful in responding to organic matter fluxes that are separated in space and time.

Overall, there are significant differences in the abundance, wet weight and species composition of the megafauna at the two Crozet sites sampled during the cruise. The reasons behind the species differences between the two stations are intriguing, as is the overall similarity of the proportions of the major species at the M5 “eutrophic” site with a similar seasonal production setting in the NE Atlantic. A detailed investigation of the *Peniagone* species might yield some interesting insights into speciation in the deep sea in relation to surface production.

Table 4.1 Megafaunal fresh wet weight biomass (g per hectare)

	15773#8	15773#17	15773#23	15773#32	**AVG M5**	15775#4	15775#13	**AVG M6**
Distance run (nm)	1.59	4.29	6.75	2.96		2.71	2.87	
Area fished (hectares)	2.532	6.833	10.751	4.714		4.316	4.571	
Porifera	190	74	167	168		84	7	
Cnidaria	642	425	681	2269		93	25	
Annelida	50	50	50	69		630	65	
Vermes	6	8	10	10		17	18	
Crustacea	56	20	33	64		18	12	
Pycnogonida	7	14	12	16		5	3	
Mollusca	35	36	19	89		40	503	
Asteroidea	256	263	175	280		590	338	
Ophiuroidea	261	240	136	491		262	138	
Echinoidea	24	1	15	4		119	13	
Holothuroidea	13106	9017	14401	19750	**14068**	4299	3074	**3687**
Echinoderms	13650	9523	14728	20529		5271	3563	
Fish	6271	2273	2833	4059	3859	2043	2101	2072
Total Invertebrates	14640	10152	15703	23216	**15928**	6175	4207	**5191**
Total Fauna	20993	12504	18823	27475		8331	6340	

5.1 Holothurians
Tania Smith, NOCS
Frédèric Chaillan

Holothurians are found in great abundance in the deep-sea and are thought to be significant reservoirs of organic and inorganic carbon. They depend on the downward flux of organic matter for their energy and essential nutrients. Changes in surface water productivity have been proposed as important drivers for variation in the biodiversity of deep-sea sediments, with biogeochemical provinces evident in surface waters mirrored in benthic community structure at the broad scale.

Samples were taken from two sites around the Crozet Islands that have contrasting overlying primary productivity regimes (sites M5 and M6). The samples will be analyzed to help elucidate if there is a link between the supply of reproductively important carotenoids (derived exclusively from phytoplankton) and holothurian species diversity.

Intact representatives of each of the species of holothurian recovered from the trawl were put in cold water and transferred to the constant temperature room. Here they were dissected for gut content, gut wall and gonads. The samples were then transferred to the freezer (-80°C). The samples will be analyzed at NOCS for pigments using High Performance Liquid Chromatography (HPLC) and in Liverpool using HPLC-Mass Spectrometry.

Unless stated otherwise, gut and gut wall samples were taken from the middle section of the intestines. The gut wall samples were taken from the areas corresponding to the gut sediment samples.

Station M5

Holothurians from all four trawls at this station were dissected.

Species	**Individuals dissected**	**Gut sediment samples**	**Gut wall samples**	**Gonad samples**	**Foregut sediment samples**	**Foregut wall samples**
Abyssocucumis sp.	8			8		
Pseudostichopus villosus	5	4	4	4		3
Oneirophanta mutabilis	5	5	5	5		5
Scotoplanes globosa	3	3	3	3	3	3
Peniagone sp.	5	4	4	5		
Ellipinion sp.	2	1	1	2		
Psychropotes sp.	2	2	2	4		
Pelopatides sp.	1	1	1	1		

Table 5.2 15773#8 – 13/12/05

Species	Individuals dissected	Gut sediment samples	Gut wall samples	Gonad samples	Foregut sediment samples	Foregut wall samples
Abyssocucumis sp.	3	0	0	6		
Pseudostichopus villosus	7	7	7	8 (+ 3 formalin samples)	4	5
Oneirophanta mutabilis	6	6	6	1 (+1 in formalin)	5	5
Ellipinion sp.	4	4	4	6 (+3 in formalin)	1	1

Table 5.3 15773#17 – 15/12/05

Species	Individuals dissected	Gut sediment samples	Gut wall samples	Gonad samples	Foregut sediment samples	Foregut wall samples
Psychropotes sp.	7	7	7	15	6	6
Pseudostichopus villosus	4	4	4	4	3	4
Ellipinion sp.	7	3	3	13		2

Table 5.4 15773#23 – 17/12/05

Samples for molecular (DNA) analysis were also taken at this station. Photographs of all specimens were also taken and are available.

Cryovial	Species	Cryovial	Species
D1	*Benthodytes sp.* sp. 1	**D26**	*Ellipinion sp.* c
D2	*Benthodytes sp.* sp. 2	**D27**	*Ellipinion sp.* d
D3	*Benthodytes sp.* sp. 2	**D28**	*Ellipinion sp.* e
D4	*Benthodytes sp.* sp. 1	**D29**	*Ellipinion sp.* f
D5	*Benthodytes sp.* sp. 3	**D30**	*Ellipinion sp.* g
D6	*Benthodytes sp.* sp. 3	**D31**	*Abyssocucumis sp.* a
D7	*Benthodytes sp.* sp. 4	**D32**	*Abyssocucumis sp.* b
D8	*Benthodytes sp.* sp. 5	**D33**	*Abyssocucumis sp.* c
D9	*Benthodytes sp.* sp. 6	**D34**	*Abyssocucumis sp.* d
D10	*Benthodytes sp.* sp. 6	**D35**	*Abyssocucumis sp.* e
D11	*Benthodytes sp.* sp. 7	**D36**	*Pseudostichopus villosus* a
D12	*Benthodytes sp.* sp. 5	**D37**	*Pseudostichopus villosus* b
D13	*Benthodytes sp.* sp. 8	**D38**	*Pseudostichopus villosus* c
D14	*Benthodytes sp.* 8?	**D39**	*Pseudostichopus villosus* d
D15	*Psychropotes sp.* 1	**D40**	*Pseudostichopus villosus* e
D16	*Psychropotes sp.* 1	**D41**	*Pseudostichopus villosus* e

D17	*Psychropotes sp.* 2	**D42**	*Psychropotes sp.* sp 3
D18	*Oneirophanta mutabilis* large	**D43**	*Psychropotes sp.* sp. 3
D19	*Oneirophanta mutabilis* large	**D44**	*Psychropotes sp.* sp. 4
D20	*Oneirophanta mutabilis* small	**D45**	*Psychropotes sp.* sp. 4
D21	*Oneirophanta mutabilis* small	**D46**	*Psychropotes sp.* sp. 5
D22	*Scotoplanes globosa*	**D47**	*Psychropotes sp.* sp. 5
D23	*Scotoplanes globosa*	**D48**	*Psychropotes sp.* sp. 6
D24	*Ellipinion sp.*	**D49**	*Psychropotes sp.* sp. 6
D25	*Ellipinion sp.*		

Table 5.5 Samples collected for DNA on 15773#23

Species	**Individuals dissected**	**Gut sediment samples**	**Gut wall samples**	**Gonad samples**	**Foregut sediment samples**	**Foregut wall samples**
Abyssocucumis sp.	5	5				
Pelopatides sp.	1	1	1	1		
Benthodytes sp.	5	4	4	4		4

Table 5.6 15773#32 – 21/12/05

Bacterial samples were also collected from 15773#32

Cryovial	**Species**	**Comments**
B1-3	*Oneirophanta mutabilis*	Hind gut
B4-6	*Oneirophanta mutabilis*	foregut
B7-9	*Oneirophanta mutabilis* 2	foregut
B10-12	*Oneirophanta mutabilis* 2	mid gut
B13-15	*Oneirophanta mutabilis* 2	Hind gut
B16-18	*Scotoplanes globosa*	Cloaca
B19-21	*Scotoplanes globosa*	foregut
B22-24	*Scotoplanes globosa* 2	Cloaca
B25-27	*Scotoplanes globosa*2	foregut
B34-36	*Scotoplanes globosa*4	Cloaca
B37-39	*Scotoplanes globosa* 4	foregut
B40-42	*Scotoplanes globosa* 5	Cloaca
B43-45	*Scotoplanes globosa* 5	foregut
B52-54	*Molpadia* 1	Cloaca
B55-57	*Molpadia sp.* 1	foregut
B58-60	*Molpadia sp.* 2	Cloaca
B61-63	*Molpadia sp.* 2	foregut
B64-66	*Molpadia sp.* 3	Cloaca
B67-69	*Molpadia sp.* 3	foregut
B70-72	*Abyssocucumis sp.* 1	Cloaca
B73--75	*Abyssocucumis sp.* 1	Oesophagus
B76-78	*Abyssocucumis sp.* 4	cloaca
B79-81	*Pseudostichopus villosus* 1	Oesophagus

B82-84	*Pseudostichopus villosus* 1	mid gut
B85-87	*Pseudostichopus villosus* 2	mid gut
B88-90	*Pseudostichopus villosus* 2	Oesophagus
B91-93	*Psuedostichopus villosus* 3	cloaca
B94-96	*Psuedostichopus villosus* 3	Oesophagus
B97-99	*Pseudostichopus villosus* 4	cloaca
B100-102	*Pseudostichopus villosus* 5	cloaca
B103-105	*Pseudostichopus villosus* 5	Oesophagus

Table 5.7 Samples collected for bacteria on 15773#32

Station M6

Holothurians from two trawls were dissected.

Species	**Individuals dissected**	**Gut sediment samples**	**Gut wall samples**	**Gonad samples**	**Foregut sediment samples**	**Foregut wall samples**
Abyssocucumis sp.	4	4		4		
Pelopatides sp.	1	1	1	1 (+1 in formalin)		
Kolga sp.	26 (frozen whole)					
Molpadia sp.	2	2 (+1 hindgut sample)	2	0	1	2
Peniagone sp.	13	13	13	13 (+1 formalin)		13
Psychropotes sp.	8	7	2	6 (+2 in formalin)		
Benthodytes sp. clear purple jelly	3	3	3	7		

Table 5.8 15775#4 – 28/12/05

Species	**Individuals dissected**	**Gut sediment samples**	**Gut wall samples**	**Gonad samples**	**Foregut sediment samples**	**Foregut wall samples**
Benthodytes sp. aff *B. lingua*	3	3	2	6		
Benthodytes sp.	2	1	1	3		
Benthodytes sp. aff *B. typica*	4	4	4	4		
Pelopatides sp.	1	1	0	1		
Kolga sp.	25 (frozen whole)					
Molpadia sp.	3	2	3	5 (+1 in formalin)	1	1
Peniagonesp.	6	6	5	3		5
Psychropotes sp.	2	2	2	2		

Table 5.9 15775#13 – 30/12/05

Holothurians were also collected for lipid analysis to be carried out in Liverpool. From trawls, organisms in good condition were collected and stored in chilled sea water (2°C), then identified, weighed and measured and finally packed in clean aluminium foil (400°C) and stored at -80°C. These organisms will be dissected at Liverpool University to analyse the lipid composition of the tissues.

Station number	**15773#8 M5**		
Reference No	Name	Length (cm)	Weight (g)
1	*Psychropotes sp.*	23	217
2	*Molpadia* sp.	6	23,8
3	*Molpadia* sp.	14,5	233
4	*Abyssocucumis* sp.	12	112
5	*Abyssocucumis* sp.	2,5	32
6	*Abyssocucumis* sp.	9	75
7	*Abyssocucumis* sp.	10	83
8	*Pseudostichopus* sp.	13	121
9	*Pseudostichopus* sp.	12	75
10	*Pseudosticopus* sp.	11	87
11	*Oneirophanta mutabilis*	14,5	148
12	*Oneirophanta mutabilis*	10	70

Table 5.10 15773#8 - 12/12/2005

Station number	**15773#17 M5**		
Reference No	Name	Length (cm)	Weight (g)
1	*Abyssocucumis* sp.	7,5	24,6
2	*Abyssocucumis* sp.	8	18
3	*Abyssocucumis* sp.	4	14
4	*Abyssocucumis* sp.	9	45
5	*Abyssocucumis* sp.	6,5	42,8
6	*Oneirophanta mutabilis*	14,5	116,6
7	*Oneirophanta mutabilis*	14,5	148,8
8	*Oneirophanta mutabilis*	8,5	25,8
9	*Amperima* sp.	9	29,4
10	*Amperima* sp.	7,5	26,8
11	*Oneirophanta*	9	29,4
12	*Psychropotes*	21	244,8
13	*Pseudosticopus* sp.	16,5	87,8
14	*Pseudosticopus* sp.	12,5	75,2

Table 5.11 15773#17 - 15/12/2005

Station number	**15773#23 M5**		
Reference No	Name	Lenght (cm)	Weight (g)
1	*Oneirophanta mutabilis*	12	101
2	*Oneirophanta mutabilis*	16	210
3	*Oneirophanta mutabilis*	9,5	33
4	*Scotoplanes* sp.	12	386
5	*Pseudosticopus* sp.	17	157
6	*Pseudosticopus* sp.	19,5	207
7	*Amperima* sp.	8,5	33
8	*Amperima* sp.	8	23
9	*Abyssocucumis* sp.	10,5	55
10	*Molpadia* sp.	9	92
11	*Abyssocucumis* sp.	6,5	28
12	*Abyssocucumis* sp.	7,5	62
13	*Abyssocucumis* sp.	7	22
14	*Psychropotes* sp.	23	305

Table 5.12 15773#23 - 16/12/2005

Station number	**15773#32 M5**		
Reference No	Name	Length (cm)	Weight (g)
1	*Abyssocucumis* sp.	10	82,6
2	*Abyssocucumis* sp.	9,5	85,2
3	*Pseudosticopus* sp.	12,5	73
4	*Pseudosticopus* sp.	11,5	76,2
5	*Scotoplanes* sp.	7,5	74,2
6	*Molpadia* sp.	10	117,4
8	*Benthodytes* sp.	17,5	54,2
9	*Benthodytes* sp.	21,5	100,4
10	*Psydropotes* sp.	24	211,4

Table 5.13 15773#32 - 20/12/2005

Station number	**15775#4 M6**		
Reference No	Name	Length (cm)	Weight (g)
1	*Molpadia* sp.	9,5	28,6
2	*Molpadia* sp.	13,5	193
3	*Abyssocucumis* sp.	6	18,8
4	*Abyssocucumis* sp.	7	27
5	*Abyssocucumis* sp.	8,5	26
6	*Oneirophanta mutabilis*	7	16,4
7	*Peniagone* sp.	9	16,6
8	*Peniagone* sp.	10,5	27,8
9	*Psychropotes* sp.	49	640,5
10	*Benthodytes* sp.	27	201
11	*Pseudosticopus* sp.	8,5	20

Table 15.14 15775#4 - 27/12/2006

Station number	**15775#13 M6**		
Reference No.	Name	Length (cm)	Weight (g)
1	*Molpadia* sp.	8	38,4
2	*Abyssocucumis* sp.	8,5	42,6
3	*Abyssocucumis* sp.	7	14,4
4	*Peniagone* sp.	8	19,2
5	*Peniagone* sp.	5,5	5,2
6	*Peniagone* sp.	7	26,8
7	*Peniagone*sp.	5,5	6,4
8	*Peniagone* sp.	7	14,8
9	*Peniagone* sp.	7,5	12
10	*Polopotetris* sp.	10	45,4
11	*Polopotetris* sp.	17	111,2
12	*Psychropotes* sp.	16,5	66,8
13	*Polopotetris* sp.	14	87,2
14	*Kolga* sp.	2 specimens	

Table 15.15 15775#13 - 29/12/2006

5.2 Demersal ichthyofaunal assessment – Nicola King, Oceanlab, University of Aberdeen.

5.2.1 Aims and objectives:

The aims and objectives were to assess the demersal ichthyofaunal biodiversity, abundance and biomass at a eutrophic site (M5), and oligotrophic site (M6) on the Crozet Plateau, and to determine any differences in biodiversity, abundance and biomass between the two regions. More specifically condition indices such as length/weight relationships and hepato-somatic indices for the macrouridae will also be compared between the two sampling regions. Demersal fish specimen identification from trawls will also be used to verify fish imaged within ROBIO lander still images, and FRESP lander video (See Section 6).

5.2.2 Trawl processing:

Fish data were retrieved from 6 OTSB trawls (see station list for further details). Four trawls were conducted at M5, and only 2 trawls at M6 due to loss of the trawl net.

Both demersal and pelagic specimens within the trawl were identified to the lowest taxonomic level possible. Specimens that could not be identified to species level on board have been kept, and white muscle samples have been taken for phylogenetic analyses in most cases. All fish were given an individual number for tracing, and where possible total wet weight, total length, standard length, head length and pre-anal length were recorded. Only demersal fish are discussed here.

Further data was specifically taken for the macrouridae (rattails), which were sexed, stomach and liver weight recorded (when not regurgitated), and the stomach fullness and sexual maturity assessed.

5.2.3 Preliminary results:

Demersal fish species richness at both M5 and M6 were equal with 12 demersal fish species present in trawls (Table 5.16 & 5.17). Species composition is similar with the same major groups present, and the macrourids dominating the overall catch (Table 5.16 & 5.17). However large differences in total mean abundance (fish.hectare^{-2}) and biomass (kg.hectare^{-2}) between M5 and M6 are obvious. Total mean wet weight (kg.hectare^{-2}) is considerably lower at M6, as is abundance (fish.hectare^{-2}) compared with M5, but differences have not been determined statistically (Table 5.16 & 5.17; Fig. 5.2). Demersal fish abundance is 1300 fish.km^{-2} at M5, and 900 fish.km^{-2} at M6, and total fish biomass at both sites is 375 kg.km^{-2}, and 199 kg.km^{-2}, at sites M5 and M6 respectively (Table 5.16 & 5.17).

When examining trawl composition, both sites display similar patterns, with the macrourids and *Bathypterois dubius* dominating trawl catches numerically, and the macrourids (particularly *Coryphaenoides (Nematonurus) armatus*) dominating the biomass (Figure 5.3).

Table 5.16 M5 demersal fish trawl summary. Taxa are listed in taxonomic order. Standard deviations are in parentheses.

	15773#8		15773#13		15773#23		15773#32		Mean	
	Abundance (fish.ha^{-2})	Wet weight (kg.ha^{-2})	Abundance (fish.ha^{-2})	Wet weight (kg.ha^{-2})	Abundance (fish.ha^{-2})	Wet weight (kg.ha^{-2})	Abundance (fish.ha^{-2})	Wet weight (kg.ha^{-2})	Abundance (fish.ha^{-2})	Wet weight (kg.ha^{-2})
Bathypterois dubius	2	0.05	3	0.07	1	0.04	5	0.13	3 (1.77)	0.07 (0.04)
Histiobranchus bathybius	0	0.00	0	0.05	0	0.14	2	0.95	1 (0.96)	0.28 (0.45)
Coryphaenoides (*N.*) *armatus*	4	4.49	2	0.86	1	0.75	1	0.53	2 (1.82)	1.66 (0.06)
C. ferrieri	3	1.52	3	1.09	3	1.68	4	1.98	3 (1.62)	1.57 (1.89)
C. ferrieri juvenile	0	0.00	0	0.00	0	0.01	5	0.20	1 (0.60)	0.05 (0.37)
Coryphaenoides spp.	2	0.05	5	0.16	3	0.08	1	0.04	3 (2.29)	0.08 (0.10)
Zoarcidae (*Lycenchelys* sp.)	0	0.00	0	0.00	0	0.00	0	0.00	0 (0.07)	0.00 (0.00)
Zoarcidae (*Pachychara* sp.?)	0	0.00	0	0.00	0	0.01	0	0.10	0 (0.20)	0.03 (0.05)
Holocomycteronus brucei	0	0.00	0	0.00	0	0.04	0	0.00	0 (0.14)	0.01 (0.02)
Liparididae (*Careproctus* sp.?)	0	0.00	0	0.00	0	0.00	0	0.00	0 (0.20)	0.00 (0.00)
Liparididae (Unidentified sp. 1)	0	0.00	0	0.00	0	0.00	0	0.00	0 (0.11)	0.00 (0.00)
Liparididae (Unidentified sp. 2)	0	0.00	0	0.00	0	0.00	0	0.01	0 (0.11)	0.00 (0.00)
Total	11	6.12	13	2.24	10	2.74	18	3.93	13 (3.68)	3.75 (1.73)

Table 5.17 M6 demersal fish trawl summary. Taxa are listed in taxonomic order. Standard deviations are in parentheses.

	15775#4		15775#13		Mean	
	Abundance (fish.ha^{-2})	Wet weight (kg.ha^{-2})	Abundance (fish.ha^{-2})	Wet weight (kg.ha^{-2})	Abundance (fish.ha^{-2})	Wet weight (kg.ha^{-2})
Bathypterois dubius	2	0.11	2	0.07	2 (0.40)	0.09 (0.03)
Histiobranchus bathybius	0	0.00	0	0.20	0 (0.31)	0.10 (0.14)
C. (*N*) *armatus*	1	1.10	1	0.83	1 (0.05)	0.96 (0.19)
C. (*N.*) *armatus* juvenile?	0	0.00	0	0.00	0 (0.16)	0.00 (0.00)
C. ferrieri	2	0.65	1	0.50	1 (0.22)	0.58 (0.11)
Coryphaenoides spp.	4	0.13	2	0.09	3 (1.38)	0.11 (0.03)
Coryphaenoides spp. juvenile	0	0.00	0	0.00	0 (0.15)	0.00 (0.00)
Zoarcidae (*Lycenchelys antarctica*?)	0	0.00	0	0.00	0 (0.15)	0.00 (0.00)
Zoarcidae (*Pachycara* sp.)	0	0.00	0	0.00	0 (0.01)	0.00 (0.00)
Ophidiidae (*Apagesoma* sp.?)	0	0.00	0	0.25	0 (0.15)	0.12 (0.17)
Holcomycteronus brucei	0	0.01	0	0.05	0 (0.15)	0.03 (0.03)
Liparididae (*Paraliparis* sp.?)	0	0.00	0	0.00	0 (0.33)	0.00 (0.00)
Total	10	2.00	8	1.99	9 (1.63)	1.99 (0.01)

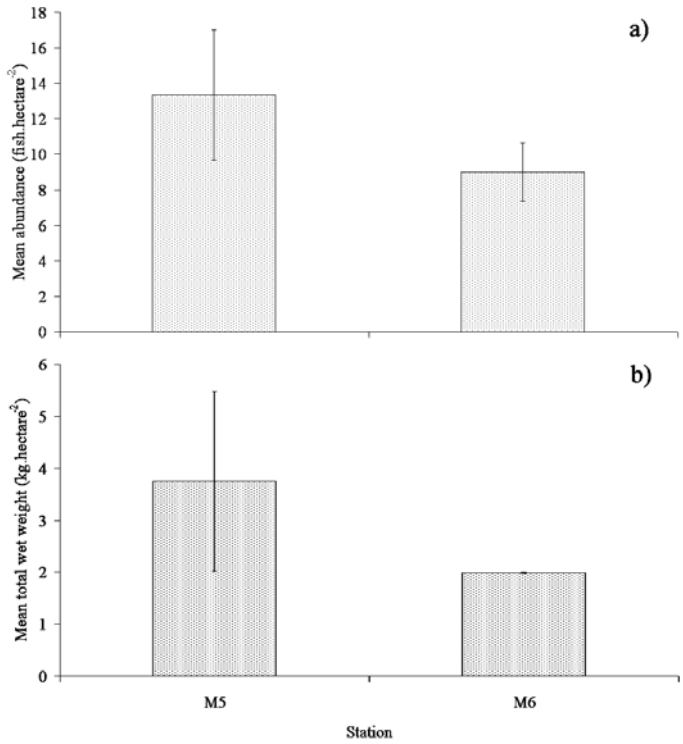


Figure 5.2. Demersal fish mean abundance and biomass. a) Mean abundance (fish.hectare^{-2}) at stations M5 and M6; b) mean wet weight (kg.hectare^{-2}) from stations M5 and M6. Solid t-bars indicate standard deviations.

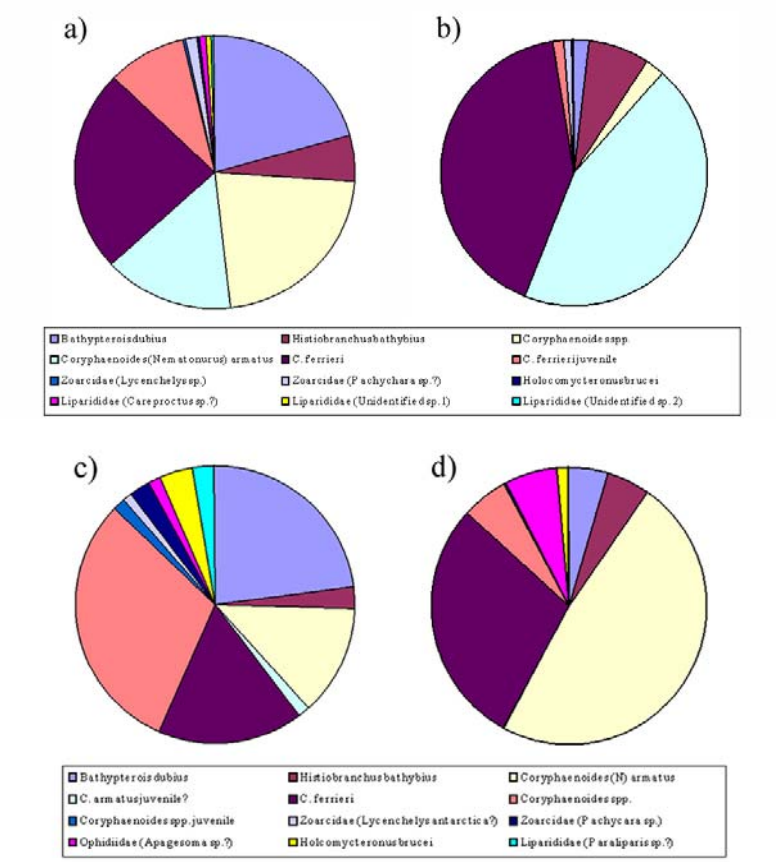


Figure 5.3. Comparison of demersal fish contributions to mean abundance (fish.hectare^{-2}) and mean wet weight (kg.hectare^{-2}) from trawl data at stations M5 and M6, Crozet Plateau; a) % contribution to mean abundance (fish.hectare^{-2}) station M5, b) % contribution to mean wet weight (kg.hectare^{-2}), station M5, c) % contribution to mean abundance (fish.hectare^{-2}), station M6, d) % contribution to mean wet weight (kg.hectare^{-2}), station M6.

Length-weight relationships between M5 and M6 follow similar patterns in more than one taxonomic group (Fig. 5.4). Using liver weight as a condition index also does not yield obvious differences between M5 and M6 for the *C. (N.) armatus* (Fig. 5.5).

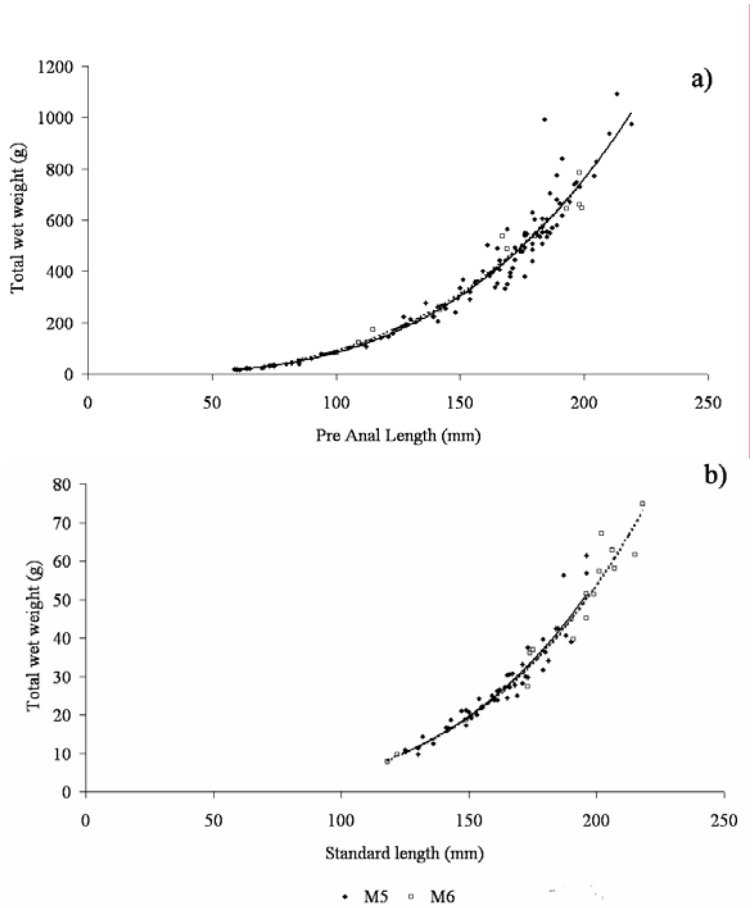


Figure 5.4. Length-weight relationships for *Coryphaenoides ferrieri* and *Bathypterois dubius* from station M5 and M6. a) *Coryphaenoides ferrieri*. Solid line indicates the length-weight relationship at M5 (Total weight (g)=$3x10^{-5}PAL^{3.1979}$, R^2 = 0.99, n = 106), dashed line indicates the relationship at M6 (Total weight (g) =$6x10^{-5}PAL^{3.0724}$, R^2 = 0.98, n = 24) and b) *Bathypterois dubius*. Solid line indicates the length-weight relationship at M5 (Total weight (g) = $3x10^{-7}SL^{3.5827}$, R^2 = 0.95, n = 63), dashed line indicates the relationship at M6 (Total weight (g) = $3x10^{-7}SL^{3.5637}$, R^2 = 0.98, n = 18). PAL = Pre anal length (mm), SL = standard length (mm).

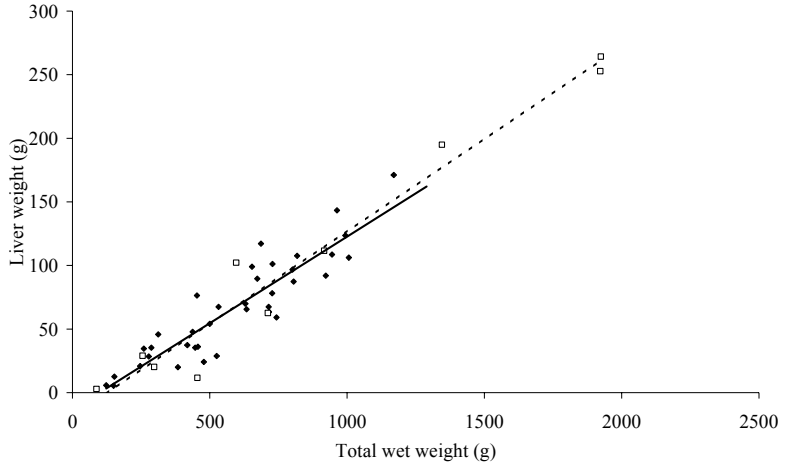


Figure 5.5. Liver weight (g) vs. total wet weight (g) for *Coryphaenoides (N.) armatus* from station M5 (closed diamonds) and M6 (open squares). The solid line indicates the linear relationship for site M5 (Liver weight (g) = 0.136WW – 13.42, R^2 = 0.83, n = 39), the dashed line indicates the relationship for site M6 (Liver weight (g) = 0.1457WW – 18.801, R^2 = 0.96, n = 10). WW = total wet weight (g).

From previous lander deployments approximate swimming speeds of *C. (N.) armatus* are known to be 0.05-0.077 $m.s^{-1}$, suggesting that it would take approximately 2 months to swim the 160 nm from M6 to M5. The prevailing current direction is from M6 to M5, and this combined with the current lack of notable difference in the morphometric data and condition indices leads us to believe that the rattail fishes are transient between the oligotrophic M6 and the eutrophic M5, and do not consider the sharp productivity gradient a barrier to migration.

5.2.4 Analysis:

Analysis of the OTSB trawl data will consist of a) statistical determination of differences in biodiversity, biomass and abundance between M5 and M6, b) length-weight relationships of all demersal fish taxa for both M5 and M6 where sufficient data is available, and the appropriate statistics to determine if there are differences in the relationships between sites, c) official identification of difficult specimens by taxonomists.

Specifically for the macrouridae length frequency analysis will be conducted to determine age classes, and analysis of condition using the hepato-somatic indices as a proxy for health (Fig. 5.5). Stomach analyses can also be used to determine differences in stomach fullness between M5 and M6, and where available stomach contents can be used to supplement information on trophic ecology. All data analyses will be conducted in time to be presented at the 11th International Deep-Sea Symposium, Southampton, 9-14th July 2006.

White muscle samples were taken from all specimens of *C. (N.) armatus* (N=50) for use as an out-group for a study on the population genetic structure of specimens from the Mid-Atlantic Ridge, North Atlantic Ocean. Tissue samples were also taken from *C. (N.) armatus* and *C. ferrieri* for Elaine Fitzcharles at the British Antarctic Survey, Cambridge, for use as an out-group in a stock population survey specific to the Southern Ocean. Several samples were also taken from *C. (N.) armatus*, *C. ferrieri* and *Cynomacrurus piriei* for a phylogenetic study being conducted by David Johnston at the Natural History Museum, London.

6. Lander Activities

Alan Jamieson, Ben Wigham, Nicola King, Phil Bagley, Oceanlab, University of Aberdeen.

6.1 Introduction

To characterise the activity of demersal fish at CROZET sites M5 and M6, Oceanlab operated 2 landers and processed the fish catch from the OTSB trawl. The Fish Respirometry Lander (FRESP) is an autonomous baited respirometry trap designed to measure the oxygen consumption of fish *in situ*. Fish community structure and abundance was to be characterised by both the analysis of the trawl data, and the use of a time-lapse baited camera system (the Robust Biodiversity lander;ROBIO).

Figure 6.1 ROBIO & FRESP Landers being used during D300

Lander	Station	Location	Depth	Deployed	Recovered	Comments
ROBIO 1	15773#6	45°50.43' S 56°06.16' E	4160m	10:28 GMT 12.12.05	07:10 GMT 13.12.05	527 photos on bottom over 13.5hrs.
ROBIO 2	15773#13	45°50.47' S 56°06.42' E	4162m	03:09 GMT 14.12.05	01:40 GMT 16.12.05	Camera firing erratically. Large gaps in data sequence. 130 photos on bottom over 3.5hrs
ROBIO 3	15773#22	45°50.41' S 56°06.24' E	4161m	12:06 GMT 16.12.05	00:55 GMT 20.12.05	Again problems with camera – only 4 photos on bottom. Camera problems traced to leaking battery cable
ROBIO 4	15773#33	45°50.32' S 56°06.28' E	4161m	08:06 GMT 21.12.05	08:05 GMT 23.12.05	Lander being dragged. Wedged against large boulder 2.5hrs into deployment. 479 photos on bottom
ROBIO 5	15773#37	45°50.63' S 56°06.16' E	4160m	12:49 GMT 23.12.05	LOST 24.12.05	Mooring line run down twice by ship. Dhan buoy recovered before glass spheres destroyed by prop. LOST
FRESP 1	15773#19	45°50.53' S 56°08.02' E	4166m	15:01 GMT 15.12.05	08:52 GMT 17.12.05	2 fish caught in trap. *Coryphaenoides armatus* Trap seal leaked – replaced. No O_2 data.
FRESP 2	15773#29	45°50.54' S 56°07.99' E	4165m	04:47 GMT 20.12.05	08:40 GMT 21.12.05	1 fish caught, 1 trapped between trap edge and base plate. Trap wedged open, no O_2 consumption data.
FRESP 3	15773#36	45°51.36' S 56°05.72' E	4161m	07:33 GMT 23.12.05	09:39 GMT 24.12.05	Mooring line run down by ship. No fish caught in trap. Mooring line lost, F4-6 deployed in new configuration
FRESP 4	15775#1	48°59.87' S 51°13.78' E	4190m	06:37 GMT 27.12.05	00:45 GMT 29.12.05	4 fish caught. 3 x *C. armatus* Zoarcidae Trap leaked after 13hrs. Elastic cord added to pull lid shut.
FRESP 5	15775#16	48°59.63' S 51°13.59' E	4191m	05:09 GMT 31.12.05	08:35 GMT 01.01.06	No fish caught in trap. Seal good, no obvious leaks.
FRESP 6	15775#24	48°59.71' S 51°13.55 'E	4192m	08:31 GMT 03.01.06	09:25 GMT 04.01.06	No fish caught in trap. 40.6g of amphipods recovered, including *Eurythenes gryllus*. Partial O_2 decline recorded

* All FRESP deployments carried 2 x baited amphipod traps for NOC DEEPSEAS Group

Table 6.1: Summary of Lander deployments

6.2 Abundance and diversity of scavenging fish fauna – ROBIO

The RObust BIOdiversity lander (ROBIO) is a baited time-lapse camera system used to assess the abundance and diversity of scavenging fish fauna. Equipped with a 3 megapixel digital camera (Kongsberg OE-218) and flash-gun, ROBIO can be deployed for up to 2 days. The time-lapse interval is pre-programmed and images are recorded internally. ROBIO is also equipped with a self-contained Aquadopp current meter (Nortek AS, Norway). ROBIO was deployed with the instrument frame tethered 2m above the seabed between 100kg of ballast below and floation above. Mackerel bait and a 1m x1m reference scale were attached to the ballast clump.

A summary of the ROBIO deployments completed at station M5 are shown in Table 6.1. No deployments were achieved at station M6 as the entire lander and mooring were lost after buoyancy spheres were destroyed by the ship's propeller during recovery of ROBIO 5. Data collection was also affected at station M5 by a combination of a leaking battery cable (ROBIO 2 and 3) and by the lander becoming wedged against a large boulder that obscured the view of the bait and rendered the deployment unusable (ROBIO 4).

The photographs recovered from the first 4 deployments showed large amounts of heterogeneously distributed phytodetritus patches on the seabed and a large amount of resuspended or sinking material in the water column. Species identified from photographs include *Coryphaenoides armatus*, *Histiobranchus bathybius* and an unidentified Zoarcid (possibly *Pachycara* sp. based on trawl catches). Figure 6.2 shows some typical images recovered from ROBIO during the first 4 deployments.

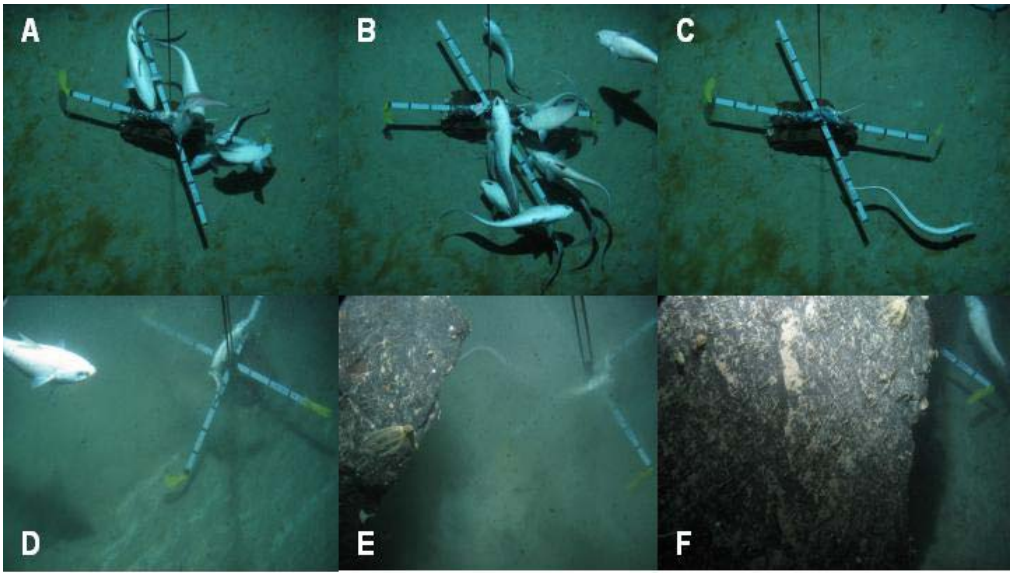


Figure 6.2. Example images from ROBIO deployments 1 (A-C) and 4 (D-F). Phytodetritus can clearly be seen aggregating on the seabed during deployment 1. Fish attracted to bait included *Coryphaenoides armatus* (A & B) and the deep-water eel *Histiobranchus bathybius* (C). Images D-F show the lander being dragged and becoming lodged against a large boulder. The reference cross is 1m x 1m, marked in 10cm intervals.

Data collected from the current meter attached to ROBIO indicated a significant rise in current velocities between deployments 1 and 2 and deployments 3 and 4 (Table 6.2).

ROBIO deployment	Minimum current velocity cm s^{-1}	Maximum current velocity cm s^{-1}	Mean current velocity cm s^{-1}
1	0.2	8.6	4.02 ±1.83
2	1.6	17.7	7.15 ±3.20
3	6.5	30.5	18.03 ±3.52
4	5.3	29.9	17.47± 4.60

Table 6.2. Near sea-bed (2mab) current velocities recorded from ROBIO lander.

A preliminary analysis of the photographs from deployment 1 was undertaken, primarily to determine the optimum time for closing the FRESP trap chamber. 527 images were viewed and the number of fish present in each frame was recorded (figure 6.2). The first arrival time for fish at the bait was 25.5 minutes. A peak abundance of 10 fish in the frame occurred 6.5hrs into the deployment. There was no visible decline in fish arriving at the bait, with bait still being visible 13hrs into the deployment.

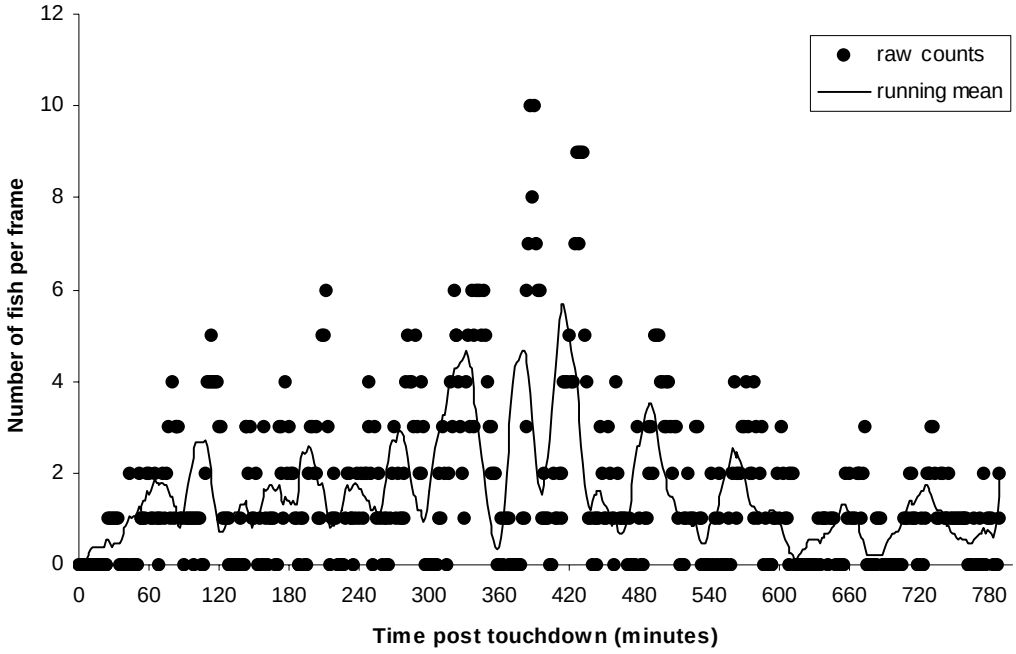


Figure 6.3. Fish arriving at ROBIO bait during deployment 1. Number of fish visible per frame plotted along with a 10 minute running mean of fish abundance.

6.3 Fish Respirometry - FRESP.

The FRESP lander deployed on this cruise had been modified from that used previously (Bailey et al., 2002; 2005) by the replacement of the polarographic oxygen electrode and pump system (SBE 23B and SBE 5 T, Sea-Bird Electronics Inc., USA) with an oxygen optode (O_2 optode 3930; Aanderaa Instruments, Norway). 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. Fish behaviour was monitored with a custom built digital system recording a compressed moving JPEG format directly to a removable hard disk. In addition 2 banks of 3 high-power LEDs provided the lighting source for the camera. The trap closing mechanism has been adapted by attaching the trap support lines to a small winch head that is attached to a stepper motor in a pressure housing. The O_2 measurement intervals, trap closure and camera start time/duration are pre-programmed with custom built text file command generator software and loaded onto the internal flash card. The controller is housed within a 6000m rated 6Al-4V titanium housing.

FRESP was deployed 3 times at each of stations M5 and M6 (see Table 6.1 for a summary). For each deployment the lander was baited with the carcasses of 3 large mackerel retained in a mesh bag to prevent rapid consumption by the scavenging fauna, increasing the probability of capture. When the FRESP is activated on deck prior to deployment the movement of the stirrer motor indicates that the program has been accepted and activated. The camera records 4 short sequences prior to the trap being closed to observe fish arriving at the bait (see Figure 6.3). Based on fish arrival times and peak abundances, calculated from the ROBIO still images, the trap was closed 5hrs after the system was activated. Taking into account the descent time of the lander this was approximately 2.5hrs after reaching the seafloor. The camera then continues to film short sequences every hour (for the first 24hrs, then every 2hrs after) to monitor the behaviour of the trapped fish (see Figure 3).

Figure 6.4. Still image grabs from FRESP video showing *C. armatus* attracted to bait and 2 specimens caught in the chamber following closure of the trap.

Although both the first 2 deployments were successful in trapping specimens of the abyssal grenadier, *Coryphaenoides armatus*, the O_2 data collection was compromised by firstly a defective gasket seal on the trap lid, then secondly by a fish becoming caught between the trap edge and baseplate, wedging it open for the duration of the deployment. Deployment 3 failed to trap any fish, although the O_2 data recorded by the optode indicated a good seal and provides a suitable control measure to account for any bacterial respiration associated with bait decay (see Figure 4). Deployment 4, at station M6, trapped 4 fish and an initial decline in O_2 concentration was recorded. However, after 13hrs the trap began to leak and the O_2 concentration rose, after viewing the video footage we believe that the trapped fish dislodged the lid seal when they pushed their way up over the mesh screen protecting the lid. Figure 2 shows the O_2 profile recorded and the associated consumption rates calculate from the data. The initial decline does appear to be a real reduction brought about by the respiring fish, and at some points on the video some the fish do appear to 'pass out' in the trap. Unfortunately, as so many fish were caught, and the fact that it was a multi-species assemblage, it is hard to attribute any species-specific rates in relation to the biomass of the fish. None of the four fish were recovered to the surface. Deployments 5 and 6 failed to trap any fish, but again the data from the optode sensor indicated that the trap seal was working effectively. Indeed deployment 6 did trap a large number of scavenging amphipods (min 40.6g wet weight, recovered at the surface) and a small reduction in O_2 concentration was recorded in the trap over the first 24hrs (see Figure 6.5).

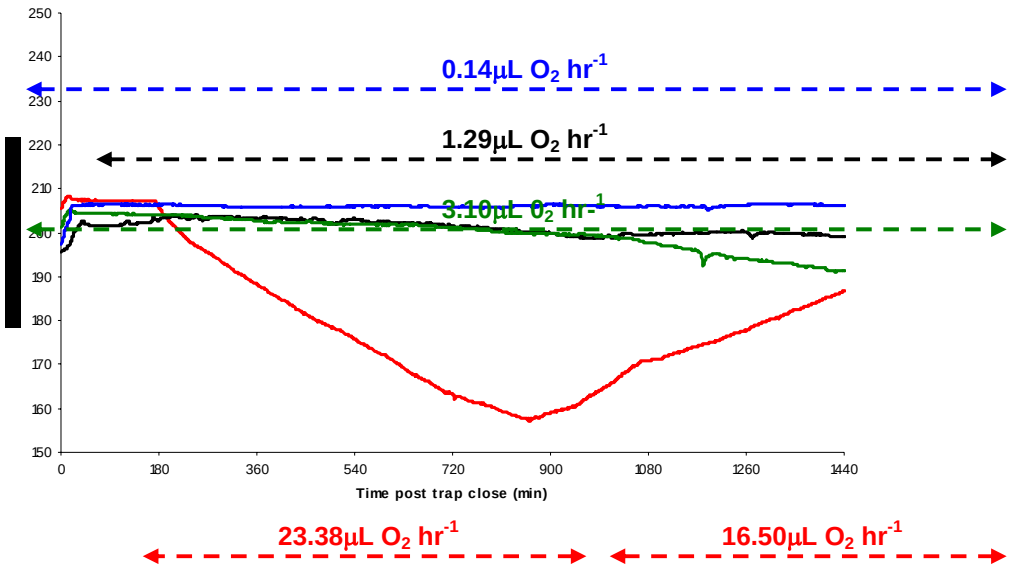


Figure 6.4. Oxygen profiles recorded from the FRESP lander over 24hrs following closure of the respiration chamber. Associated rates of change in O_2 concentration indicated by dashed lines and are converted to micro litres of oxygen per hour. FRESP 3 = blue; FRESP 4 = red; FRESP 5 = black; FRESP 6 = green.

In addition to the collection of oxygen profile data, the video footage from the FRESP lander also underwent a preliminary analysis to record the number and size of fish arriving at the bait. The video sequences in the hours prior to the trap closing were viewed and the numbers of fish present at 1-minute intervals were recorded. Table 6.3 shows a summary of the mean number of fish arriving at the FRESP lander in the hours leading up to the trap closure.

Time before trap closes (hrs)	**FRESP 1 M5**	**FRESP 2 M5**	**FRESP 3 M5**	**FRESP 4 M6**	**FRESP 5 M6**	**FRESP 6 M6**
4	Water column	Water column	Water column	Water column	Water column	Water column
3	0.4	0.3	Water column	Water column	Water column	0
2	3.8	1.2	0.8	0.4	1.2	2.2
1	6.6	1.0	2.2	1.4	0.6	2.0
0	4.8	2.2	3.4	3.8	0	3.0

Table 6.3. Mean number of fish arriving at the FRESP lander in the hours preceding trap closure. Means calculated from video sequences of 5-10mins in length recorded every hour.

The total lengths of all *C. armatus* arriving at the bait were also estimated using structures of known length on the lander (base-plate = 800 x 800 mm). Fish present at the bait at 1-minute intervals were measured; those that were considered to be too high above the bait and base-plate reference were discounted from the length analysis. Based on the size distribution of *C. armatus* specimens caught in the OTSB trawl, the fish measured from the FRESP video were grouped into size classes of small, medium and large for comparison among deployments. The arbitrary size classes used were 0-40cm = SMALL; 41-60cm = MEDIUM, and 61cm+ = LARGE (Fig. 6.5).

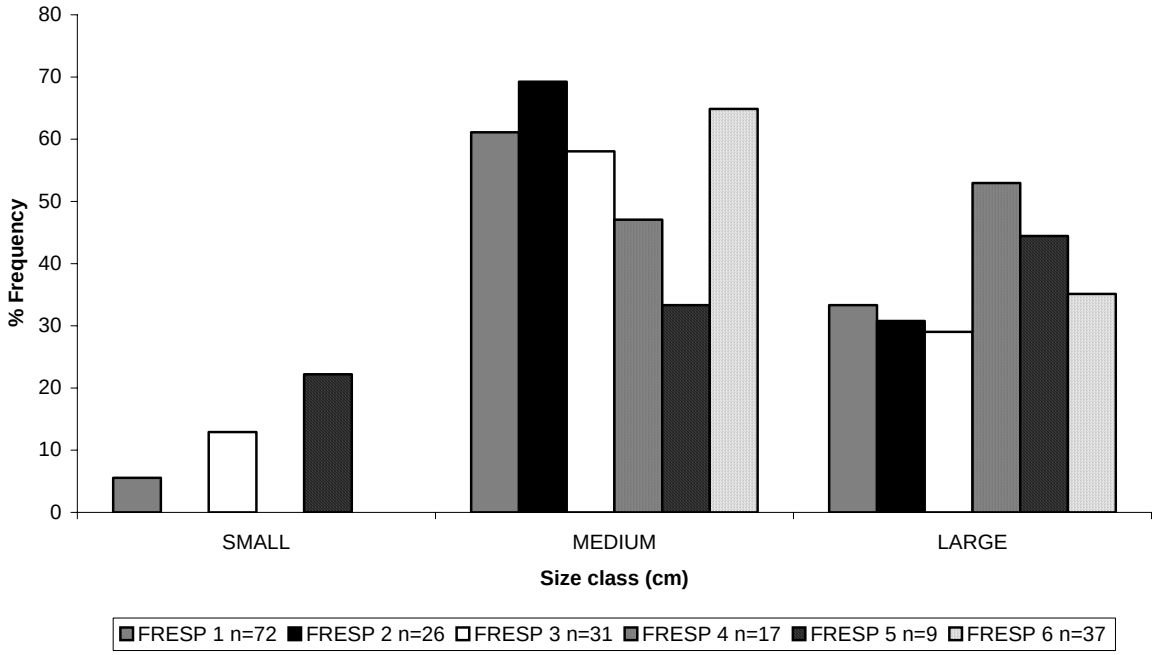


Figure 6.5. Percentage frequency histograms showing distribution of total body lengths for *C. armatus* arriving at the FRESP lander.

With the exception of two deployments (FRESP 4 and 5) the fish arriving at the lander were largely those in the medium size class (~60-70% of the total fish observed). However, both these deployments attracted low numbers of fish (17 and 9 respectively). Small fish were only observed in 3 of the 6 deployments. Large fish contributed more to the observed assemblages at M6 compared to M5. Large fish were much more evident on the FRESP video when compared to their percentage contribution to the total trawl catches (~15-20% greater at both stations, See Section 5.2).

6.4 Scavenging amphipods
Brian Bett - NOCS

Scavenging amphipods are an important and ubiquitous component of the deep-sea necrophage community. Collections of scavenging amphipods were made at sites M5 and M6 on an opportunistic basis in association with deployments of the OceanLab FRESP lander. Amphipods were collected from the FRESP chamber and bait package (see FRESP report) and from two simple tube traps (NOCS) mounted on the lander frame. Collections were made from six lander deployments (Table 6.4)

Site	Station	Depth (m corr.)	Deploy date	Bottom time	Release date	Release time	Soak time (Hrs)	Catch	Preser-vation
M5	15773#19	4165	15/12/2005	17:01	17/12/2005	08:52	40	c. 20	Ethanol
	15773#29	4163	20/12/2005	06:43	21/12/2005	08:31	26	1	Formalin
	15773#36	4161	23/12/2005	09:33	24/12/2005	09:38	24	3	Ethanol
M6	15775#01	4182	27/12/2005	08:45	29/12/2005	00:45	40	c. 70	Ethanol
	15775#16	4191	31/12/2005	07:20	01/01/2006	08:35	25	c. 70	Ethanol
	15775#24	4192	03/01/2006	08:40	04/01/2006	09:24	25	100+	Formalin

Table 6.4 Amphipod trap deployments and details

Figure 6.5 A good haul of amphipods from the last deployment of the FRESP lander at site M6 (Stn 15775#24), including large specimens of the "giant amphipod" Eurythenes gryllus (left).

Catches at site M6 were considerably greater than at M5 (*e.g.* Fig. 6.5). Whether this reflects a true difference in the amphipod populations between the sites is a matter of speculation. Catch rates are liable to be influenced by bottom current speeds and levels of fish activity around the traps in addition to the underlying population density. The amphipod material will be returned to NOC (*Discovery Collections*) for further examination by Tammy Horton and Mike Thurston.

7. Sediment trap mooring recovery

Sue-Ann Watson, David Billett - NOCS & George Wolff – University of Liverpool

7.1 Recovery

Four sediment trap moorings were deployed during RRS *Discovery* cruise 286 (D286) at sites M2, M5, M6 and M10 between 20 December 2004 and 6 January 2005. The four moorings were recovered in the order M10, M5, M2, M6 during RRS *Discovery* cruise 300 (D300) from 8 December 2005 to 3 January 2006 (Table 7.1).

Moorings M10 and M2 comprised of a single sediment trap with a current meter supported by glass spheres. Moorings M5 and M6 comprised of two sediment traps at different depths with accompanying current meters and a single current meter 100 m above the seabed.

Figure 7.1: Recovering one of the sediment traps

7.2 Deployment schedules

Particle interceptor traps (PITS) measure export production from surface waters. These sediment traps passively collect particulate organic matter (POM) sinking through the

water column. The traps are deployed in anchored vertical arrays at preset depths. Each Parflux sediment trap can accommodate 21 cups capable of opening and closing at preset time intervals according to the temporal resolution required. Time intervals ranged from 7 to 28 days in these traps. Generally shorter time intervals were programmed during periods when elevated flux was expected, providing greater resolution of the temporal evolution of the overlying phytoplankton bloom. Sample cups were filled with a preservative solution denser than seawater allowing particulate material to be stored throughout deployment without degrading.

7.3 Locations

Sites M10 and M5 were chosen because composite satellite images show these areas had elevated surface chlorophyll levels compared to sites south of the Crozet Islands. South of the Islands, sites M2 and M6 were chosen as they are considered oligotrophic HNLC regions.

DEPLOYMENT				**RECOVERY**		
Site	**Cruise no.**	**Deployment no.**	**Date of deployment**	**Cruise no.**	**Station no.**	**Date**
M10	D286	XXXVI	20:XII:04	D300	15772#1	08:XII:05
M5 (A&B)	D286	XXXVIII	26:XII:04	D300	15773#30	20:XII:05
M2	D286	XXXVII	06:I:05	D300	15774#1	26:XII:05
M6 (A&B)	D286	XXXIX	03:I:05	D300	15775#23	03:I:06

Table 7.1: Sediment trap mooring deployment and recovery details

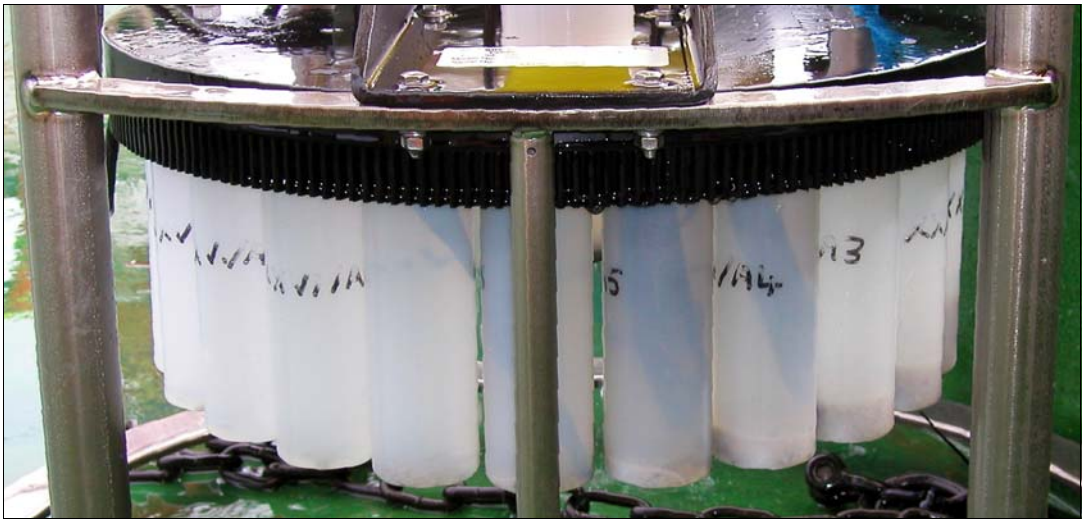


Figure 7.2: Sediment trap cups on recovery (fish can be seen in cups 4, 5, 6 and 7)

7.4 Sample processing onboard

Cups were removed in sequence and the cup under the funnel on retrieval was recorded. Screw top lids with rubber seals were placed on the cups as they were removed from the sediment trap. Some cup tops were missing rubber seals so more seals were sent from the UK and replaced in Cape Town. Sample numbers were rewritten on the cups and the pH of each was recorded using pH indicator paper. M10, M5 and M2 traps were tested using pH indicator paper accurate to 0.5 units. M6 traps were tested using pH indicator paper accurate to 1 unit. On occasion where the pH was between units, the value was interpolated. The pH of most of the samples was between 7.5 and 8.5. A low pH could indicate degradation of the sample.

Cups were filled with a weak formaldehyde solution (more dense than seawater) prior to deployment. On recovery, after recording the pH, the contents of each cup were fixed by the addition of concentrated formaldehyde (1 mL). By the time the last sediment trap was collected (at M6) the concentrated formaldehyde had precipitated out because of the cold temperatures (<4 ºC) in the water bottle annex. The concentrated formaldehyde was left to settle, decanted and then pumped through a 0.2 µm vacuum filter. This filtered solution was then added to the cups as normal.

During the rest of the cruise, samples were stored in the walk-in cold store (at 4 ºC). Preserving the samples with concentrated formaldehyde enabled their transportation to the UK at ambient temperature. Photographs were taken to record the amount of material in each cup on recovery (Figure 5.3). Unfortunately, whilst the cups of Trap B at M5 were being photographed the ship took a violent roll and two samples, B6 and B12, were partially and completely lost, respectively, when they fell.

7.5 Sample contamination

Many of the sample cups were contaminated by pelagic fish (thought to be *Notolepis coatsi*) which had made their way into the funnel to feed on the contents of the open cup. When the trap rotated to the next cup the fish were cut by the mechanism with their heads remaining in the cup. Often the tail was not found, although slices of fish were frequently found in subsequent cups. Up to two fish heads could be present in a cup in this way.

Cups containing fish remains had a lower pH (6.0 – 7.5) compared to the other samples. They were also often quite full of material. The material may have included fish remains and possibly regurgitated fish stomach contents. Alternatively, fish were attracted to full cups. When the cups were removed from the sediment trap rosette, contaminant fish remained trapped in the mechanism and cups were pulled free without the fish. All fish were preserved separately in 5% seawater buffered formal-saline in 500 ml plastic containers.

7.6 Initial observations

15772#1 (XXXVI)
This sediment trap was at M10 for just less than one year. Cup 17 was open when the mooring was retrieved and the beginnings of the new summer export flux at 2000 m can be seen in this cup. A long, gradual export flux can be seen in cups 1-3. Fish contaminated material in cups 4-7 but some material in these cups is also likely to be export flux.

15773#30 (XXXVIII)
Two sediment traps at 2001 m (Trap A) and 3195 m (Trap B) were recovered from M5. In Trap A, fish contaminated cups A1, A3 and A4. In Trap B, fish contaminated cups B9-11 and B13. A long, gradual export flux during the austral summer was evident at 2001 m in cups A1-7 and starting again in cup A19. However, some of the material in cups A1, 3 and 4 may have been of fish origin. The deeper trap B had export material in cups B1-7 and B19. A modest flux of long duration is common at the two eutrophic sites north of the Crozet Islands.

15774#1 (XXXVII)
The sediment trap at M2, a HNLC oligotrophic site, at 1973 m was deployed for just short of one year. Cup 20 was open when the mooring was retrieved. On recovery it was observed that some material which had remained in the funnel may have washed into cup 20 during recovery. Fish contaminated cups 4, 14 and 19 and the material seen in these cups is most likely a result of contamination. A decapod, or possibly a mysid, was found in cup 3. A very large flux of export material at 1973 m occurred from 08:I:05 – 16:I:05. Very little export production occurred for the rest of the year. A possible new flux may be evident in cup 20, although some of this material may be funnel washings.

15775#23 (XXXIX)

At M6, another oligotrophic site, two sediment traps were recovered from the mooring at 2007 m (Trap A) and 3160 m (Trap B) in depth. These sediment traps were deployed for one year and cup 21 was open on both traps during retrieval. Trap B was recovered upside down, and cup B21 was filled with surface seawater. Fish contaminated cups A1, A7, A21 and B6. B6 had the remains of a slightly larger fish than seen in other cups. Ian Waddington observed seeing a very large dead fish floating free from Trap B during recovery. A large export flux in early January 2005 can be seen in the deeper trap cup B1. Despite fish contamination therefore, much of the material in cup A1 is also likely to be export flux. There is very little material in the cups at any other time of the year at M6. Sites south of the Crozet Islands appear not to be permanently oligotrophic and a large episodic export flux in early January may be characteristic of this region.

Figure 7.3: Material in cups on recovery (contaminated cups are marked with 'C')

8. WASP operations and observations

Brian Bett - NOC

The National Oceanography Centre's WASP (Wide-Angle Seabed Photography) system was used throughout the cruise in its standard configuration. Briefly, WASP is a self-contained, off-bottom, towed camera vehicle that provides still and video footage of the seabed, and is capable of operation to 6,000m water depth on a simple mechanical cable (i.e. conducting or fibre-optic cable not required). As deployed during the present cruise, WASP was fitted with: OSIL Mk7 (stills) camera, OSIL 1200J flash gun, NOC OceanCam6000V (digital video) camera, 2 x 250W DSPL video lamps, 3 x DSPL 24V batteries, Simrad Mesotech 200kHz altimeter, and a NOC acoustic telemetry system (10kHz). Data from the altimeter is telemetered to a ship borne display enabling the operator to make fine adjustments of the amount of cable deployed with the aim of keeping the vehicle at c. 3m above the seabed. The still and video cameras are both automatically activated by the altimeter when the range to the seabed is <10m. For all deployments made during the cruise, the still camera was loaded with Kodak Vision 250D (c. 40m loads) and the video camera loaded with a 65 minute MiniDV tape. The acoustic telemetry from WASP was monitored using a "Waterfall" display system (PC-based continuous display of acoustic signals) fed from a receiver box (providing timing and signal attenuation controls) connected via the Simrad EA500 echo sounder to the PES tow fish.

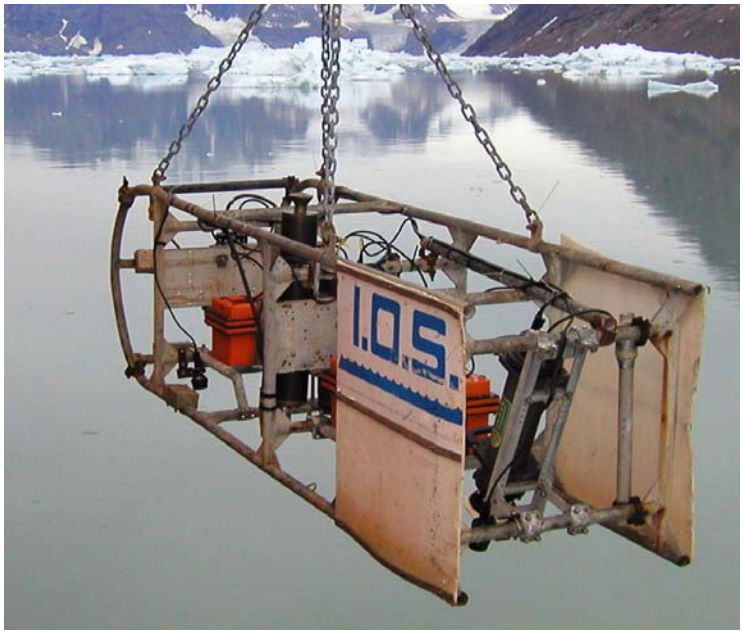


Figure 8.1 The WASP vehicle, shown as rigged during RRS Discovery cruise 300 (photograph taken during RRS James Clark Ross cruise 106, East Greenland).

WASP 1, site M5, stn 15773#9
Initial deck test start up completed successfully, but vehicle systems did not start at power on for launch. After waggling various cables and connectors the system started and was deployed as normal. Telemetry to the seabed was as normal (two mid-water activations, one shallow, one at c. 560 mwo), altimeter locked on at 100 mab and the cameras activated at 10 m. However, the altimeter went to permanent fault and consequently the cameras shut down after only 6 minutes of operation at the seabed. The video recovered shows abundant megabenthos, patchy phytodetritus, with no indication of any hard substrata.

The next WASP launch was planned for 16.XII.05. In preparation for this launch the flash power connector and altimeter connector were cleaned, the altimeter to monitor lead was replaced and the radius of the cable runs into the monitor pie connector relaxed. Following these changes and some further cable waggling, the vehicle completed several successful test start ups and the altimeter could be activated by scratching the transducer face resulting in camera activation.

At time of proposed launch the winch (coring) lost power and smoke was reported in the winch room. Substantial repairs to the winch system were required and so the WASP launch was abandoned.

WASP 2, site M5, stn 15773#27
Initial test start up completed successfully. However, after moving the vehicle into position for launch the next start up showed the altimeter in fault. Tightening the altimeter connection and restarting the system appeared to cure the fault and the vehicle was launched. Telemetry to the seabed was as normal (some mid-water activations), altimeter locked on at 100 mab and the cameras activated at 10 m. The vehicle towed well, with the telemetry showing cameras active throughout the seabed phase, although on hauling at the end of the tow the altimeter went to permanent fault. On recovery the video was found to only have run for three short mid-water sequences, with no seabed footage at all. The still camera appears to have run as normal.

WASP 3, site M5, stn 15773#42
Initial test start up completed successfully. Telemetry to the seabed was as normal (some mid-water activations), altimeter locked on at 100 mab and but the cameras failed to activate at 10 m. The tow was continued in the hope that the video was running. On recovery the video was found to have run fully. The video was effectively of rather poor quality as a result of a very dense suspension of phytodetritus in near bottom waters. Very abundant holothurians were nonetheless evident, with megabenthos density of the order of 10,000 ha^{-1}.

During the third WASP deployment there were several problems with the winch – power loss and CLAM monitoring system resetting – during the haul in, the cable-out reading was totally spurious.

WASP 4, site M6, stn 15775#2

Initial test start up completed successfully. Telemetry to the seabed was as normal (some mid-water activations), altimeter locked on at 100 mab and the cameras activated at 10 m. Camera activation was continuous throughout the tow, although the altimeter was in near permanent fault for the last 20 minutes. On recovery no video had run at all, the stills camera is assumed to have run as normal.

WASP 5, site M6, stn 15775#11

Prior to deployment a full deck test of the system was carried out, including activation of the video system – all aspects operated correctly and the vehicle was launched. However, at 3800 mwo there was a mid-water camera activation and the altimeter went to permanent fault. The deployment was continued to the seabed in the hope of altimeter reactivation, but at 6 mab there was no activation and the deployment was aborted.

WASP 6, site M6, stn 15775#26

Prior to deployment the main camera-flash connectors were removed and clean; both were found to have an excess of fluid (WD40) which was dried before reconnection – and may well have been a primary cause of earlier failures. Five successful test start ups were then completed prior to launch. After launch, telemetry to the seabed was as normal (some mid-water activations), altimeter locked on at 100 mab and the cameras activated at 10 m. The tow itself was fair given the rather heavy weather; camera activation was continuous through out. On recovery a full run of video was evident with the flashgun firing throughout (it is assumed that the still camera ran as normal). The video shows no evidence of phytodetritus and a comparatively sparse megabenthos, abundant holothurian faecal casts were about the only other feature of note.

Site M5

The first video observations of site M5 seafloor (stn 15773#9, Fig. 8.2) showed distinct patches of phytodetritus on the seabed. Megabenthos appeared to be abundant, particularly the holothurians, many of which seemed to show a common orientation (presumably bottom current related). The second successful video (stn 15773#42; Fig. 8.3) was notably different – there were no phytodetritus patches on the seabed, instead it was in a dense suspension in the near bottom water. Again, megabenthos, particularly holothurians, appeared to be very abundant. One boulder was observed during the second video – note also the observation of a large boulder during one of the ROBIO deployments (Fig. 8.4 *vs*. 6.2). Three of the WASP deployments at site M5 (15773#9, #27 and #42) yielded brief video sequences from the water column. All three showed the presence of abundant large particulate marine snow (Fig. 8.4).

The resuspension of phytodetritus evident in the second WASP video was also recorded by the FRESP lander's video system (see Section 6.3). Current meter data recorded during deployments of the ROBIO lander (Fig. 8.5) show a major change in the bottom water flow regime from the start to the end of operations at site M5. In the first days of occupying M5 (corresponding with WASP stn 15773#9) current speeds were low ($<10 cms^{-1}$) and there was considerable variation in current direction (interquartile range 69°). However, in the latter half of our occupation of M5 current speeds were markedly

higher (up to 31cms^{-1}) and distinctly more directional (interquartile range 21°). Under such conditions there is clearly scope for both resuspension and significant lateral transport of phytodetritus (to the SSE, 160° based on the ROBIO dataset, see figure below). Interestingly, in the case of M5 such lateral transport could result in mass accumulation in the channel to the south of the site.

Site M6

Only one seabed video transect (stn 15775#26) is available for site M6, it nevertheless provides a very convincing contrast with site M5 (Fig. 8.5). No phytodetritus was observed in suspension or deposited on the seabed. Megafaunal density was very markedly lower than at site M5. Visually, the seabed was dominated by tracks, trails and faecal casts (presumably holothurian). Two short sequences of mid-water video footage (Fig. 8.6) do show marine snow particles, but they are smaller and less dense than those observed at site M5.

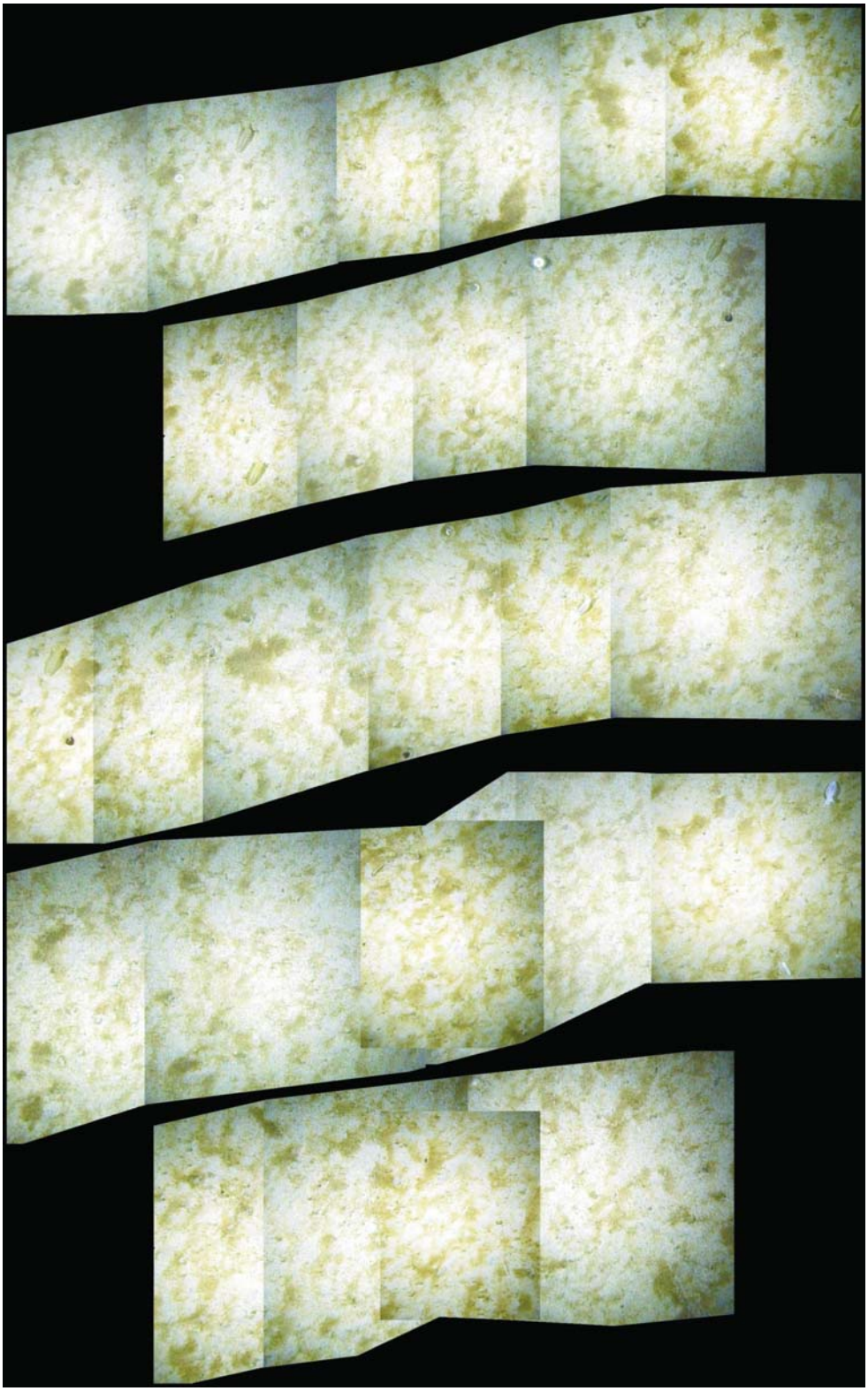


Figure 8.2 Seabed video montage M5 WASP stn 15773#9, the video swath width is approximately 2m.

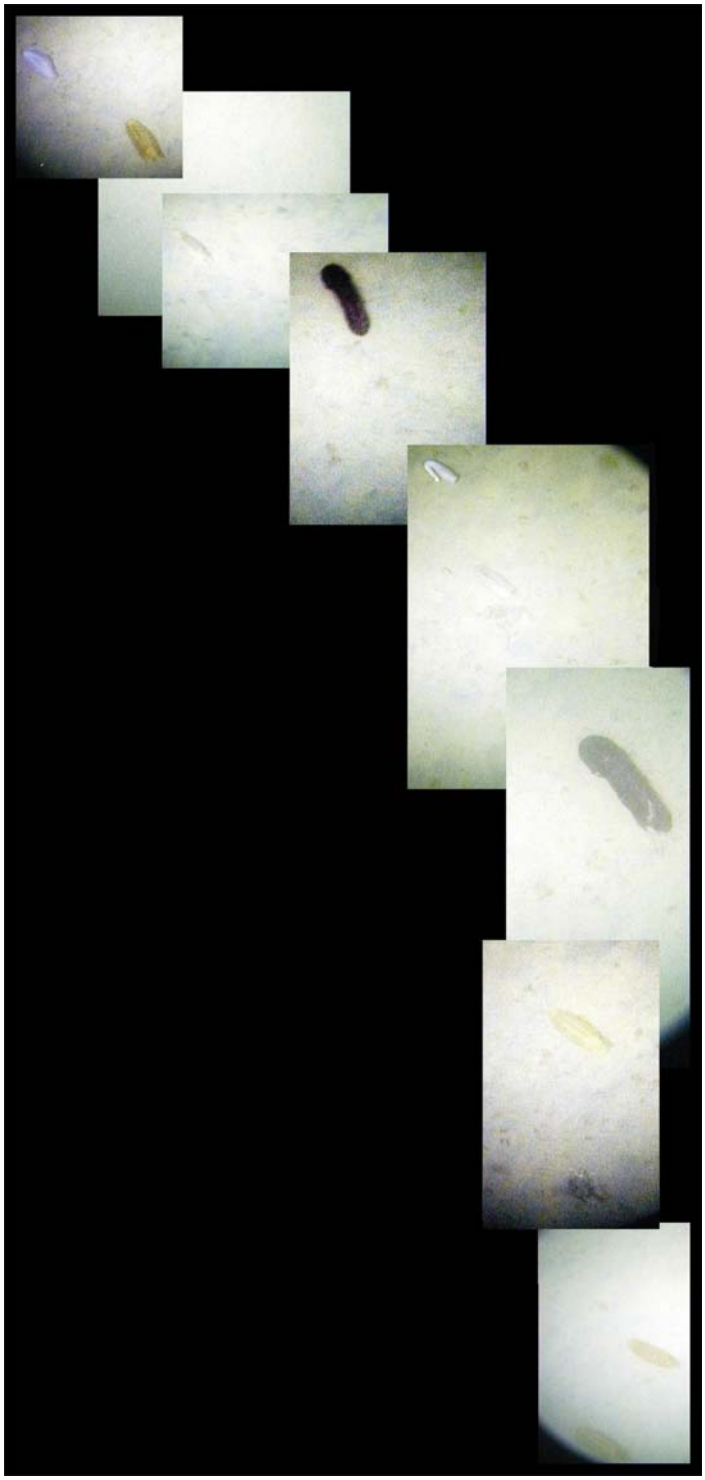


Figure 8.3 Seabed video montage M5 WASP stn 15773#42, the along-track distance shown is c. 6 m within which there are 10 holothurians from 6 species.

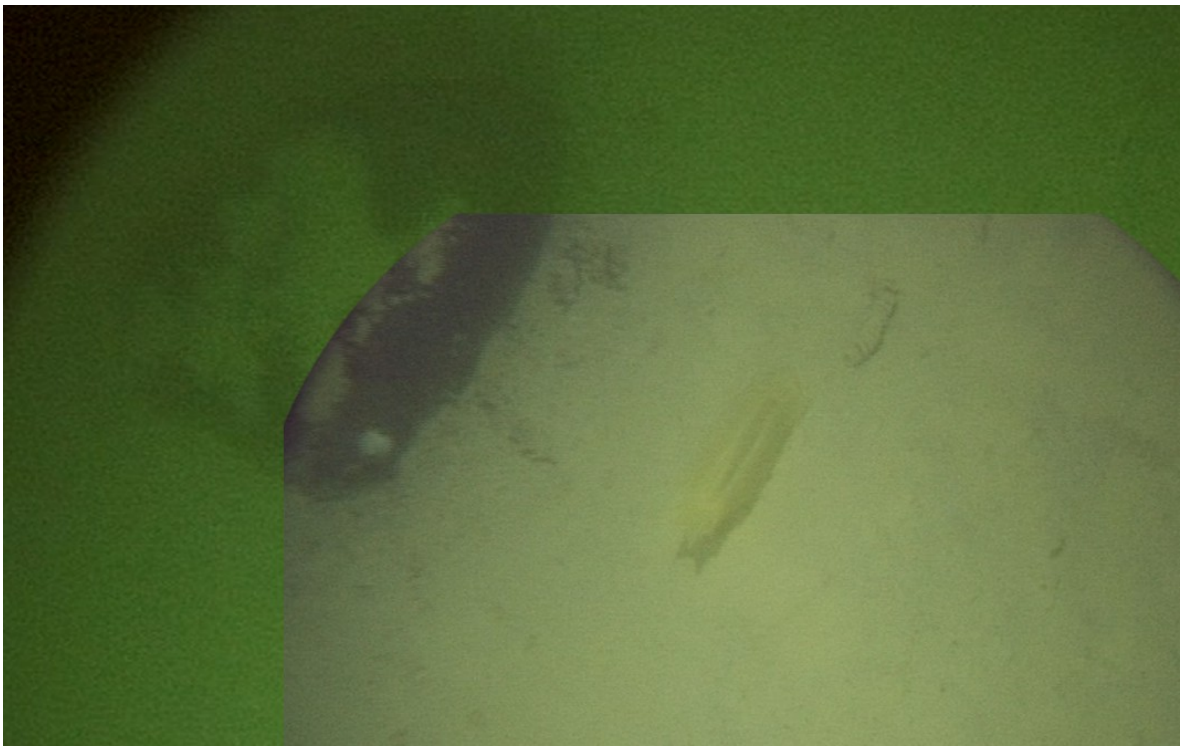


Figure 8.4 Seabed video montage M5 WASP stn 15773#42, note boulder (c. 30 cm), holothurian and faecal cast.

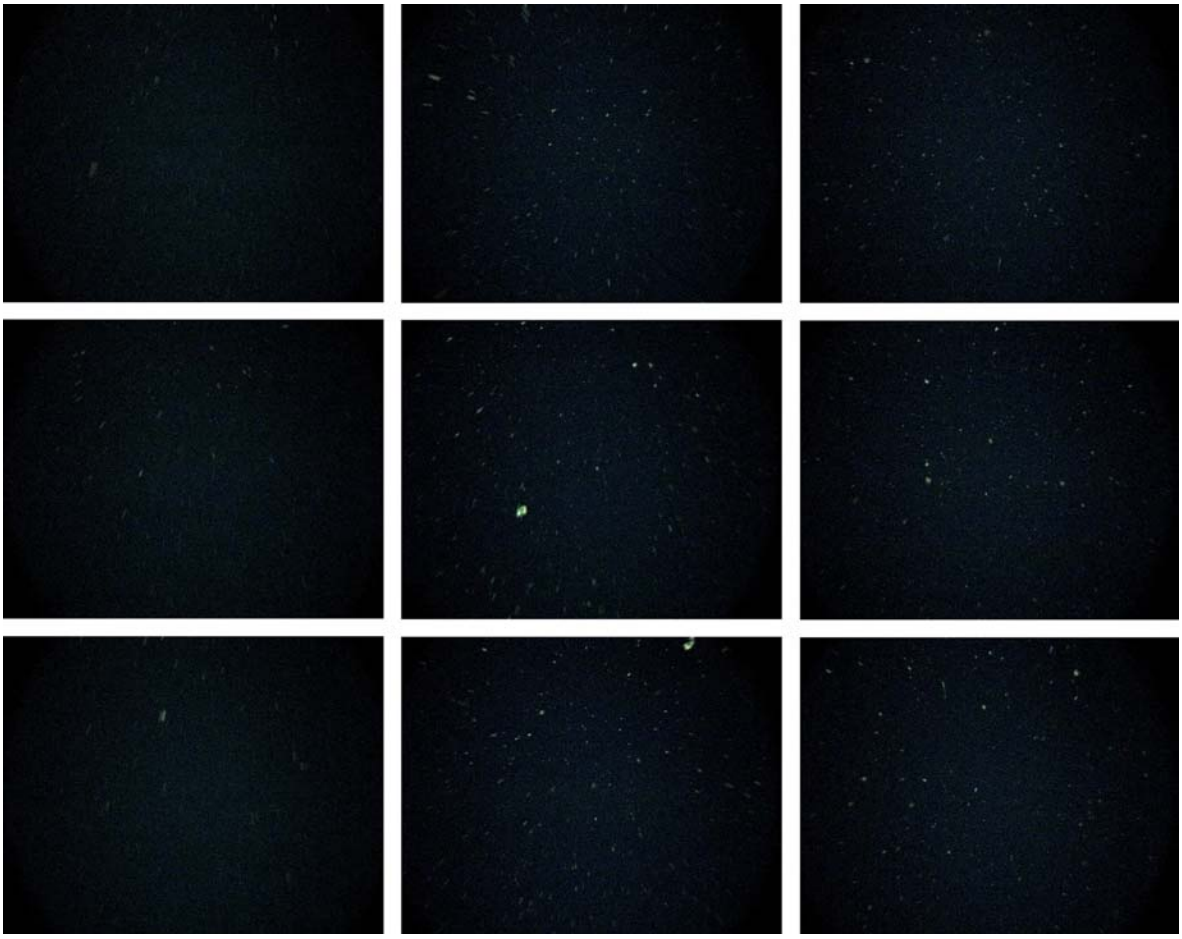


Figure 8.5 Mid-water video grabs from site M5 WASP deployments (stn 15773#9, left; 15773#27, centre; 15773#42, right).

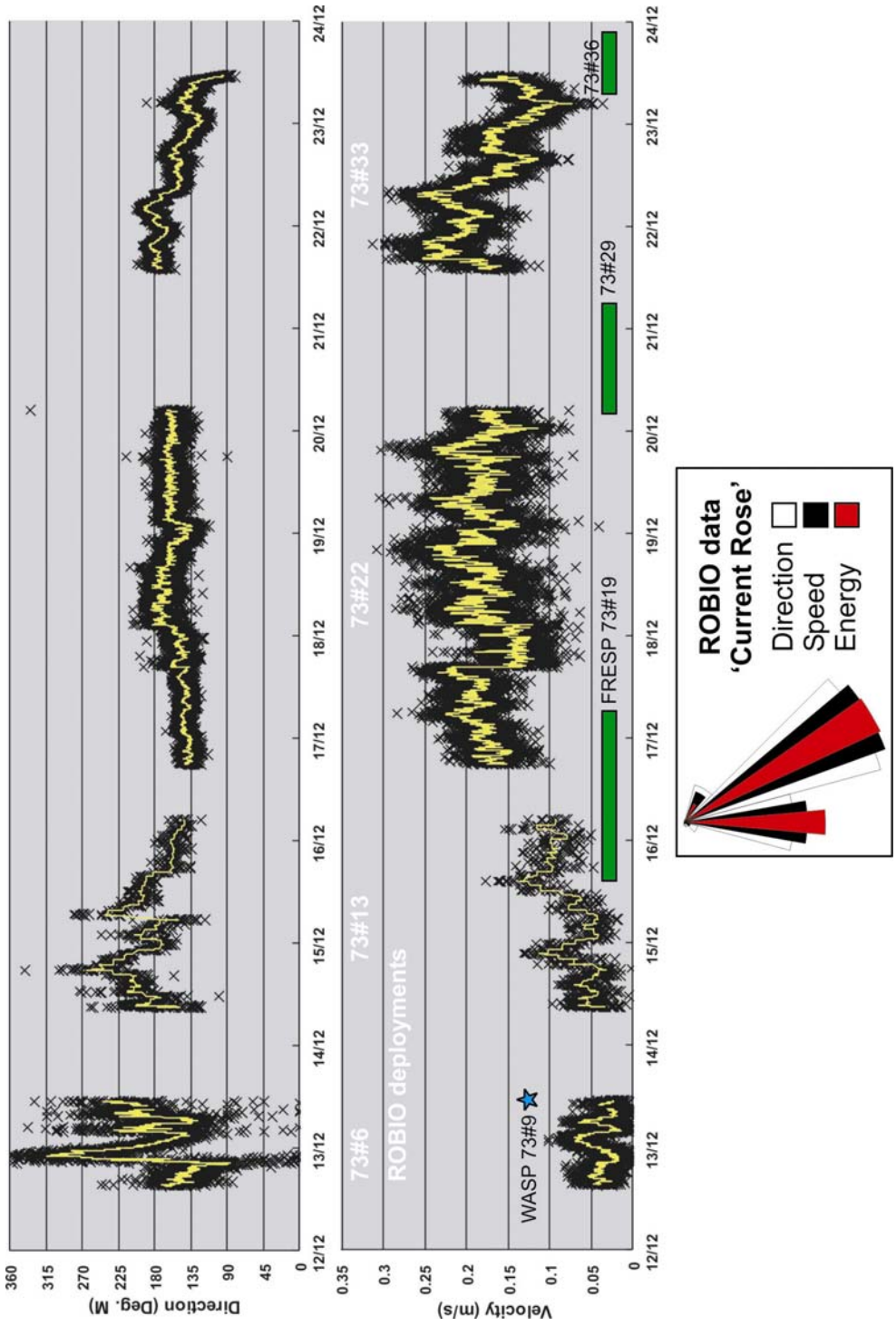


Figure 8.6 Near-bottom current meter data from ROBIO deployments at site M5, courtesy of OceanLab team.

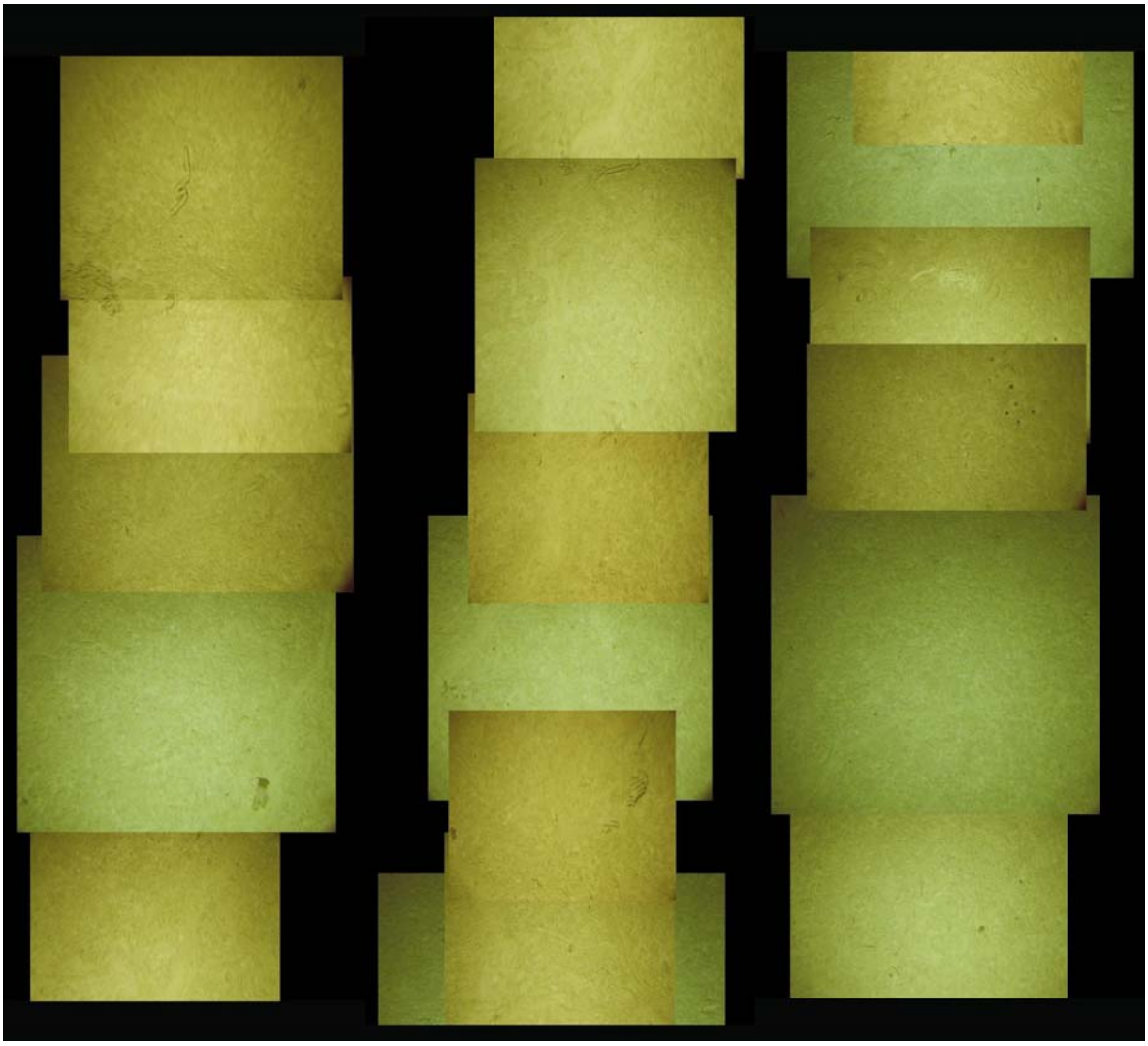


Figure 8.7 Seabed video montage M6 WASP stn 15775#26, the video swath width is approximately 2m.

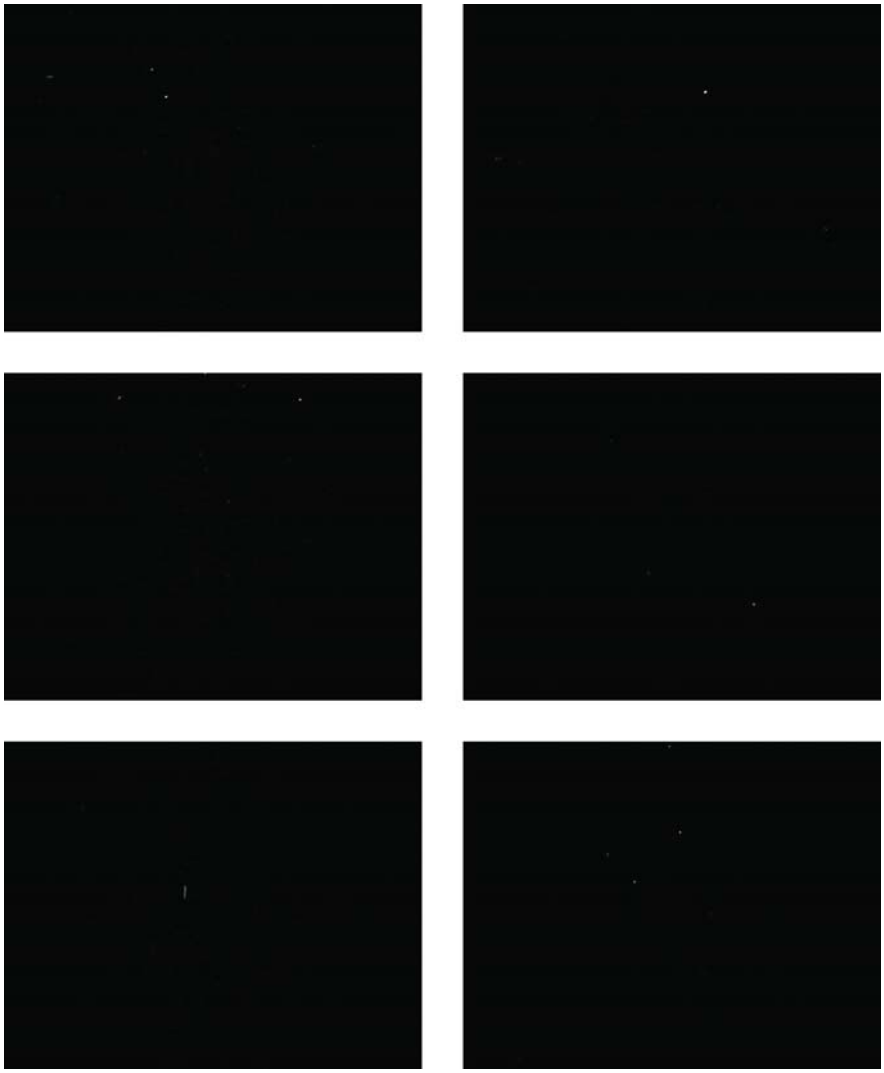


Figure 8.8 Mid-water video grabs from site M6 WASP deployments (stn 15775#11, left; 15775#26, right).

9. Bathysnap

Brian Bett, Ben Boorman, NOCS

Bathysnap is a long-term time-lapse camera system designed to repeatedly photography ~ 2 m^2 of seabed over extended periods. The system comprises an OceanCam 6000S stills camera and associated 25J flashgun and is operated on a simple mooring with a MORS RT661 B2S acoustic release (Fig. 9.1).

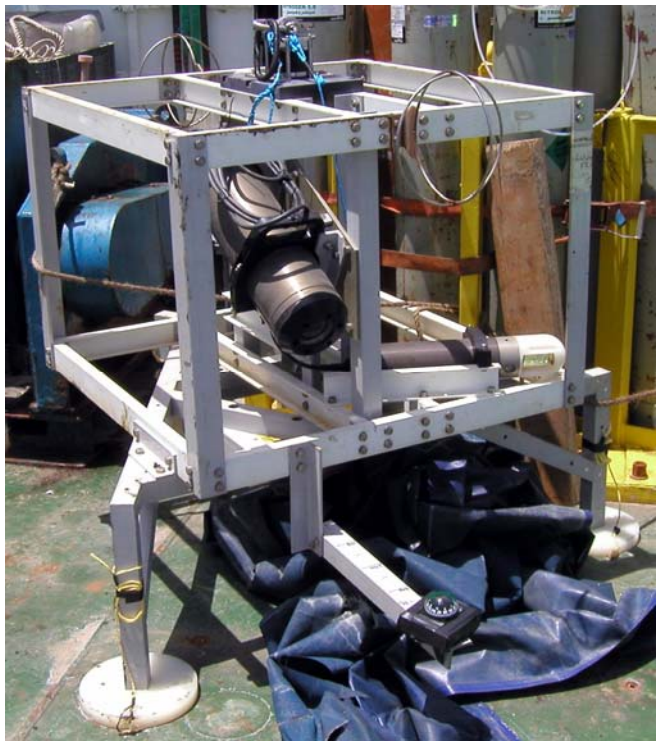


Figure 9.1 Bathysnap system (in new "Roughsnap" frame), photograph *RRS Charles Darwin* cruise 145

Two Bathysnap systems were deployed on the previous RRS *Discovery* CROZEX cruises (D285 and 286):

Site M5, stn 15583#1, 46º 00.59'S 56º 07.37'E, 4245 m (release Mors S/N 386)

Site M6, stn 15509#1, 48º 59.81'S 51º 28.67'E, 4172 m (release Mors S/N 283)

Recovery of the M5 Bathysnap (stn 15583#1) was attempted on 20/XII/05. The pinger on the release activated readily and the deck unit reported that release commands were received and executed – but the mooring failed to rise. Numerous further attempts to release the mooring were made (using all three deck units aboard and transmitting through the PES fish and MORS dunking transducers). Still the mooring refused to rise and was abandoned with the pinger still active in the vain hope it might surface while we were still in the area (Fig. 9.2).

The cause of this failure can only be speculation, but it is conceivable that it may have landed badly and fallen over on sloping channel-side topography:

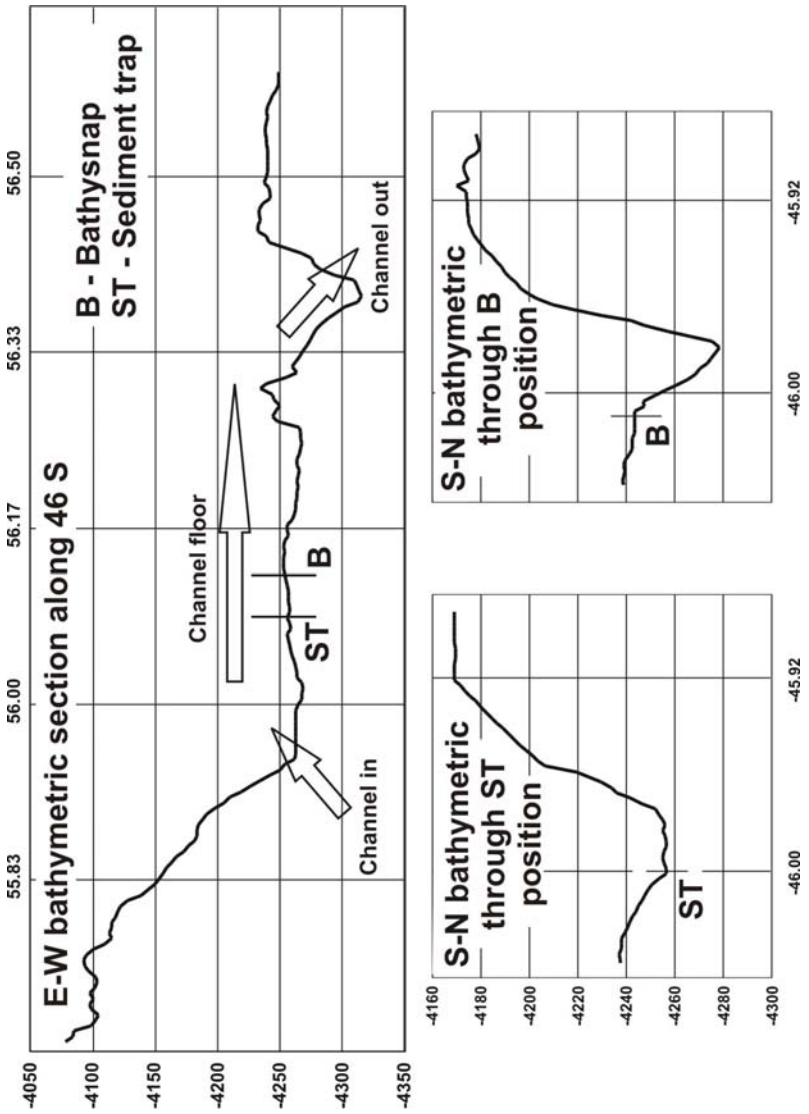


Figure 9.2 Bathymetric sections through the M5 mooring sites

The Bathysnap system at site M6 (stn 15509#1) was successfully released at 04:29 on 1/I/06, surfaced at approximately 05:40 and was sighted at 06:05. The mooring was grappled at the first attempt and hooked up to the recovery winch. During this time the ship came over the Dahn buoy and main buoyancy pack resulting in the Dhan buoy coming fast on the rudder. After a long period of pulling, heaving and grappling, the mooring came free. The Dhan buoy was wrecked in the process – flag mast snapped off, flashing light flooded through impact damage, the spar pole bent and the buoy cross-bracing cracked.

Other than the damage sustained against the ship, the mooring and instrument were in good clean condition. A few "cnidarian" tubes were seen on the flying hook attachment points; one was retained for further examination. The camera was found to have run ~ 35 m of film, which would suggest that it has run for over 300 days.

10. Keystone Members of The Deep-Ocean Microbial Community And The Impact Of Organic Loading

John Patching & David McCarthy, NUI Galway.

In previous studies in the NE Atlantic, we have established that the bacterial community in the water immediately above the sea bed (Sediment contact water, SCW) is adapted to its environment and active under in situ conditions (Patching, J.W. & Eardly, D. [1997] Deep Sea Research pt. 1, 44, 1655-1670).

During this cruise, samples of the SCW and deep waters were taken, so that comparisons may be made between the allegedly eutrophic (M5) and oligotrophic (M6) sites and also with samples taken in the NE Atlantic. The objectives of our studies are:

- To determine the bacterial biomass, both total and active.
- To determine the bacterial community structure, using DNA based methods
- To examine the response of the bacterial community to the addition of nutrients.
- To obtain isolates which are representative of the active component of the community

Samples taken are listed in Table 10.1. Samples of deep water were taken by CTD/bottle rosette casts. Samples of water from intermediate (2500m wire out) and shallow (140m wire out) depths were also taken for comparative purposes. Sediment contact water was siphoned off from cores obtained by megacorer casts. Forty millilitre subsamples were taken from all water samples. These were preserved by the addition of 0.4mL of 40% 0.22µm filtered buffered formalin and stored at 4°C. They will subsequently be used for total counts of bacteria, using Sybr Gold™ (Molecular Probes Inc USA) staining and epifluorescence microscopy. Samples of bacteria in deep waters were also taken by SAPS filters, using membrane filters (0.2µm, 293mm diam: Whatman, UK) and 2 hours filtration time. The filters were halved and each half preserved either for community structure analysis or enrichment culture as described below

Water samples for community structure analyses were immediately transferred to a 4°C environment and pumped through 0.22µm Millipore Sterivex® filter cartridges. The cartridges were then sealed and stored (-80°C). DNA will subsequently be extracted from these filters. Other water samples were treated in the same way using both Sterivex and flat filters (0.2µm, 47mm diam: Gelman Inc. USA), except that glycerol (40% v/v) was added to the filters before freezing. These will be used for enrichment cultures under *in situ* conditions. Isolates obtained from the enrichment cultures will be characterised and identified. DNA sequence data obtained from them will be compared with DNA based community structure analyses to determine their importance in the community.

M	Station	#	Sample Depth (m)	Sample vol. (Litres)	Treatment/Use
10	15772	4	2852 (60ob)	18	DNA
10	15772	4	134	17	DNA
10	15772	2	2936 (SCW)	4	DNA
5	15773	5	4224 (10ob)	18	DNA/MPN/Incubations
5	15773	5	2501	7.5	DNA
5	15773	5	133	7.5	DNA
5	15773	14	4195 (15ob)	18	DNA
5	15773	14	2493	18	DNA
5	15773	14	137	18	DNA
5	15773	40	4143	15	Glycerol
5	15773	18	4208 (SCW)	4	DNA
5	15773	25	4224 (SCW)	4	Glycerol
5	15773	28	4191 (SCW)	5	Glycerol
5	15773	31	4220 (SCW)	5	DNA/MPN/Incubations
5	15773	34	4224 (SCW)	4.5	Glycerol
5	15773	35	4214 (SCW)	25	DNA
5	15773	39	4200 (SCW)	9.5	Glycerol
5	15773	39	4200 (SCW)	9	DNA
5	15773	26	4233 (8ob)	2186 (SAPS)	DNA/Glycerol
6	15775	7	4199 (10ob)	19	DNA/MPN/Incubations
6	15775	7	2506	9	DNA
6	15775	7	137	9	DNA
6	15775	14	4212 (12ob)	12	Glycerol
6	15775	14	4212 (12ob)	15	DNA
6	15775	14	2496	20	DNA
6	15775	14	138	20	DNA
6	15775	3	4232 (SCW)	8	DNA/MPN/Incubations
6	15775	25	4232 (SCW)	7	Glycerol
6	15775	32	4227 (SCW)	7.5	DNA
6	15775	33	4222 (SCW)	6	DNA
6	15775	35/36	4225/4222 (SCW)	7	Glycerol
6	15775	36/37	4222 (SCW)	9.5	Glycerol
6	15775	15	4204 (20ob)	1517 (SAPS)	DNA/Glycerol

Table 10.1 : List of samples taken by NUI, Galway. SCW: Sediment contact water. Ob: over bottom. SAPS: SAPS filtered in situ. DNA: filters frozen. Glycerol: filters frozen with 40%glycerol for subsequent enrichment/isolation experiments. MPN: most probable number counts of culturable bacteria. Incubations: incubations under in situ and surface pressures and in the presence and absence of substrate. Subsamples were taken from all samples for total counts of bacteria.

10.1 MPN enumeration and isolation of marine bacteria

The 'Most Probable Number' (MPN) method is a statistical technique employing extinction dilution to provide an estimate of microbial density per unit volume of water sample. Multiple replicates of a water sample are diluted down until no cells remain. The number of wells showing positive growth at each dilution level is counted and the number of bacteria in the original neat sample is estimated by reference to statistical tables, or an MPN calculator programme in the case of large numbers of replicates. In this study MPNs were performed in 96 well microtitre plates, with eight replicates and 12 dilution levels per plate. The MPN system can also isolate clones through extinction dilution of the original sample. In a halving dilution series, growth in the last well (shown red in Fig.1) is likely to have been derived from a single cell. In this manner each 96 well plate can simultaneously isolate clones representing the most numerous members of the community that are metabolically-active under the given conditions. Isolated clones can then be characterised in order to complement nucleic acid-based studies of changes in community structure resulting from organic loading. In the current study isolated clones are expected to represent those clones in the original water sample that exhibit a response to the substrates supplied in the medium.

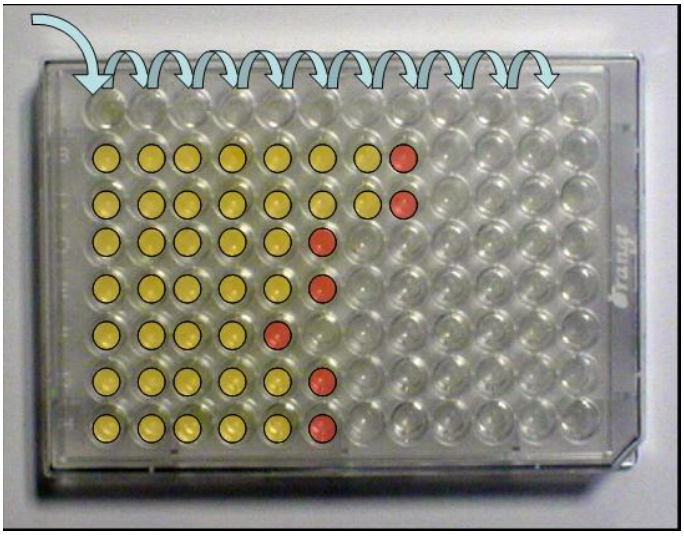


Figure 10.1. MPN assay plate

MPN assays were carried out in 96-well microtitre plates and incubated 4ºC at ambient and *in-situ* pressures. The supplemented seawater medium (SSW) used in the assay contained peptone (2.5 mgL^{-1}), yeast extract (0.5 mgL^{-1}), and N-acetyl-d-glucosamine (1.285 mgL^{-1}), a monomer of chitin. Each well was filled with 150µL of SSW, except for the first which was left empty. 50 mL of the seawater sample was supplemented by the addition of 1.25 mL of 40X SSW nutrient solution to bring it to the same nutrient concentration as the medium in the microtitre test plates. 300 µL of this sample was then inoculated into seven of the wells in the first column. The remaining well was filled with sterile SSW medium to serve as a negative control.

A halving serial dilution was performed by withdrawing 150 µL from the wells in the first column (using an eight channel multi-pipette) and transferring it to the second, and so on to the 12th column in the plate, resulting in eight parallel dilution series, one of which being an un-inoculated control. Test plates were regularly monitored for turbidity in a Tecan GENios® microtitre plate reader. Eventually the last well in each row showing positive growth was isolated and stored at -80ºC as a 40% glycerol stock. A 50 mL aliquot of the original un-supplemented sample was retained and fixed with 0.4% formalin for total counts using epifluorescent microscopy. The MPN method was modified as follows for the performance of assays at *in-situ* pressure (420 Bar) in NUNC® modular strip wells. The first well of each strip was inoculated with 250µL of nutrient supplemented sample (prepared as above) and the dilution series was based on 125µL volumes. After inoculation of the dilution series an additional 125µL of sterile SSW medium was added to each well, completely filling the wells in order to exclude any air. Well strips were then separated, sealed with film and incubated in a pressure vessel at 420 Bar, 4ºC. Turbidity monitoring of pressure MPN incubations could not be performed. Table 10.2 comprises a list of samples on which the assay was performed.

MPN at Ambient Pressure						
Site	**Station**	**#**	**Type**	**Depth (m)**	**Replicates**	**Clones Isolated**
M5	15773	2	CTD	4234	16	15
M5	15773	31	SCW	4220	24	19
M5	15773	39	SCW	4200	16	17
M6	15775	3	SCW	4232	24	21
M6	15775	7	CTD	4199	24	23
MPN at *in-situ* pressure (420 bar)						
M5	15773	2	CTD	4234	16	None
M5	15773	31	SCW	4220	16	None
M6	15775	3	SCW	4232	8	None
M6	15775	7	CTD	4199	16	None

Table 10.2. SCW: Sediment contact water; 'Replicates' refers to the number of individual dilutions i.e. rows available for calculation of MPN and clone isolation.

In addition, the well positions of isolated clones were noted and the GENios® turbidity data compiled in order to render growth curves for each individual isolate of interest. Growth rates and lag times will be calculated from these data. In-situ pressure MPNs failed to generate usable data. There was no pattern discernible in the distribution of positive wells and clones could not be isolated on the basis of dilution. From analysis of the negative control strips it would appear that random ingress of water in the pressure vessel was accountable for much of the growth. Samples from enrichment incubations under pressure have been saved on filters in glycerol and will serve as sources for the isolation of piezophiles at a later date.

10.2 Long-term enrichment incubations

Aliquots (100mL) of seawater (sediment contact water and near-bottom water from CTD) were placed in plastic bags, with or without the addition of SSW medium as an organic loading. Two replicates of each sample were prepared. Controls were stopped immediately by the addition of 5mL of 40% buffered formalin. All bags were heat sealed, taking care to exclude air. Bags to be incubated at *in-situ* pressure were placed in water filled pressure vessels which were then pressurised to 420 bar. Other bags were placed in covered buckets of water for incubation at ambient pressure. All bags and pressure vessels were incubated at 4ºC. Sub-samples (50 ml) were taken and fixed with 0.4% formalin for total counts. Table 10.3 comprises a list of samples which underwent enrichment incubations.

Site	Station	#	Type	Depth (m)
M5	15773	2	CTD	4234
M5	15773	31	SCW	4220
M6	15775	3	SCW	4232
M6	15775	7	CTD	4199

Table 10.3. Enrichment incubations

After approximately 21 days the incubation bags were processed as follows:

Samples (20 mL) were taken and fixed with 0.4% formalin for total counts. 40ml samples were taken from each bag and filtered through a 0.2µm 47mm nitrocellulose membrane to which was added 600µl of 40% glycerol. Filters were stored at -80ºC. The remaining incubation material was fixed with 0.4% formalin and stored at 4ºC for DNA extraction.

10.3 SPRATS: Sampling, Pressure Retaining and Transfer System

SPRATS (Fig 10.2) is a prototype system intended to facilitate the sampling of deep-ocean waters and the subsequent culture of resident microflora under uninterrupted *in situ* conditions of pressure and temperature.

A sample of deep-ocean water is drawn into a self-sealing chamber by means of a retracting piston operated by a motor-driven screw. *In situ* pressure is retained upon recovery and the water sample can then be transferred wothout decompression into an experimental vessel by the use of a specially designed high pressure transfer rig. Substrates can be added to and samples removed from the experimental vessel in order to study the effects of organic loading on the deep-ocean microbial milieu. In this manner, SPRATS can also be used to carry out semi-continuous (flow through) enrichments under *in-situ* conditions which will select for keystone species capable of functioning under nutrient-limiting conditions.

The first deployment of the SPRATS in July 2005 aboard the RV Celtic Explorer (CE0506 in the NE Atlantic) revealed several serious design flaws which were referred to

the manufacturer for remedy. The major problems encountered included low motor torque, leaking pressure housings, fragile electronics package, and a general lack of robustness. However the most critical problem that could not be accommodated was a grossly insufficient power supply. An extensive rebuild was completed by the manufacturer just prior to this cruise.

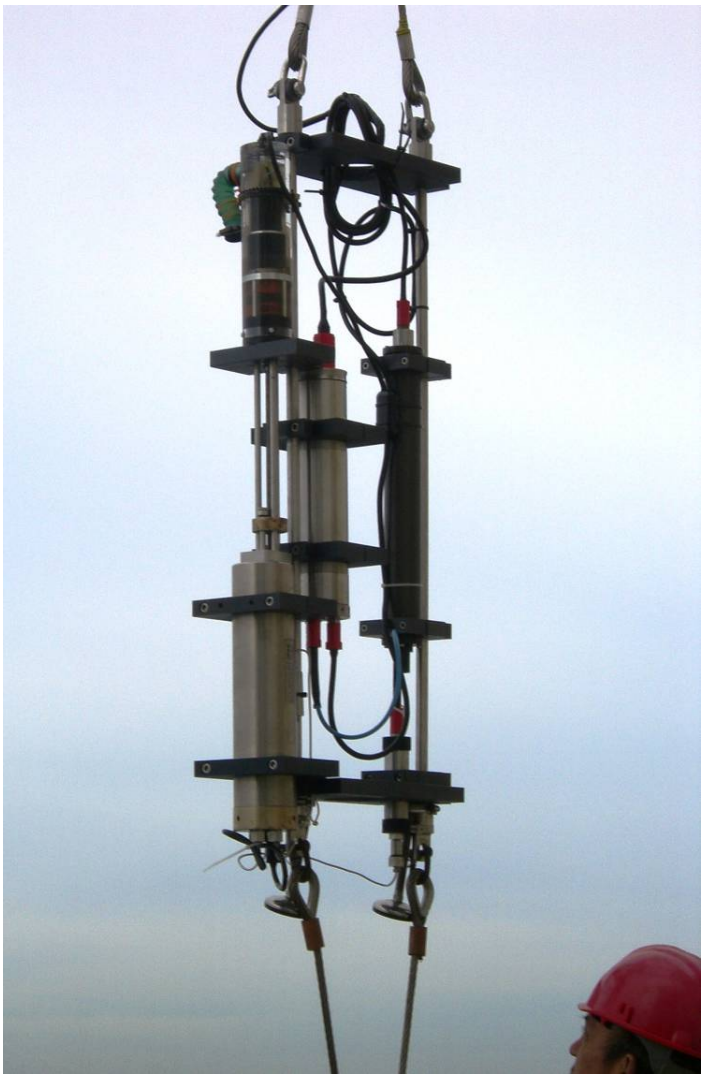


Figure 10.2 SPRATS sampling module. Components are as follows: Left side: Sample vessel (bottom) connected to the actuator motor by the piston actuating system. Centre: Electronics package. Right side: battery case (top) and pressure sensor.

10.3.1 SPRATS Deployments aboard RRS Discovery cruise D300.

Dec 8th
M10 15772 #3 Deployed to 400m (cable out).
Linear actuator ran and successfully drew in a sample, but internal pressure was not maintained upon retrieval. This was due to failure of the non-return valve which had been modified by removal of a spring in order to lower the burst pressure. The valve was replaced with an unmodified spare.

Dec 11th
M5 15773 #1 Deployed to 400m (cable out).
The linear actuator was found to have jammed at the start position. Investigations showed that the batteries were almost fully discharged. The voltage output was found to be restored however when the battery pack was tested again upon re-equilibration to room temperature. The spring was removed from the valve and weakened (shortened by compression), in order to reduce the load on the motor, thereby reducing the drain on the batteries. The valve was also repositioned with the ball facing downwards to ensure that gravity would help it seat back into the closed position once a sample has been taken. With the spring modified in this way it was possible to force and draw water through the valve using a 50ml syringe, apparently without loss of the non-return function.

Dec 14th
M5 15773 #10 Deployment to 400m (aborted).
The Deployment was aborted due to winch / cable problems. It was the opinion of ships crew that SPRATS was too light and did not provide sufficient tension on the cable, causing it to jump off the drum. A new steel harness was prepared for suspending more weight from the bottom of the frame.

Dec 17th
M5 15773 #24 Deployed to 400m (cable out)
The motor had driven the lead nut all the way to the top and the piston was seated as it should. However pressure was not maintained upon recovery. The internal pressure dropped as soon as hauling-in commenced and stayed in pace with the external pressure as it was brought to the surface, indicating a leak in the non-return valve. An alternative power source was sought that would provide enough output to run the motor with an intact non-return valve in place. No suitable battery could be found that would fit into the existing pressure housing, and no alternative housing could be found.

10.3.2 Conclusions

SPRATS was deployed four times during the course of this cruise but no samples were taken. The apparatus was found to still be seriously underpowered. The battery package consists of twelve 1.5V lithium AAA batteries of domestic specification which supply ~16V to the motor (at room temperature and without load). However, at working temperatures (typically between 0ºC and 3ºC) the power output drops well below that required by the motor to successfully retract the piston against the resistance of the non-

return valve. Modification of the non-return valve resulted in the motor/batteries successful retraction of the piston at working temperature (2.7ºC). Unfortunately any modifcation of the non-return valve compromises its pressure-retaining function. This is an identical repeat of the same problem encountered during the first testing of SPRATS. Furthermore it had been made explicitly clear to the manufacturer, and could have been easily remedied with the use of existing commercially available batteries.

Further testing is planned in an immersion pressure vessel which will allow us to run experiments aimed at identifying the actual power requirements of the unit at deep-ocean temperatures and pressures.

Finally, the deck crew and technical officers of the RRS Discovery deserve a special mention for their excellent assistance under difficult conditions.

11. Coring Activities

Alan Hughes, Brian Bett and Ben Boorman

11.1 Overview

Megacorer deployments were carried out at four stations: M10, M5, M6 and at a shallow water station located between the Crozet Isles. The sampling focused on sites M5 and M6, where 13 and 20 deployments were carried out, respectively (Tables 11.1 and 2), while single deployments were carried out at M10 and the shallow site. The corer was deployed with both standard (10 cm internal diameter) and smaller "multicorer" sized (5.9 cm internal diameter) core tubes (Figure11.1).

Cores were used for a variety of studies (see below, and Tables 11.1 and 2). In general, samples obtained at M5 were replicated at M6, with the exception that no macrofauna samples were obtained at M6.

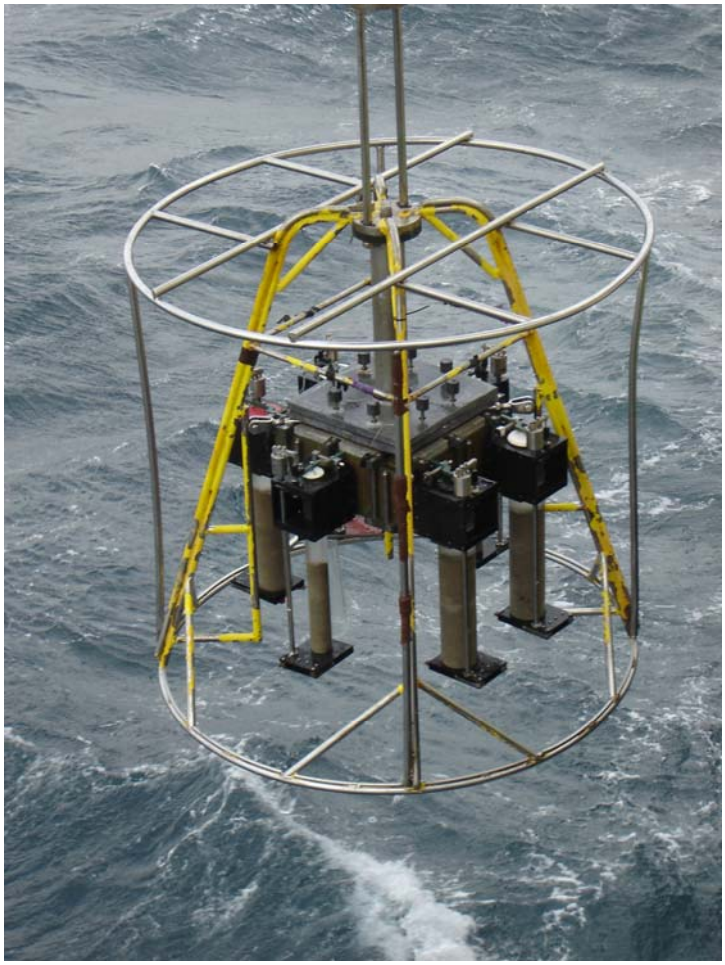


Figure 11.1: The Megacorer, being recovered following a successful deployment at M5. The corer has both standard and small diameter core tubes fitted to it, and 100 kg of extra weight has been attached to the corer head.

11.2 Site M10

The one deployment at M10 (15772#2) returned 6/8 good Megacores. The cores were all 20 to 35 cm deep and contained soft mud which was light brown at the surface, gradually turning grey deeper in the cores (Figure 11.2). All the cores were slightly disturbed, with cloudy overlying water. Four of the cores were taken by Will Homoky (NOCS), one for microbiological analysis (BAS), and one for nematode studies (NHM).

Figure 11.2: Representative photographs of cores from Site M10 (15772#2). The external diameter of the Megacore tubes is 10.9 cm.

11.3 Site M5

The first three Megacore deployments at M5 returned no useable cores (15773#07, 11 and 12; Table 1) presumably due to a lack of sediment penetration by the core tubes. Deploying the corer with 100 kg of extra weight, while fitted with 4 Megacore tubes and 2 small diameter core tubes (15773#18 onwards) improved the returns (Table 11.1). In the last four deployments (15773#34, 35, 38 and 39) the corer was deployed with eight Megacore tubes and 150 kg of extra weight.

The 50 useable cores returned from M5 ranged from 10 to 43 cm deep (average 29 cm). The sediment in all samples was basically light brown, very soft mud, sometimes containing small stones (Figure 11.3). There was noticeable variation in the sub-surface structure of the cores; the sediments were often mottled, with various light and dark banding. In many cores there was a coarse dark band of variable thickness (generally less than 1 cm deep) around 10 – 15 cm depth, possibly volcanic in origin. Although phytodetritus was visible in photographs from M5, this was not observed in any of the cores, thus may have been in suspension for most of the period at M5.

One box corer deployment was also carried out at M5 (15773#14). This returned a core 21 cm deep. Unfortunately, all the top water had drained through a hole in one corner. Nonetheless, two sub-cores were taken for microbiology (BAS), and the remainder of the sediment (0-1 cm sediment depth) was sorted by Adrian Glover (NHM) for polychaetes. There was a burrow (echiuran?) at 10 cm sediment depth, which appeared to contain

green material, possibly phytodetritus; George Wolff (University of Liverpool) took samples of this. There was a coarse black layer, presumably volcanic ash, throughout the core at 5-6 cm sediment depth.

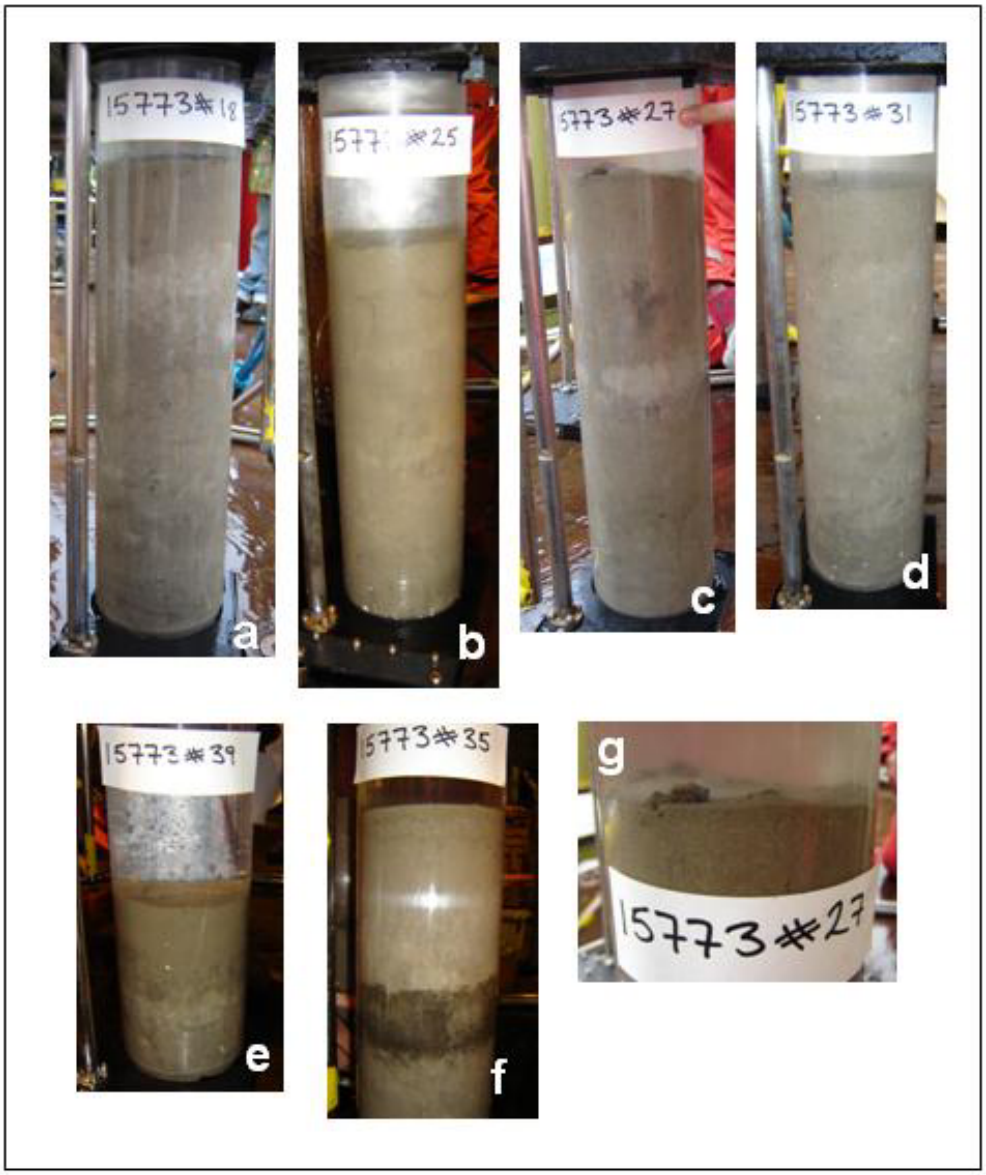


Figure 11.3: Representative photographs of cores from Site M5. The external diameter of the Megacore tubes is 10.9 cm. a) 15773#18, b) 15773#25, c) 15773#27, d) 15773#31, e)15773#39, f) 15773#35 and g) 15773#27 detail, showing stones at the sediment surface.

Series (#) number:	**15773#**	07	11	12	18	20	21	25	28	31	34	35	38	39
Number of useable cores:		0/8	0/8	0/8	5/6	6/6	6/6	4/6	5/6	6/6	4/8	7/8	0/8	7/8
University of Liverpool	Sectioned					S	S	S	S	S				
"	Whole core frozen					✓								
British Antarctic Survey	Microbiology				S		✓	✓	✓		✓			
Natural History Museum	Nematodes				✓		✓		✓	✓				
" "	Polychaetes				D	✓				✓				
Tania Smith (NOCS)	Pigments					S	S		S	S				
"	Degredation					D		✓	✓		✓			
Alan Hughes (NOCS)	Meiofauna				✓		✓			✓	✓			
"	Foraminifera				✓	✓		✓		✓				
"	Macrofauna (cores/sample)											7		6
Iain Salter (NOCS)										✓	✓			✓
Will Homoky (NOCS)	Oxygen profiles						✓				✓			

Table 11.1: Summary of the Megacore deployments and samples obtained from Station M5. ✓= Megacore sample; D = disturbed core; S = Small diameter core sample.

11.4 Site M6

Coring at Station M6 proved difficult, and had a low overall success rate; 50 useable cores were returned from 20 megacorer deployments, although ten of these were too disturbed to be used for quantitative analyses (Table 11.2). This may have been due to a combination of the heavy seas experienced during the sampling period, together with the uncohesive nature of the sediments. It was not obvious what the optimum set-up of the Megacorer was at this site, and various combinations of core tube numbers and extra weight were tried. The final arrangement, with eight or ten coring heads and no extra weight, appeared to be the most successful, although this still produced variable returns (Table 11.2). The nominal sampling location was moved north by two miles following 15775#30. The sea-state also improved markedly on the final days sampling (i.e., for 15775#35, 36, 37 and 38).

The cores obtained at M6 ranged from 9 to 45 cm deep (average 24 cm). The surficial sediments were soft, light brown muds (Figure 4). Below the surface, a variety of coloured layers and bands were observed. Below a few centimeters, the sediments were generally dry and uncohesive, and had an unusual "cheese-cake" like consistency. Many of the cores had the bottom portion missing (Figures 4 a, e, h, i and k). It is assumed that this happened when the core penetrated a layer of very uncohesive sediment which was not retained in the core tube.

11.5 Shallow water site

The final Megacorer deployment of the cruise (15778#1) was carried out at a shallow water (approximately 150 m water depth) site located between Île de l'Est and Île de la Possession. This returned 0/6 cores, although there were the remains of some serpulid polychaetes in one of the core tubes. It was assumed that there was a hard substratum at this site.

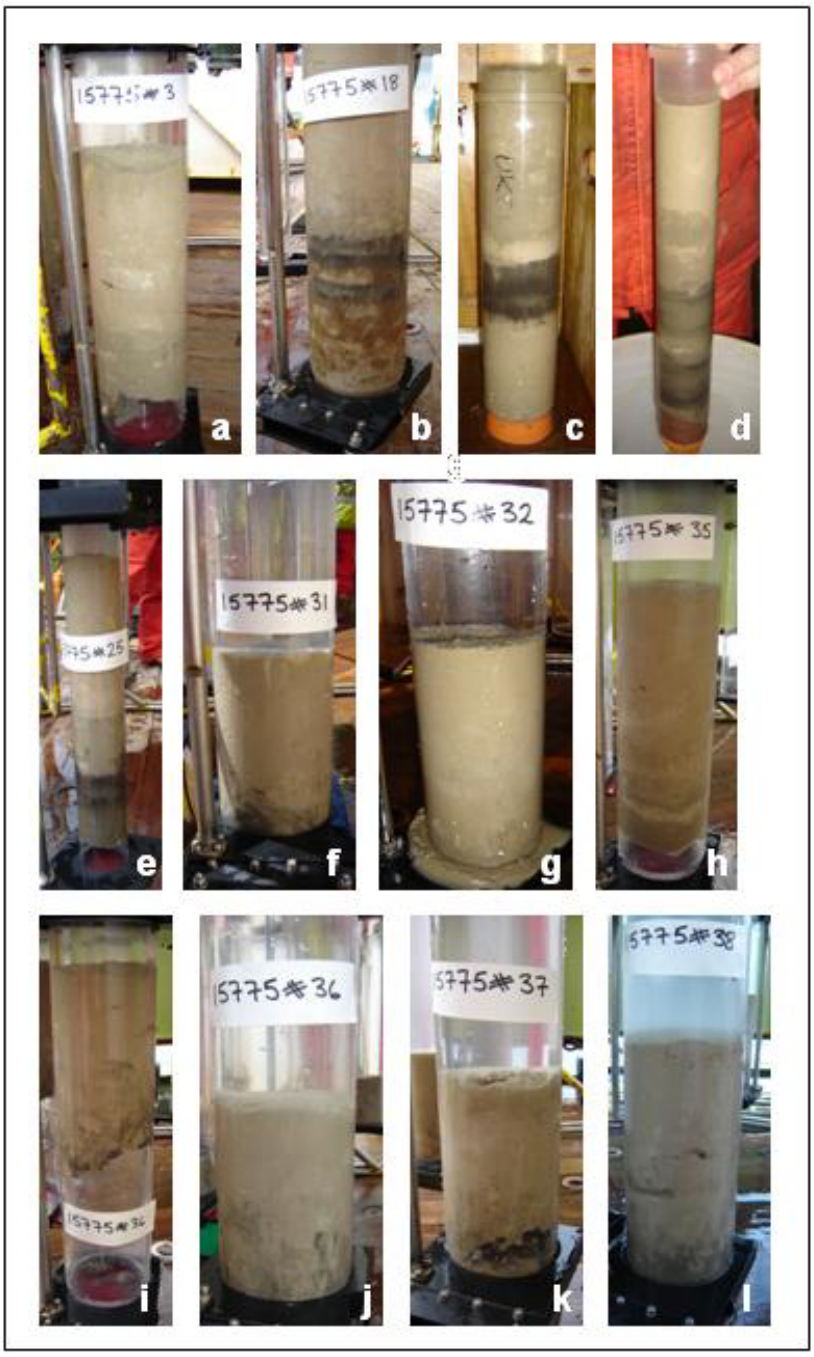


Figure 11.4: Representative photographs of cores from Site M6. a) 15775#3, b) 15775#18, c) 15775#19, d) 15775#19, e) 15775#25, f) 15775#31, g) 15775#32, h) 15775#35, i) 15775#36, j) 15775#36, k) 15775#37 and l) 15775#38. Photographs c) and e) show small diameter core tubes (external diameter 6.4 cm), while all other photographs show Megacore tubes (external diameter 10.9 cm).

Series (#) number:	15775#	3$	5$	6$	10$	12*	17$	18	19	21	22	25	27	30	31	32	33	35	36	37	
Number of useable cores:		5/8	0/6	1/8	2/8	0/6	1/4	2/4	3/4	3/6	0/6	3/6	0/6	0/6	5/8	3/8	4/8	2/8	6/8	4/10	6
University of Liverpool	Sectioned	S			S				S											S	
"	Whole core frozen																	✓			
British Antarctic Survey	Microbiology	✓						✓							✓		✓		✓		
Natural History Museum	Nematodes	✓										✓				✓	✓			✓	
" "	Polychaetes						D			2D					3D			D	2D		
Tania Smith (NOCS)	Pigments			S					S			S							S		
"	Degredation	✓			S			S(D)		S(D)											
Alan Hughes (NOCS)	Meiofauna	✓										✓				✓			✓		
"	Foraminifera								✓							✓	✓		✓	✓	
Iain Salter (NOCS)																				✓	
Will Homoky (NOCS)	Oxygen profiles														✓		✓				

Table 11.2: Summary of the Megacore deployments and samples obtained from Station M6. ✓= Useable Megacore sample; D = disturbed core; S = Small diameter core. * = 100 kg extra weight added to the corer head. $ = 150 kg extra weight attached to the Megacorer head.

12. Analysis of Megacore Samples

12.1 Faunal studies - Alan Hughes (NOCS)

Four megacores were taken for both metazoan meiofauna and benthic foraminifera at both Stations M5 and M6. These were sectioned to 5 cm sediment depth (0.0-0.5, 0.5-1.0, 1.0-1.5, 1.5-2.0, 2.0-3.0, 3.0-4.0 and 4.0-5.0 cm sections) and fixed in buffered 4% formalin.

At station M5, two Megacorer samples were taken for macrofaunal studies. The first of these samples incorporated seven Megacores, while the second used six. The cores were all sectioned into 0-1, 1-3, 3-5 and 5-10 cm sections, and then sieved on a 250 μm mesh. The residues were fixed in buffered 4% formalin.

12.2 Pigment analyses – Tania Smith (NOCS)

The objective of pigment analysis is to determine the essential compounds available to deep sea megafauna and how they may affect the community structure and biodiversity. It is hoped that it will be possible to compare material that what the megafauna consume with that available to them, as well as comparing the two contrasting primary production regime sites.

12.2.1 Pigment quantification

Multicores from each site (M5 and M6) were sectioned for pigment analysis. 0 to 0.5 cm, 0.5 to 1 cm and 1 to 2 cm. They were frozen immediately at -80 ^{o}C. HPLC will be used to analyse the samples at NOCS.

12.2.2 Pigment degradation experiment

The top 1cm of sediment from either multi or mega cores was incubated at 4^{o}C in the dark. Samples were taken at intervals over the cruise and will be analysed back at NOCS using HPLC. The results will be used to help elucidate the degradation rate of individual pigments relative to one another.

12.3 Polychaetes - Adrian Glover (Natural History Museum, London)

The polychaete component of the benthos is both abundant and diverse at abyssal sites such as that sampled with the Benthic Crozet cruise. The cruise represented an opportunity to add to an ongoing program analysing global biodiversity and biogeographic patterns of polychaetes, being carried out by the Natural History Museum, London, in collaboration with Census of the Diversity of Abyssal Marine Life (CeDAMar) partners. Few data exist for regions such as the Southern Ocean, and material from this region is ideal for examining relationships between apparently globally distributed abyssal fauna, and species recorded from the Antarctic shelf. An additional goal was to characterize the community composition of the two contrasting sites, which

would assist in investigating the effects of productivity on the benthos, as well as helping to place biogeochemical parameters within a global context.

The principal aim was to collect material that could be used both for molecular sequencing and morphological analysis. Previous studies from the central Pacific abyss (Glover et al., unpublished data) had shown significant problems in obtaining quality material for molecular analysis from ethanol bulk-fixed sediment samples. This is mainly due to the small size of abyssal infauna, and the effect of dilution of ethanol within sediments. For this reason, on benthic Crozet it was decided to live sort all material, identifiying species before fixation, and preserving a reference collection in formalin, with tissue samples (or whole animals) preserved in RNALater (and frozen to -80C), or in DMSO, a preservative known to produce good DNA preservation. An additional benefit of this approach is that the chemical and shipping requirements are far lower, as there is no need to bring back large volumes of fixed sediment which may or may not contain animals of interest.

Gear	Site	Sample #
Trawl	M5	15773#17
		15773#23
		15773#32
		15773#8
	M6	15775#13
		15775#4
Megacore	M10	15772#2
	M5	15773#18
		15773#20
		15773#31
	M6	15775#21
		15775#25
		15775#3
		15775#31
		15775#32
		15775#33
		15775#36
		15775#37
USNEL Box-core	M5	15773#14

Table 12.1: Polychaete samples from cruise D300

Although time-consuming, the live sorting approach was successful in that over 300 animals were picked from a combination of trawl, megacore and box-core samples. All material was picked directly from the samples under the microscope, with megacore and box-core samples having been sieved on a 300 μm sieve in cold seawater. In several cases, the top 0-1cm layer of the nematode DNA cores was live-picked for polychaetes, with the residue being returned to the nematode sample. A single box-core was taken, and

because of the large size of the sample, only a fraction was live-picked, with the remainder being bulk-preserved in DMSO.

Figure 12.1: Abyssal polychaetes from the Crozet Region, (a) onuphid polychaete retrieved from trawl samples, (b) *Laetmonice* sp. (Polynoidae) from trawl samples, (c) ampharetid polychaete picked from megacore samples, (d) cirratulid polychaete picked from megacore samples.

There were dramatic differences in the faunal composition of trawl samples and core samples. This was expected, given the different mesh size and spatial scale of sampling. The abundant trawl collections were very welcome, as there have been few recent studies of the larger abyssal polychaete fauna, and certainly no molecular work. The trawl samples were dominated by polynoid, terebellid, onuphid and large maldanid polychaetes, with some of the maldanid tubes being over 30cm long. Large polynoids (which probably belong to a common abyssal species complex within the genus *Laetmonice*) were abundant at both M5 and M6 (Figure 12.1). At M6 there was an increased abundance of maldanids.

Within the core samples, a community dominated by infaunal deposit-feeding polychaetes such as cirratulids, spionids and paranoids was recorded. Although our samples are non-quantitative, preliminary observations suggest that abundance was lower at M6, the low-productivity site. An extremely good find was *Aurospio* cf *dibranchiata*, a species which appears to show global distribution, and is also present on the Antarctic shelf. It is most likely that this is a species complex, and molecular information will help

to resolve this. Subject to further proposals pending, we will be able to examine the phylogenetic position and degree of gene-flow between Antarctic shelf and Southern Ocean faunas. This will provide data to test the hypothesis that the Antarctic shelf has been subjected to numerous reinvasions from the surrounding deep-sea following expansions of the Antarctic ice-sheet during glacial maxima.

All samples will be returned to the Natural History Museum for both molecular sequencing in the Museum's DNA lab, and morphological analysis, including electron microscopy work. Abundant species may also be selected for histological examination for reproductive features, and potential periodicity of reproduction (e.g as measured by oocyte size frequencies). All data will be coordinated with CeDAMar and the Census of Marine Life, through their online databases and workshops.

12.4 Nematodes - Dr Robin Floyd, Ms Margaret Packer, Dr Adrian Glover (Natural History Museum, London and British Antarctic Survey)

Nematodes are an abundant and species-rich phylum which occupies a wide range of ecological niches, both in the terrestrial and the marine environment. Most of our existing knowledge relates to soil and shallow-water habitats; nematodes are also abundant in deep-sea sediments, but very little data exist on biodiversity, species ranges or species distributions in this environment.

We are interested in utilising DNA barcoding as a method for assessing biodiversity. By sequencing an informative segment of DNA, animals may be placed to taxonomic groups without the process of morphological identification, which for nematodes is highly difficult and time-consuming. This information is also useful for phylogenetic analysis. While the NOC group are collecting meiofaunal samples in formalin for morphological identification, we are fixing samples in a DMSO (dimethylsulphoxide)-based buffer, which preserves the animals' DNA as well as their physical integrity (formalin preserves morphology but is destructive to DNA molecules).

12.4.1 Methods

A mud core extruder was used to remove the mud sample from the Perspex Megacore tube. A rubber bung was placed on top of the core tube to form a seal, this prevented the sample sliding out of the core tube when the bottom bung was removed. The bottom of the core tube was aligned with the core extruder and the bottom bung removed, then quickly the core tube was fitted onto the extruder. The bung at the top of the core tube was then removed. At that point the surface waters were removed for bacterial analysis by the National University of Ireland, Galway (see Section 10). The mud core was gently eased up the core tube using the extruder. The top 2 cm's of water was retained and extracted using a syringe and kept with the surface sample, this was in case slight disturbance of the mud sample had resulted in some nematodes being suspended in the water at the surface boundary layer. A measuring ring was placed on top of the core tube and the top 1cm sliced off using a metal slicing plate and placed in a marked container with the surface water. The measuring ring and slicing plate were also rinsed with filtered seawater (45μm) and retained with the sample. The mud core was then extracted to a

depth of 2cm and the procedure repeated for this sample. A total of the top 3cm of mud core was taken in two horizons; 0-1cm & 1-3cm, the rest was discarded.

These mud samples were then sieved through a 45μm sieve to remove the fine sediment reducing the sample size for return to the United Kingdom. The samples were transferred to HDPE bottles and preserved in DMSO, then placed in a 4°C refrigerator. Although DMSO should preserve adequately at room temperature, due to the experimental use of this chemical, refrigeration was used as a precautionary measure.

12.4.2 Sampling

Samples collected were: one core from site M10 (deployment no. 15772#2); four cores from site M5 (nos. 15773#18, #21, #28 & #31); and five cores from M6 (15775#3, #21, #25, #32 & #33). A total of 10 cores were collected, split into two horizons giving 20 samples.

12.4.3 Post-cruise aims

DMSO-preserved meiofaunal samples will be shipped to Prof John Lambshead's group at the NHM for extraction, mounting, identification and video capture. The processed material will then be sent to Dr Alex Rogers at the Institute of Zoology where the DNA work will be carried out.

12.5 Dissolved oxygen measurements of surface sediments - William Homoky (NOCS)

12.5.1 Introduction

The study of dissolved oxygen concentrations in surface sediments around the Crozet Islands is part of a larger initiative to study the redox characteristics of surface sediments and relate these to the potential for a sedimentary flux of Fe to the overlying seawater; a possible source for the annual growth in surface water productivity. Pore-waters analyzed for nutrient geochemistry gradients from CROZEX cruise D286 (see D286 log, section 14.4) will compliment the dissolved oxygen data from D300.

The primary objectives for D300 were two fold:

1) To study the oxygen concentration gradients in the surface sediments around the Crozet Islands.

2) To gather samples for the study of Fe release characteristics from the surface sediments during controlled microcosm experiments at NOC.

12.5.2 Methods

12.5.2.1 Sampling

Three sites were of interest for this study. M10 (15772), M5 (15773) and M6 (15775). A minimum of two mega-core samples from each site was required for the study of dissolved oxygen profiles. The sites represent both areas of high and low productivity during the annual bloom event. M10 is believed to be more proximal to the source of the bloom than M5, and M6 is a relatively low productivity site. Only cores longer than 15cm with little to no surface layer disturbance and no apparent 'bubbling' during extraction were accepted. Megacore surface sediments were sub-sampled into a shorter (20 cm) megacore tube for storage and mounting in the oxygen sensor. See Table 4 for a record of the sampling efforts.

12.5.2.2 Analysis

All analyses, including sub-sampling, were carried out in a controlled temperature laboratory at a recorded 4 - 5°C. Oxygen concentration was measured using a suite of Unisense microelectrode equipment including; Micro-sensors with 50µm tip diameter; M33-2 micromanipulator; LS18 lab stand; MC-232 motor drive; PA2000 Picoammeter; and Profix software.

Sensors were calibrated using a Unisense Cal300 chamber. A linear calibration was attained from a 100% and a 0% dissolved oxygen concentration by firstly aerating a benthic sea water sample in the chamber, and secondly passing nitrogen gas through the sample for at least 5 minutes until the sensor output had stabilized to within $1x10^{-3}$ Volts. A calibration was only accepted when the zero oxygen reading was not more than 10% of the aerated output; typically they were within 2-5%.

After sub-sampling, samples were allowed to re-equilibrate for 30 minutes with a gentle surface water aeration that did not produce any visible disturbance of the surface layer.
A minimum of two oxygen profiles were then recorded from -1 mm to 57 mm depth at 500µm steps, at approximately 30 minute intervals, and until the profiles appeared repeatable and representative of the sample. Deeper profiles would have been desirable however; a maximum penetration of 60 mm was the maximum range available with the M33-2 micromanipulator.

Station	Site	Date	No. of cores	Fate of sample(s)
M10	15772#2	08/12/2005	4	All cores used for O2 profiles, one core frozen(-20°C) for Rachel Mills(NOC) biomarker analysis. Remaining 3 cores chilled for NOC microcosm experiments.
M5	15773#21	16/12/2005	1	O2 profile, chilled for NOC microcosm experiment.
M5	15773#34	21/12/2005	1	O2 profile, chilled for NOC microcosm experiment.
M6	15775#31	04/01/2006	1	O2 profile, chilled for NOC microcosm experiment.
M6	15775#33	05/01/2006	1	O2 profile, chilled for NOC microcosm experiment.
M6	15775#38	05/01/2006	1	O2 profile, chilled for NOC microcosm experiment.
Islands	15778#1	06/01/2006	0	~4g sediment detritus bagged for return to NOC

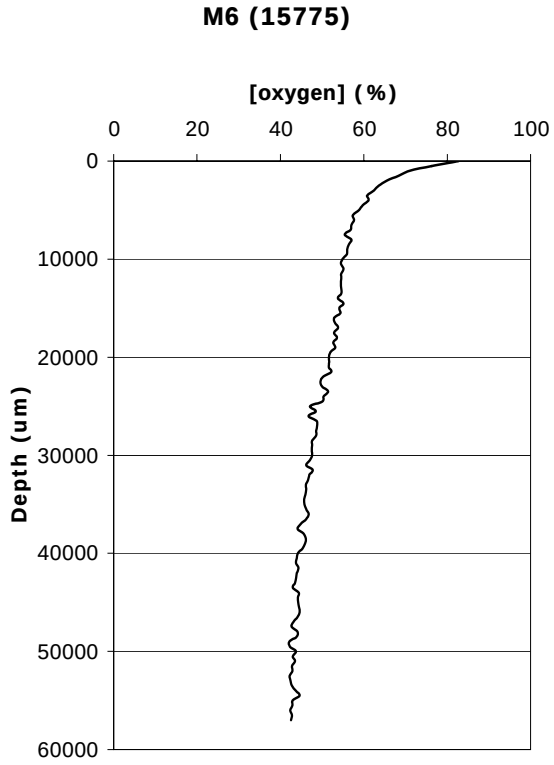
Table 12.2: Sampling Log.

12.5.3 Preliminary results

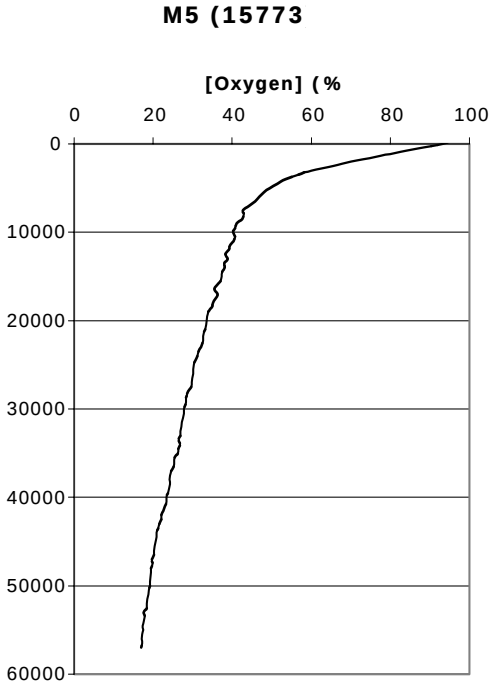
Typical oxygen profiles from three sites, M10, M5 and M6 are summarized in Figure 12.2. The M6 samples have the highest dissolved oxygen content of the three sites. M5 and M10 represent sites under the annual phytoplankton bloom, where M5 has a rapidly lowered dissolved oxygen concentration in the top 3-5mm of the sample, associated with a visible phytodetritus layer of similar thickness. M10 samples preserved no phytodetritus layer, however, the dissolved oxygen concentration is the lowest of all three sites, reaching 0% dissolved oxygen in less than 60 mm.

12.5.4 Anomalies

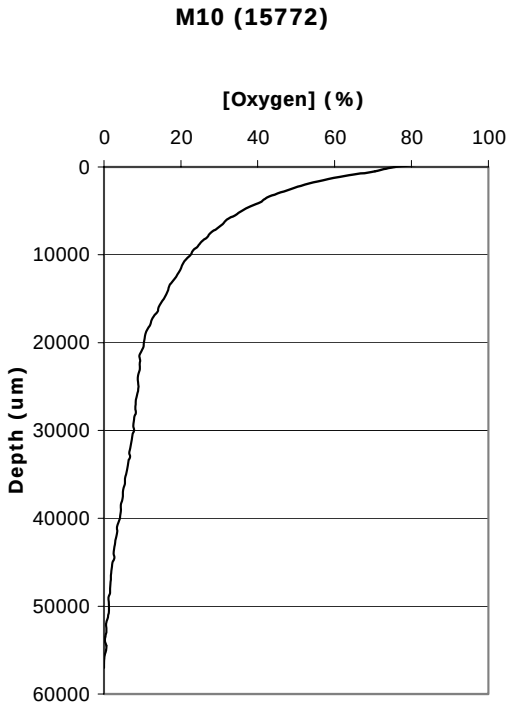
An M5 core sample from deployment 15773#34 showed an unusually low oxygen concentration (Figure 12.3). The microsensor measured a condition of anoxia by 10 mm depth in the surface sediment. A total of six profiles were taken over a period of 90 minutes, during which surface waters were maintained at 90-100% oxygen saturation. The profiles showed little-no variation between runs, and the recorded anoxic boundary was consistently recorded at 10 mm. A color change in the surface sediment was not identified, at any depth in the sub-sample. The sensor recorded no dissolved oxygen between 10 mm and 60 mm (the probes maximum penetration depth). Recalibration and switching of sensors failed to produced a change in the result. The probe was then run on a previous M5 sample (15773#21), which proved to still have a higher concentration of dissolved oxygen, despite surface waters being stagnant for 5 days. It is speculated that the core is host to an anomalous micro-reducing zone, and not considered representative of the site.


M6 (15775)
[oxygen] (%)
0
20
40
60
80
100
0
10000
20000
30000
40000
50000
60000
Depth (um)

(a)


M5 (15773
[Oxygen] (%
0
20
40
60
80
100
0
10000
20000
30000
40000
50000
60000

(b)


M10 (15772)
[Oxygen] (%)
0
20
40
60
80
100
0
10000
20000
30000
40000
50000
60000
Depth (um)

(c)

Figure 12.2: Dissolved oxygen concentration with depth, measured as a percentage of total potential dissolved oxygen. (a) Shows the relatively oxic surface sediments at M6 south of the phytoplankton bloom. (b) and (c) represent two sites, M5 and M10 respectively, that are both within the phytoplankton bloom. M10, which shows the least oxic surface sediments, is most proximal to the speculated source of the annual bloom.

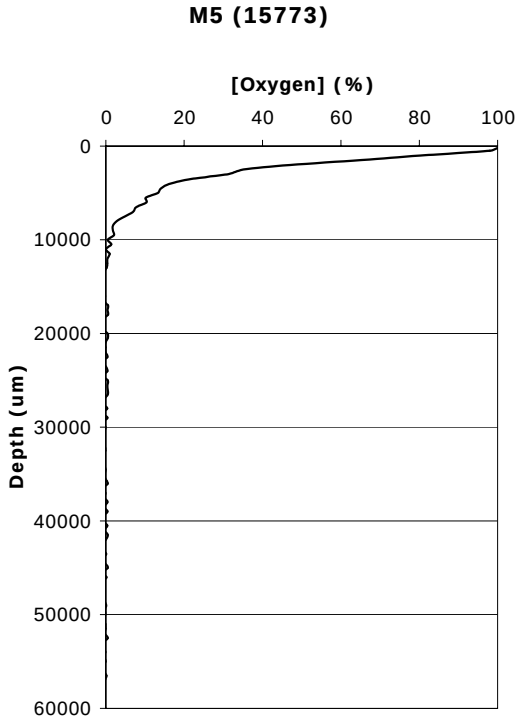


Figure 12.3: Unusual oxygen profile from M5 deployment 15773#34, speculated to be a localized reduction zone, not thought to be representative of the site.

12.6 Microbiology of the Southern Ocean Sediment - David Pearce, Rachel Malinowska, Robin Floyd (British Antarctic Survey)

12.6.1 Background

The micro-organisms that colonise marine sediment play a significant role in the global cycling of carbon and other nutrients. Upon reaching the sea-floor, the organic matter resulting from primary production at the ocean surface is remineralized by the microbial community or incorporated as refractory organic matter by burial in the sediment. Marine sediments probably represent the most complex microbial habitats on earth. Knowledge of the abundance and diversity of the benthic microbial communities is essential to our understanding of biogeochemical cycling and the role of the benthos in all oceanic processes.

The Southern Ocean represents a major oceanic CO_2 sink and though generally described as oligotrophic, areas such as the Crozet basin frontal zone and surrounding deep-sea are of biogeochemical interest due to the enhanced primary productivity exhibited here.

Our objective on this cruise was to establish the abundance and diversity of the microbial community using molecular methods in the marine sediment of two areas of contrasting productivity (M5 and M6) within the Crozet region. The knowledge obtained will contribute to a wider study investigating the effect of biogeochemical processes (carbon, iron cycling etc.) on benthic community structures, dynamics and diversity.

12.6.2 Sampling

12.6.2.1. Megacoring

12 Megacores and a sub-samples from a box core were taken from corer deployments, 5 cores and a box core from the M5 site and 6 cores from M6. All the cores were sectioned immediately into 1 cm sections to final depths of between 15-30 cm depending on the state and the length of the core. Sections were sub-sampled and stored in Petri-dishes and sterilin tubes at -20 °C.

	Sample no.	**Station no.**	**Depth (m)**	**Features**
M5 Site				
	Box Core	15773#14	4209	Top layer lost, ash layer at 5-6 cm
	M5.m1	15773#20	4211	20 cm core, undisturbed, dark bands below 9 cm depth
	M5.m2	15773#21	4210	12 cm core, light brown with dark layer at 11-12 cm depth
	M5.m3	15773#25	4320	20 cm core, undisturbed, uniform
	M5,m4	15773#28	4191	30 cm core, slightly disturbed, mottled dark patches below 10 cm. Worm holes at 5-6 and 10-11 cm. Stones at 8 cm possibly volcanic.
	M5.m5	15773#34	4219	20 cm core, undisturbed, wet texture throughout. Dark layer between 13-20 cm depth.
M6 Site				
	M6.m1	15775#3	4232	15 cm core, no layering, very watery and fine silt-like texture throughout.

	M6.m2	15775#18	4197	31 cm core, very watery, slightly disturbed, very black layers below 15 cm depth, dark grains below 20 cm, possibly volcanic.
	M6.m3	15775#31	4222	15 cm core, flat and undisturbed, light brown.
	M6.m4	15775#33	4200	12 cm core, uniform and undisturbed.
	M6.m5	15775#36	4192	12 cm core, watery, undisturbed, no layering.
	M6.m6	15775#38	4224	20 cm core, flat, undisturbed, no layering, worm holes at 18-20cm depth.

Table 12.3 Table showing Core Sampling Details

12.6.3 Methods and Techniques

Development and optimization of techniques was carried out on sediment obtained from the M10 site and sediment from M5 (box core).

12.6.3.1 Determination of microbial abundance

4'-6-Diamidino-2-phenylindole (DAPI) staining followed by epifluorescent microscopy was employed to establish total microbial abundance through a vertical profile of each core. Microbial cells were harvested by filtration (0.2 μm polycarbonate filter) from a know quantity of sediment and stained with DAPI at a concentration of 2-5 $\mu ml^{-1,}$ washed and placed on a glass slide with coverslip for counting. DAPI forms fluorescent complexes with natural double-stranded DNA of both active and apoptotic cells, showing fluorescence specificity for AT, AU and IC clusters. Cells fluoresce under the fluorescent microscope at an excitation wavelength of 350 nm. Counts obtained are representative of all viable and non-viable cells within the sediment sample.

12.6.3.2 Determination of Community Composition and Structure Fluorescent in situ hybridization (FISH)

The FISH method was used in order to determine the presence of specific groups of micro-organisms in the sediment and to provide molecular information on the community composition and structure. Seventeen fluorescent probes were employed each binding to a different group-specific bacterial or archael RNA sequence within the ribosomal gene.

Probe	**Target Group**	**Reference**
EUB338	Eubacterial 16S rRNA (338-355)	Amann *et al.* (1990)
ARCH915	Archaeal 16S rRNA (915–934)	Stahl and Amann

		(1991)
ALF968	alpha-proteobacteria 16S rRNA (968–986)	Neef (1997)
BET42a	beta-Proteobacterial 23S rRNA	Manz *et al.* (1992)
CF319a	Cytophaga*Flavobacterium* cluster of the *Bacteroidetes*phylum 16S rRNA (319–336)	Manz *et al.* (1996)
GAM42a	Gamma-Proteobacteria 23S rRNA	Manz *et al.* (1992)
HGC69a	*Actinobacteria* 23S rRNA (1901–1918)	Roller *et al.* (1994)
HGC236	*Actinobacteria* 16S, 235–253	Glockner *et al.* (2000)
LGC354b	*Firmicutes*16S rRNA (354–371)	Meier *et al.* (1999)
PLA46	*Planctomycetal* 16S rRNA (46–63)	Neef *et al.* (1998)
DSS658	*Desulfosarcina-Desulfococcus* group of alpha-proteobacteria	Manz *et al.* (1998)
SRB385	Sulphate-reducing proteobacterial	Amman *et al.* (1992)
NSO190	Ammonia-oxidizing proteobacterial 16S rRNA (190–208)	Mobarry *et al.* (1996)
NON338	Negative Control	Wallner *et al.* (1993)
ANME-1-350	ANME-1 Euryarchaeota	Knittel *et al.* (2005)
EeIMS032	ANME-2 Euryarchaeota	Knittel *et al.* (2005)
MBGB-280	Crenarchaeota	Knittel *et al.* (2005)

Table 12.4 FISH probes

Cells within sediment samples were fixed immediately following core sectioning with 4% paraformaldehyde. Microbial cells were harvested by filtration (0.2 micron polycarbonate filter) from a know quantity of fixed sediment. Cells were washed and air dried on a glass slide. 20μL of a hybridisation solution (containing hybridization buffer and probe in 16:1 ratio per sample) was added to the cells and the slide incubated in hybridization chamber at 46°C for 90 minutes. Cells were washed and allowed to air dry ready for counting by epifluorescence microscopy.

12.6.3.3 Determination of cell viability CTC

To assess the number of viable cells obtained following depressurization from 4000 m depth, cells were incubated with an intracellular fluorescent probe 5-cyano-2,3-ditolyl tetrazolium chloride (CTC).The CTC is reduced within active cells only to form a fluorescent CTC-formazan product (CTF) visible under the microscope. The formation of this product indicates that cell electron transport system activity or respiration is occurring within the cell. Fluorescent cells were counted.

12.6.4 Results

12.6.4.1 DAPI

Counts were obtained for all sections through a vertical profile. Both M5 and M6 cores showed the greatest bacterial abundance within the top 0-3 cm. For M5 after an initial decrease in abundance below 2-3 cm the cell count remained constant with vertical depth up to 20 cm. An initial increase in cell number was seen below 3 cm in the M6 cores but as at M5, bacterial abundance remained constant with depth. The overall counts for the top 3 cm of a core for each site are indicative of that site's level of productivity. Greater numbers of bacteria are seen at M5, the eutrophic site in comparison with the HNLC M6 site at M6.

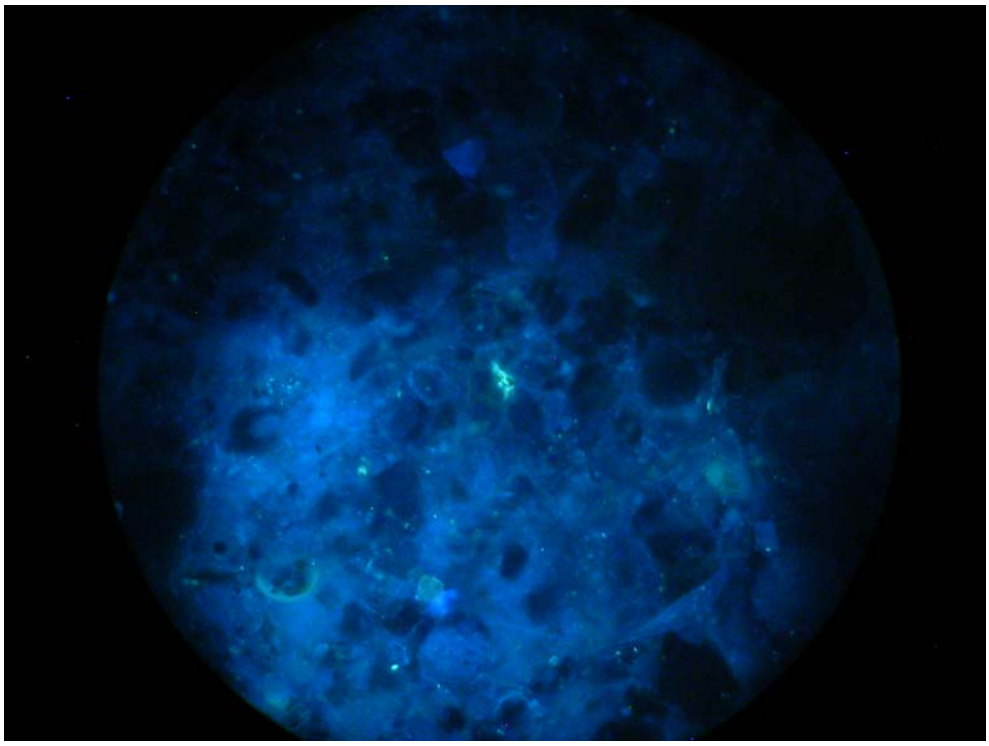


Fig 12.4 A typical DAPI image (single cells can just be seen here subject to the limited contrast provided by the camera at very low light levels).

12.6.4.2 FISH. Replicate slides for the 0-1 cm sediment samples were prepared and counted for each of the seventeen probes (including DAPI and EUB 338). 500 to 1000 cells were counted for each slide where present. A large amount of count data was obtained and the cruise was used to focus on data collection. Data analysis will take place on return to the UK.

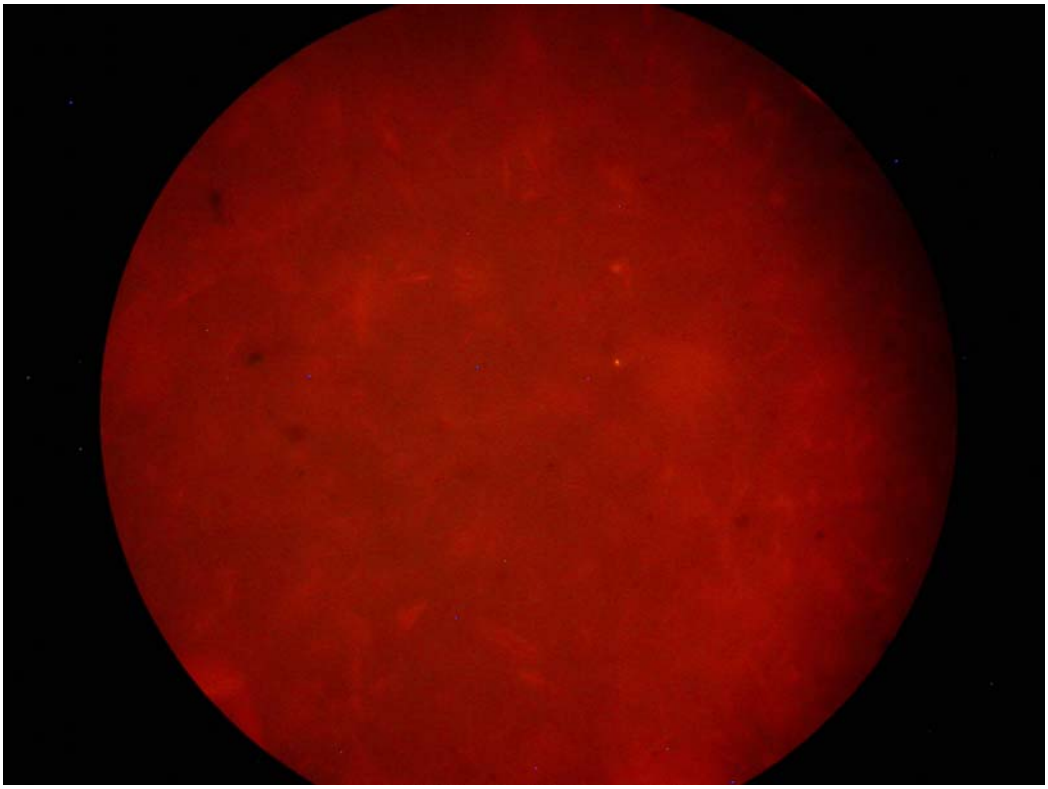


Fig 12.5 A typical FISH image showing a single cell centre right (again clarity has been compromised by the contrast of the camera at low light levels).

12.6.4.3 CTC. Small numbers of viable cells were observed in both immediately processed and frozen samples.

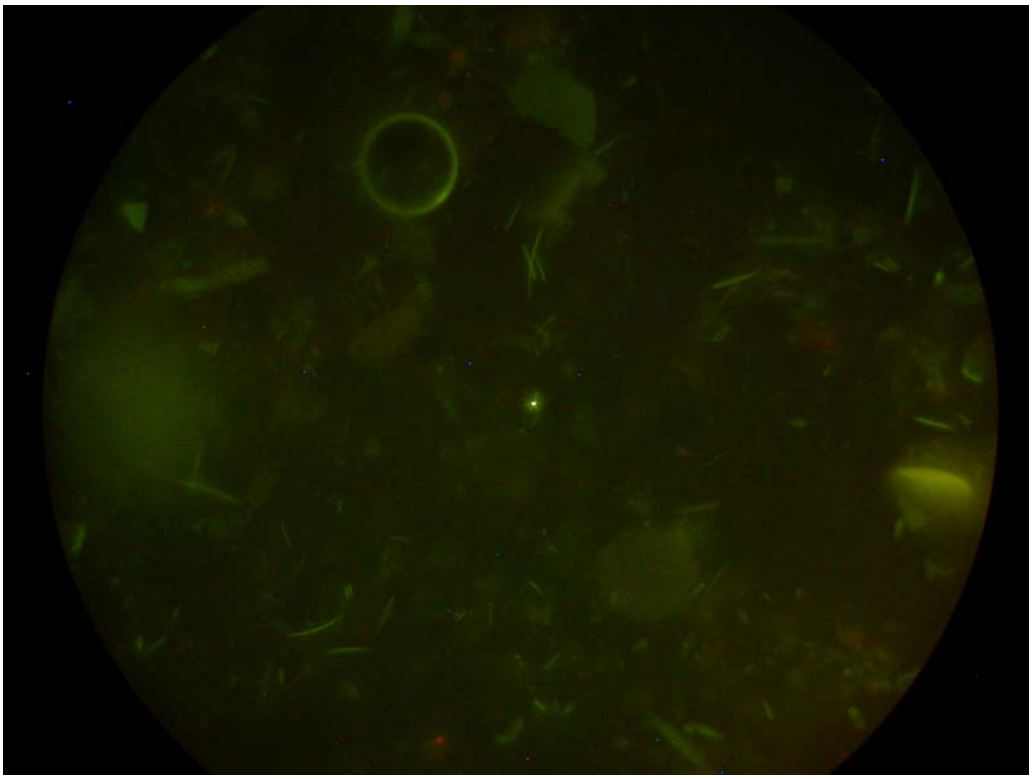


Fig 12.6 A surface CTC image with a single cell (centre)

12.6.5 Conclusions

Our immediate objective (an absolute minimum of three cores at M5 and three cores at M6) was successful. Initial analysis has suggested a significant difference between the two sites. A degree of variability within the same site was also recorded. DAPI results indicated a greater population density at M5 than M6 and showed constant cell density with depth after an initial decrease in the first 3 cm. FISH demonstrated patterns in the community structure. Expected groups were identified, whilst those expected to be absent did not occur. CTC showed that the majority of cells returned to the surface were unable to form the fluorescent CTC-formazan product (CTF). As part of her PhD research, Rachel Malinowska will continue to work on the samples and conduct a rigorous analysis over the next two and a half years at BAS & NOC.

12. 7 Lipid composition of deep-sea sediments - Frédèric Chaillan, University of Liverpool

The goal of this component of the work is to understand the difference of lipid composition in two different regions of productivity and their consequences to the quality

of organic matter reaching the sea floor and its potential impact on deep-sea diversity. In order to do this, the lipid composition of organic matter of sediments, sinking particles and in organisms will be determined. Within the coring programme, it was hoped that a good, replicated undisturbed sample set could be taken from M5 and M6, using the Megacorer.

To this end, small cores (5cm diameter) were sliced from the top to 10cm depth in 1 cm slices, except for the first centimetre which was sliced in 0.5 cm sections. The slices were packed in clean aluminium foil (400°C; 12h) and stored in Petri dishes (-80°C). Additionally larger diameter cores (10cm) were directly frozen in their tubes at -20°C and later extracted frozen and stored at -80°C. The samples were returned to Liverpool, where they will be weighed, freeze-dried, extracted and analysed.

Site	Log Number	Core Size	Events
M5	15773#20	Small	Slice 0:10
M5	15773#21	Small	Slice 0:10
M5	15773#25	Small	Slice 0:10
M5	15773#27	Small	Slice 0:10
M5	15773#28	Small	Slice 0:10
M5	15773#27	Mega	Frozen
M6	15775#10	Small	Slice 0:10 + Detritus pellet in vials
M6	15775#19	Small	Slice 0:10
M6	15775#35	Small	Slice 0:10
M6	15775#36	Small	Slice 0:10 + Slice 21:22 cm
M6	15775#38	Small	Slice 0:10
M6	15775#35	Mega	Frozen
M6	15775#38	Mega	Frozen

Table 12.5 Log of cores collected for lipid/organic analysis.

13. CTD, Sensors, and Stand Alone Pumps

Peter Keen UKORS

13.1 CTD Operations

Ten casts in total were conducted for physical parameterisation and water sampling during the period of this cruise. Casts were carried with a 12-way stainless steel frame carrying a Sea Bird 9+ underwater unit, SBE32 24-way rosette and associated sensors linked via a torque balanced conducting cable and auxillary deck cabling to a Sea Bird 11*plus* Deck unit and dual PC system where incoming data was monitored, stored and from where water sampling via the SBE32 24-way rosette was controlled. The frame

was also equipped with two RDI Workhorse 300kHz ADCP units working in a master/slave lowered configuration.

Casts were commenced on deck, LADCP's were initiated and decoupled from the lab computer prior to the instrument package being moved into position and connected to the winch cable physically and electronically. The Sea Bird system was then activated and data recording commenced. The package was raised on it's wire and taken outboard of the ship, lowered into the water and taken to a depth of 10 metres, where it was held until the SBE 5T pumps had begun pumping and instrument measurements coupled to the pumped system had stabilised. At this point the winch operator was requested to raise the package back up to the waters surface and then commence the downcast to a depth appropriate for that cast. The package was veered at a nominal rate of 60 metres per minute to this depth and then adjustment, if necessary, would be made to bring the instruments somewhere in the vicinity of 15 – 20 metres above the ocean floor*.

13.1.1 System and sensor configuration

The CTD system was deployed in the following configuration:

The reader is referred to the files: D300_0528_01.txt, D300_0528_03.txt, D300_0528_09.txt in the directory "~\Data\CTD\configuration files as modified" of this Data CD for details of calibration coefficients in relevant configuration files or to the individual instrument calibration sheets and work histories in "~\Data\CTD\instrumentation files"

The Sea Bird system included:

Sea Bird SBE 32 24-way rosette (s/n 0518) on 12-way SS frame
Sea Bird SBE911+ underwater unit (s/n 0528) with:
- SBE Digiquartz pressure sensor s/n 73299
- SBE 5T Pumps s/n
- SBE 3p Temperature sensors
  - Casts 1 & 2: s/n 4116, 2919
  - Casts 3 to 10: s/n 4383, 2919
- SBE 4c Conductivity sensors
  - Casts 1 & 2: s/n 3052, 2571
  - Casts 3 to 10: s/n 3153, 2571
- SBE 43 Oxygen sensor (voltage channel 0)
  - Casts 1 to 8: s/n 0621
  - Casts 9 & 10: s/n 0862

* This deployment procedure was adhered to in all but one instance where the sea conditions made it imprudent to raise the package from its 10 metre holding position in case it should collide with the side of the ship, this cast (006) therefore was commenced from 10m.

Connected to SBE 911+ through Breakout Box (s/n B019106)
Voltage Channel 1: Free
Voltage Channel 2: Altimeter (Benthos, s/n 1040)
Voltage Channel 3: Fluorometer (Chelsea Aqua 3, s/n 088195)
Voltage Channel 4: Free
Voltage Channel 5: Free
Voltage Channel 6: BBRTD (Wetlabs)
Casts 1 to 7: s/n 168
Casts 8 to 10: s/n 169
Voltage Channel 7: Transmissometer (Chelsea Aquatracka s/n 161047)

The LADCP system was made up by:
RDI Workhorse 300 kHz ADCP s/n 5414 (upward) and s/n 1881 (downward)
WH01 48V battery pack

Ancillary equipment also carried on the frame included:
Sonardyne HF Beacon
10 kHz Pinger

13.1.2 Cast Log

CAST 1
Station 15772#1 Cast 001 44º 28.94'S 050º 00.36'E 2908 m (corrected)

Full depth cast to approximately 60m off bottom. Decided not to go deeper as altimeter not functioning and pinger trace extremely noisy. Primary conductivity and temperature traces show a large amount of noise.

Action: All connectors on underwater unit and BOB pulled and cleaned, re-greased and re-seated. Optical instruments cleaned. Pinger batteries replaced.

CAST 2
Station 15773#2 Cast 002 46º 00.05'S 056º 50.30'E 4204m (corrected)

Full depth cast to approximately 10m off bottom. Cast conducted in marginal sea condition and a number of modulo errors (8) were recorded for data transmission, suspect this resulted from transient loading on sea cable. A large spike occurred around 3500m on downcast, which froze calculated salinity values on display though conductivity and temperature remained normal. Primary temperature and conductivity sensors noisy on upcast.

Action: Exchanged primary T/C sensors for new pair (04C s/n 3153 and 03p s/n 4383) and new cables. Configuration file modified accordingly and saved as D300_0528_02m.con

CAST 3
Station 15773#15 Cast 003 45º53'05"S 056º22'44"E 4189m (corrected)

Full depth cast begun at 0811GMT. At 265 metres the clam system reset itself to zero. The system was rebooted and the instrument package bought back to the surface to re-zero the counter. Downcast recommenced at 0911GMT and the same problem occurred at the same depth. It was noted that hauling back through 265m brought back the clam numerical display and veering through it set the readout back to zero and then started the metering count again. Downcast suspended at this point and ships engineers consulted. The package was brought back to the surface and the winch system rebooted. Downcast recommenced at 1021GMT and instrument package passes 265m with no evidence of the previous problem, downcast continued. Engineers report PLC software problem and there is no apparent with mechanical hardware.
Transmissometer and BBRTD register zero volts for entire cast, voltage channel 5 reads a constant 4V.

Action: Transmissometer and BBRTD removed from frame and tested on the bench.
Transmissometer results; V_{air} = 3.778V, V_{blank}= 0.017V
BBRTD results; V_{air}= 0.089V*, V_{blank}= 4.948V
It is concluded that these instruments are functioning correctly. They were then retested back on the frame but on different input channels (V2 and V4) and function correctly. In the V6/V7 position as originally set up instruments are powered but have no return signal connectivity. Cable between V6/V7 on BOB and SBE 911+ underwater unit replaced, instruments put back to original configuration and function well on deck.

CAST 4
Station 15773#40 Cast 004 45º 45.7'S 056º 25.1'E 4122m (corrected)

Full depth cast carrying 2 x RCM11 and 1 x Aquadopp current meters for temperature and conductivity calibration against Sea Bird sensors. Cast proceeds well until 200m off bottom at which point the oxygen trace displays a sudden drop and becomes quite variable, this continues for the rest of the cast, primary T and C also become noisy at this point. It is subsequently discovered, on recovery, that the hose between the pump and the O_2 sensor has come off which means the instruments were reading unpumped values from the moment this occurred. Heading data recovered from the Aquadopp (at 1 minute intervals) indicate the instrument package is revolving, this is confirmed from the LADCP heading data. On this cast the spinning begins just prior to the loss of O2 data integrity and it is supposed that this, the spinning, lead to the disconnection of the pump hose#.

* Test conducted in darkened room as this instrument is sensitive to AC lighting at 50/60 Hz.
# Further investigation indicated that this package was spinning on other casts at what seem random intervals. In theory this package should have a fin to prevent this but was not supplied by NMFD at the time and there were no materials on board to fabricate one.

Action: O2 to pump tubing reattached with new cable ties.

CAST 5
Station 15775#7 Cast 005 49º 03.43'S 051º 17.41'E 4199m (corrected)

Full depth cast carrying 3 x RCM11 current meters for calibrations similar to previous cast. Oxygen becomes variable around 1000m on downcast (pipe from pump to sensor had come off again). Examination of real time data indicated a correlation between O_2 noise and BBRTD spikes, the latter occurring immediately before the former. It is decided to remove the BBRTD for the next cast to see if this improves the O_2 signal

Action: Old cable ties on O_2 to pump hose removed and hose softened in hot water prior to re-fixing with new cable ties in the hope that this will allow more compression to be applied (the operating area is relatively cold and may have led to stiffening of the pipe). Further ties used to prevent any further pipe flexing.

CAST 6
Station 15775#14 Cast 006 49º10'46"S 051º10'43"E 4231m (corrected)

Full depth cast. BBRTD removed for this cast. Sea conditions marginal with periodic large swell but deployment and recovery proceed with out any difficulties. The removal of the BBRTD seems to have settled O2 output for the downcast thought noise increases on the upcast in association with increases in 2º-1º temperature and conductivity differences. Above 300m this sharply increases making all readings of O2, and 1º T/C suspect from there on.

CAST 7
Station 15775#28 Cast 007 49º04'35"S 051º13'32"E 4201m (corrected)

Cast to 2000m with 3 x RCM11 and 2 x RCM8 current meters for temperature and conductivity cell calibration. Originally planned as a shallow cast but later decided to take it to the full range of the low pressure RCM8 pressure sensor for a complete record. No specific issues to report.

CAST 8
Station 15775#34 Cast 008 49º 01.93'S 051º 13.96'E 4147m (corrected)

Full depth cast to approximately 20m off bottom, accompanying the instrument package was an AR861 (s/n 262) for release test at depth. BBRTD s/n 168 was replaced with s/n 169 though no modification of *.con file as raw voltage only being logged. LADCPs started on deck well before cast began and, on deployment, the CTD package was stopped at the surface and brought back on board when the wire came off one of the gantry sheaves. The cast log was terminated while the problem was fixed then restarted under the same deployment identification number.
Oxygen was very noisy on this cast and 2º-1º temperature and conductivity variation was relatively large at times. Transmissometer indicated a number of large spikes, however

the BBRTD was much more settled with only relatively few base line shifts. Oxygen measurements finally settle around 2500m on downcast.

Action: SBE43 Oxygen sensor s/n 0621 replaced with s/n 0862. Configuration file altered accordingly.

CAST 9
Station 15576#1 Cast 009 46º29'57"S 051º55'01"E 369m (uncorrected)

Full depth cast to approximately 20m off bottom. 1º T/C trace very noisy. On downcast the noise appeared to 'jump' between temperature and conductivity traces with a saw tooth pattern showing alternately on one or the other while the other resumed a smooth trace. On the upcast primary conductivity displayed an uncharacteristic hysteresis while the temperature settled down and tracked nicely.

CAST 10
Station 15777#1 Cast 010 46º22'50"S 051º49'47"E 67m (uncorrected)

Cast to 50m, inshore off Isle de la Possession. Several bottles (6) were removed from the rosette to provide space for 2 SAPs (s/n 02 and 05), leaving 5 bottles for water collection. The CTD package was stopped at the chlorophyll maximum on the upcast for the SAPS pumping cycle of 1 hour and 30 minutes. This was the final CTD cast for the cruise.

13.1.3 Summary
On almost all casts, the quality of the data obtained from the primary temperature and conductivity sensors must be questioned. These channels showed a large amount of noise compared to the secondary set of sensors. Data obtained from the bottle samples for conductivity show the secondary conductivity sensor to be much more reliable. Quite what the cause of the problem was, was not determined on this cruise and despite regular cleaning and re-greasing of connectors it is possible that there was a small amount of water ingress into the JT1 connector on the 9+ underwater unit (1º conductivity) as suggested by minor corrosion on one pin of this connector when the CTD package was dismantled. In so saying, however, the corrosion was extremely minor and not consistent with water persistently in the connector, which would have been expected to produce a much greater amount of corrosion than was observed. Other factors were observed which on balance indicate a more systemic issue within the body of the underwater unit. These include the fact that the problem persisted even after the primary conductivity and temperature sensors were changed for a new set, that there seemed to be some correlation between the noise observed on these and the oxygen sensor (which, again, when exchanged continued to exhibit the same symptoms of poor quality data) and a correlation between the performance of the BBRTD and the oxygen sensor. Finally the pattern of noise on 1º sensors when observed under the microscope of a shallow cast and concomitant expanded depth scale (cast 010) indicates that the noise appeared to switch between the conductivity and temperature sensor so that when it appeared on one channel it was absent from the other and vice versa. For this set of data it is recommended that only the 2º sensor data is used.

One other issue that was discovered while examining the heading data from the LADCPs was that the entire CTD package was spinning for significant periods on almost all casts. This will increase the complexity of extracting current profiles from the LADCP data and, physically, caused problems in keeping the hose between the pump and the oxygen sensor attached (this is speculative but on a number of occasions loss of oxygen data quality coincided with periods of maximum spin or the onset of spin). At one stage it was proposed to attach a stabilising fin to the package to lower the incidence or magnitude of the spin but unfortunately there were no materials to manufacture such an attachment on board. It is difficult to determine the exact cause of the spin, which was most often clockwise (as viewed from above), but it may indicate some imbalance in the tensioning of the cable back in the winch room or a current induced turning moment as the package encountered differently moving water masses in the course of a cast.

13.2 Lowered Acoustic Doppler Current Profilers

The CTD package carried two RDI Workhorse 300kHz ADCP configured to work in concert with each other in the lowered mode. This method uses one (the Master) to provide time synchronisation of acoustic pulses to the other (the Slave). Data sets obtained from either the master, or slave, are identified by a 'M' or 's' suffix on the data file and associated log file (see ~\D300\Data\LADCP\LADCP_down, or~\LADCP_up, for data). Command scripts used for the deployment of these instruments can be found in ~\D300\Data\LADCP\Command Scripts and differ subtly depending on whether one is the master or the slave. In general terms, however, the units were operated with 16 bins of 10m each and a blanking distance of 15.25m, giving each a range of 175.25m in optimum conditions and an average ensemble interval of approximately 2 seconds. A typical command script for master and slave units was:

MASTER
CR1
CF11101
EA00000
EB00000
ED00000
ES35
EX11111
EZ0111111
TE00:00:01.00
TP00:01.00
LD111100000
LF0500
LN016
LP00001
LS1000
LV250
LJ1
LW1
LZ30,220
SM1
SA001
SW05000
CK
CS

SLAVE
CR1
CF11101
EA00000
EB00000
ED00000
ES35
EX11111
EZ0111111
TE00:00:01.00
TP00:01.00
LD111100000
LF0500
LN016
LP00001
LS1000
LV250

LJ1
LW1
LZ30,220
SM2
SA001
ST0
CK
CS

13.3 Stand alone pumps system (SAPS)

Cast Log

Cast No.	Day	Latitude	Longitude	SAP 03-	SAP Depth	Pump time	Volume pumped	Purpose
001	342	44º 28.81' S	050º 00.2'E	02	55m	1 hr	Nil	
001	342	44º 28.81' S	050º 00.2'E	06	130m	1.5hr	10L	Fe
002	342	44º 28.81' S	050º 00.2'E	05	55m	1 hr	430L	Archaeo bacteria
003	345	46º 00'S	056º 15'E	05	80m	0.6hr	446L	Lipids
003	345	46º 00'S	056º 15'E	02	80m	0.6hr	2463L	
004	345	46º 00'S	056º 15'E	02	140m	1.5hr	2169L	Fe
005	348	45º 54.5'S	056º 24.7'E	05	80m	1.5hr	2284L	Lipids
005	348	45º 54.5'S	056º 24.7'E	02	45m	2hr	231L	
006	351	45º 55'S	056º 30'E	06	4125m	2hr	86L	Fe
006	351	45º 55'S	056º 30'E	02	4125m	2hr	2138L	
006	351	45º 55'S	056º 30'E	05	4125m	2hr	1403L	Fluff Lipids
007	358	45º 55.9'S	056º 24.9'E	05	80m	1.5hr	267L	
007	358	45º 55.9'S	056º 24.9'E	02	100m	1.5hr	2278L	Fe
008	362	49º 03.6'S	051º 16.3'E	02	100m	1.5hr	2339L	Fe
008	362	49º 03.6'S	051º 16.3'E	05	60m	0.6hr	513L	Lipids
009	362	49º 04.4'S	051º 14.9'E	02	60m	0.6hr	428L	
010	364	49º 11.3'S	051º 04.5'E	05	4200m	2hr	1469L	Fluff Lipids
010	364	49º 11.3'S	051º 04.5'E	02	4200m	2hr	1517L	
011	004	49º 06.3'S	051º 12.5'E	05	50m	1.5hr	798L	Lipids
011	004	49º 06.3'S	051º 12.5'E	02	110m	1.5hr	2359L	Fe
012	006	46º 29.9'S	051º 55'E	05	70m	1.5hr	2434L	
012	006	46º 29.9'S	051º 55'E	02	345m	1.5hr	2313L	Fe
013	006	46º 22.8'S	051º 49.8'E	02	30m	1hr	601L	Lipids
013	006	46º 22.8'S	051º 49.8'E	05	30m	1hr	1647L	Fe

Table 13.1: SAPS deployment log

As shown Table 13.1 SAPS sampling did not get off to a good start. The first deployment yielded poor volumes on all units and post-deployment investigation indicated that on two units (03-02, 03-05), the impellor housing had been over-torqued and was impeding impellor motion. The housings were relieved and the units subsequently tested successfully under test conditions in a barrel of water on deck. The third unit (03-06) was found to have a defective power regulating FET on the power supply board. Under load this switched power off to the motor. The power regulator was swapped for an equivalent provided by another member of the scientific party but the problem persisted. It appeared that the logic circuit was providing the cut-out. When this low voltage cut out occurs, the counter on the timer board stops counting down and so it remains somewhat mysterious that on deployments where low or zero volumes were pumped the counter had returned to zero indicating an uninterrupted timer cycle. It was decided to discontinue use of this unit after a further unsuccessful deployment (cast 006).

Two SAPS casts (006 and 010) were conducted to full water depth with the units being held approximately 15m above the bottom for a pumping period of 2hrs. These were undertaken using the coring warp. On cast 6, while being held at full depth, the winches power control panel burnt out with a resulting loss of control over the sampler's height over the substrate. By judicial use of ship speed and heading, in conjunction with a fortuitously flat bottom, the required distance of 10 to 15 metres from the bottom was maintained for the duration of most of the cast. On regaining winch control the package was raised to 60m as a safety margin in case control was again lost and the last few minutes of pumping time were completed at this depth.

The final SAPS deployment (013) was conducted on the CTD frame. Three bottles from opposite sides of the rosette were removed and the SAPS were mounted using specialised fittings designed to utilise the same fixtures as the niskin bottles. This deployment method proved successful though the package was veered and hauled at half the normal CTD rates (30m/min) to avoid placing too much strain of the SAPS filter housing and frame fixtures given the extra surface area presented to the waters path over the entire package.

13.4 Surface and underway sampling

Manufacturer	Sensor	Serial no	Comments
FSI	OTM temperature	1370	HOUSING, calibration held internally in sensor
FSI	OTM temperature	1360	REMOTE, calibration held internally in sensor
Wetlabs	fluorometer	246	
Seatech	transmissometer	112R	
Vaisala	Barometer PTB100A	Z4740021	
Vaisala	Temp/humidity HMP44L	U1420016	
SKYE	PAR	28558	port
SKYE	PAR	28557	stb
Kipp and Zonen	TIR CMB6	07462	port

Kipp and Zonen	TIR CMB6	07463	stb
Sensors without cal			
FSI	OCM conductivity	1376	Original manufactures calibration.
Vaisala	Sensor collector QLI		
Vaisala	Anemometer WAA		
Vaisala	Wind vane WAV		
Rhopoint	+/- 5v		
Rhopoint	+/- 5v		

Table 13.2 System and Sensor configuration

No sensor changes were made during the course of the cruise and the underway surface sampling system operated in a trouble free manner. Samples for conductivity and salinity calibration were taken on a regular basis while the vessel was underway. Samples were periodically taken and processed by Hugh Venables, and the calculated salinity compared to measurement values as an ongoing check on instrument performance. A summary of these results can be found in the subdirectory ~D300\Data\Surfmet\tsgbot3002calpos.txt

14. Stand Alone Pump System and CTD – suspended particulate matter

Hélène Planquette – NOCS
Frédéric Chaillan – University of Liverpool

14.1 Particulate iron

Suspended matter in open ocean waters varies from as little as 0.5 μg L^{-1} to as much as 1000 μg L^{-1} (Eggiman et al. 1976). The greatest portion of ocean waters, however, is characterized by a suspended particle load less than 20 μg L^{-1}. There are some estimates from the Southern Ocean: Tovar-Sanchez (2003) reported 0.05 μg L^{-1} (47 ºS 145ºE), while Price and Morel (1998) found 0.031 μg L^{-1} in the HNLC waters of the NE subarctic Pacific.

Iron is important for marine biota, particularly in HNLC regions, and its presence in suspended particulate matter (SPM hereafter) affects its biogeochemical cycling.
There are numerous carrier phases and types of associations possible between trace elements and SPM. A large fraction of suspended material consists of organic compounds; the remainder is composed mostly of alumino-silicates, quartz, carbonates, and amorphous silica (Eggiman et al. 1976). More specifically, there are two different pools of Fe associated with plankton and other suspended marine particles.

a. Scavenged Fe adsorbed to particulate surfaces, such as:

- fine grained materials, terrigenous material which is supplied through the atmosphere as airborne dusts and by rivers as suspended matter (mainly clays), iron-manganese oxides.
- Biogenic materials, such as calcium carbonates, opal and organic matter which are formed by phytoplankton in overlying surface water. The contents of Fe in this

pool is originally low because of the low iron concentration itself in the surface waters

b. The other pool corresponds to the intracellular "biological" fraction that comprises the cellular Fe quota (Hutchins, 1995). This pool is essential to understand the specific growth rate of phytoplankton as it is correlated with intracellular Fe content (Sunda et al. 1991; Sunda et Hunstmann 1995, 1997).

The majority of trace element analytical procedures require the sample to be in solution form. There is no universal dissolution procedure for every type of sample. Ideally, such a procedure should:

- Be able to dissolve the sample completely, without any insoluble residue.
- Exclude any possible source of sample loss through volatility, and adsorption onto the wall of the vessel.
- Avoid sample contamination from the reagents used in the dissolution process.
- Be reasonably quick and safe.

14.1.1. Sample Collection

The aim was to collect particles sinking from the biologically productive mixed layer of the water column in order to measure C and Fe export from the upper ocean. An integrated flux of Fe from the upper ocean can then be calculated. The depth at which the SAPS were deployed was determined at each site by making a CTD cast was prior to the deployment of SAPS. Peter Keen and James Cooper (UKORS) operated these instruments. Samples were taken for nutrients and chlorophyll (see Table 14.1). Nutrients will be analysed at NOCS. The parameters used to determine the deployment depth were water temperature, fluorescence and transmission. We aimed to place the SAPS at a depth that would collect sinking particles falling out of the biologically productive surface layers of the water column. Therefore, SAPS were deployed below the thermal mixed layer, *i.e.* below the chlorophyll maximum and below the point of increasing transmission corresponding to decreasing chlorophyll concentrations. We then applied a 20 m margin of error below these features.

Station No.	Sampling depth	Chorophyll a	Nutrients	Station No.	Sampling depth	Chorophyll a	Nutrients
15772#4	2892		x	15773#15	4175		x
	1800		x		2500		x
	1000		x		130	x	x
	130	x	x		80	x	x
	80	x	x		60	x	x
	60	x	x		45	x	x
	45	x	x		25	x	x
	30	x	x		8	x	x
	15	x	x				
15773#2	4211		x	15773#40	4178		x
	2500		x		4000		x
	1500		x		3560		x
	500		x		3000		x

	130	x	x		2100		x
	80	x	x		1800		x
	60	x	x		1200		x
	45	x	x		80	x	x
	30	x	x		25	x	x
	15	x	x				
15775#7	4175		x	15775#14	4210		x
	2500		x		2500		x
	1500		x		130	x	x
	500		x		60	x	x
	130	x	x		45	x	x
	80	x	x		30	x	x
	60	x	x		15	x	x
	45	x	x				
	30	x	x				
	15	x	x				
15775#28	2000		x	15775#34	4180		x
	1500		x		4000		x
	1000		x		3500		x
	750		x		3000		x
	500		x		2500		x
	300		x		2000		x
	130	x	x		1500		x
	100	x	x		1000		x
	80	x	x		500		x
	40	x	x		150	x	x
	20	x	x		70	x	x
15776#1	345		x	15777#1	50	x	x
	300		x		30	x	x
	250		x				
	180		x				
	150		x				
	120	x	x				
	90	x	x				
	70	x	x				
	40	x	x				
	30	x	x				
	10	x	x				

Table 14.1: CTD casts for chlorophyll *a* and nutrients.

In total, 8 deployments of SAPS were made at depths ranging from 30 to 4125m (see Table 14.2). SAPS were set to pump for 90 minutes except at one station where the biomass had a high concentration (sample was taken at chlorophyll maximum) and a 60 minute pump time was chosen (D300, station BUS). A typical volume of ~2000 L was filtered for each deployment at depths that avoided any potential source of shipboard contamination.

Trace metal clean handling techniques were used throughout the preparation of the filters, and also for deployment and recovery of the pumps. The filter used in the SAPS was a 52 μm nylon mesh monofilament screen chosen because particles above this pore size are considered to be the sinking fraction and therefore exporting carbon. Each filter was acid

washed in 10% HCl solution, pre-weighed and stored in double plastic bags. Before each deployment, Teflon filter holders were soaked in 10% Micro solution for 2 to 3 days depending of the frequency of the stations during the cruise. Just before deployment, they were rinsed with freshly taken Milli-Q. The filter housing was kept covered with a plastic bag until immediately prior to the deployment.

On recovery, excess water in the housing was drawn off under vacuum in a flow laminar hood. Any macroscopic zooplankton caught on the filter were removed and placed in vials, and then the filter was immediately put in a freezer at –20°C, together with the sample of swimmers, in order to avoid any physical or chemical changes.

Julian Day	Day	Depth (m)	Pumping time (min)	Volume filtered (L)	Comments
342	342	130	90	16	failed
345	345	140	90	2169	
348	351	4125	90	10	failed
351	358	100	90	2278	
358	362	100	90	2339	
362	4	110	90	2359	
004	6	345	90	2313	South Islands
006	6	75	90	2434	South Islands
006	6	30	60	1647	BUS

Table 14.2: SAPS deployments during D300

14.1.2 SAPS For 'Proxy Calibration' Study

Rachel Mills (SOC) and Richard Pancost (University of Bristol) requested that suspended particulate material be collected from the upper water column as a part of their proxy calibration study. The aim was therefore to collect particles at the chlorophyll maximum.

The depth at which the SAPS were deployed was determined on a case-by-case basis. Parameters we used to determine this depth were water temperature, fluorescence and transmission. In total, 2 deployments were made at deployment depths 60 and 80m (see Table 1). SAPS were set to pump for 60 minutes and typically filtered ~500 litres.

Station #	Date (Julian day)	Name	Depth (m)	Volume filtered (L)
	345		80	346
	362		60	513

Table 14.3. SAPS Deployments for Rachel Mills.

The filter put in the SAPS for Richard Pancost consisted of two 293 mm diameter ashed GF/F filters, foiled in pairs (refer to 14.2). Two stacked GF/F filters were used to give greater structural strength to the filters and represent a nominal pore-size of 0.7 μm. They were placed on to the filter plate carefully with tweezers rinsed in methanol. The filter for Rachel Mills consisted in a 1 μm Nucleopore Filter, placed in the SAPS filter holder under a laminar flow hood.

Immediately after recovery of the SAPS pumps, excess water in the housing was drawn off under vacuum in laminar a flow hood, then the filters for Rachel Mills were immediately rinsed with Milli-Q water to remove the sea-salts. The filters were stored in a –20°C freezer. As anticipated, there was a significant variability in the amount of material collected, reflecting the variable biomass at each station sampled.

Fig. 14.1. Day 345, left: Nucleopore filter, right: GF/F filter.

The Nucleopore filters proved to be very difficult to handle, especially in a laminar flow hood, and were often found dislodged after filtration. It is recommended that during any future deployments the Nucleopore filters are supported on a matrix such as Nitex screen.

14.2 SAPS for lipid analysis – Frédèric Chaillan, University of Liverpool.

SAPS samples were collected in order to determine the lipid composition of organic matter of suspended POM in the water column. Samples were collected in the upper mixed layer (see sections 13.3 and 14.1), in order to assess potential source material (phytoplankton). Additionally, bottom water material was collected in order to capture "phytodetritus" which was evident on the sea floor and in the water column (See Sections 6 and 9), but which was not effectively sampled by sediment coring. Two clean GFF filters (22cm; 400°C; 24 h) were used in each drop. Following deployment, they were packed in aluminium foil and stored in -80°C. On return to Liverpool, the filters will be split 50:50, with samples being retained in Liverpool for lipid analysis and those for archael ether lipid analysis being sent to the University of Bristol (Dr R. Pancost). For details of the deployments, see Section 13.

15. Underway Sampling

Hélène Planquette, Hugh Venables, William Homoky

During D300, about 160 underway samples were taken for salinity, nutrients, chlorophyll *a* and iron whilst steaming, using the clean towed fish system and the non toxic supply.

15.1 Dissolved iron

The main objectives of the work are:

a) To map changes in total dissolved Fe around the Crozet islands in relation to other key parameters including macronutrients, chlorophyll and salinity, in order to better understand the role of Fe in initiating and maintaining the bloom.
b) To determine the vertical flux of particulate Fe at key stations around the islands in order to understand the processes affecting the Fe cycle.

The intention was to collect surface samples using the clean fish system (see below) and to use the SAPS for the particulate iron analysis (see this section in the cruise report).

15.1.1 The Fe analyser system.

The system is based on pre-concentration of Fe (III) and Fe (II) from seawater onto an NTA column, which is then subsequently eluted and mixed with a buffered ammonium acetate stream in the presence of hydrogen peroxide. The chemistry is carried out in a continuous flow system. The solution is passing through a spectrophotometer cell, and the absorbance at 514 nm is measured. The absorbance is directly related to the Fe in the original sample. Control of the flow system and data collection is done through a LabView programme, and NI DAQ and control cards.

The system had performed well at NOC immediately before D300 in analysing samples collected on the last Crozex cruises.

15.1.2 Samples collected for Fe analysis using the TMS Fish System

In all, 160 surface samples were collected during the cruise in order to provide a broad range of samples across the region of interest. About 35 samples were taken through the islands, note that they are not represented on the map below.

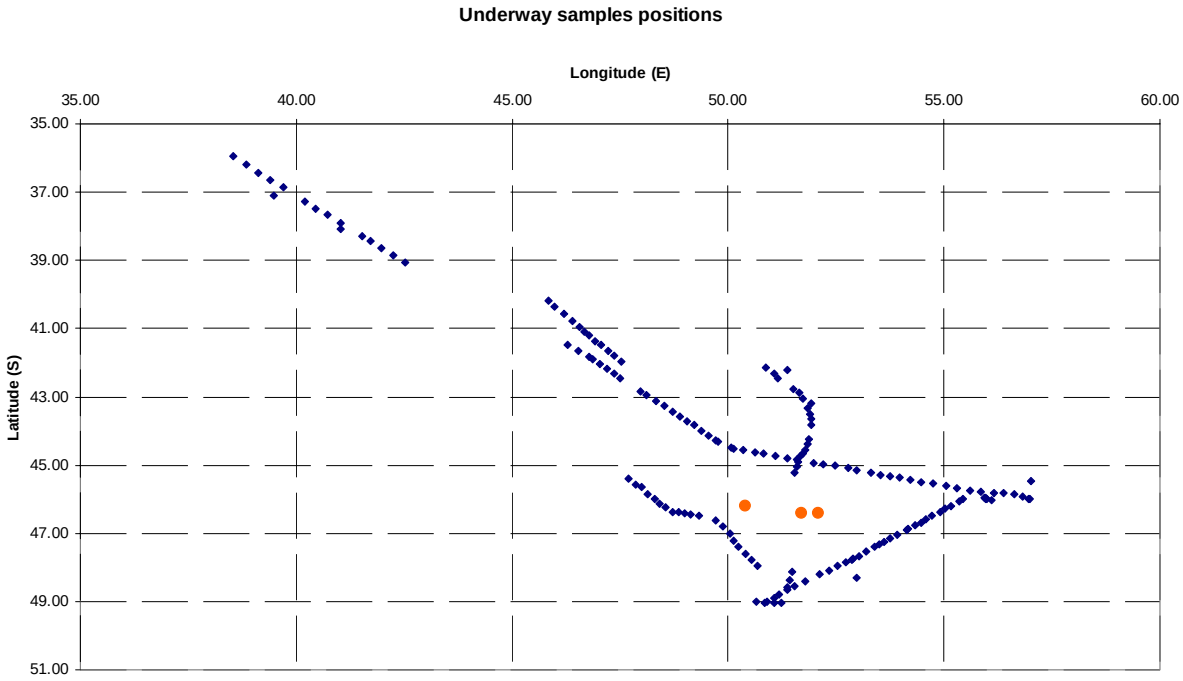


Figure 15.1. Positions of surface sampling sites

However, further problems were encountered with the fish. Three attempts were necessary to keep the fish at correct distance from the ship. It was successfully redesigned by Alan Sherring (UKORS). For details, see 15.1.2.2. Samples for dissolved iron analysis are usually acidified prior to storage and measurements to avoid any reactions due to the biology. This as done on the basis of 10 µL per 10 mL.

15.1.2.1 Clean container laboratory. Overall the container lab worked well, despite few episodes of when the Milli-Q reservoir leaked! It provided a high quality environment for the taxing trace metal work being undertaken in CROZEX.

15.1.2.2 Underway clean Fish sampling system. During the cruise one major mechanical problem was encountered with the fish operation. We first tried the fish on the 3rd of December, but it appeared that it was getting too close to the ship. On the 4th, Alan Sherring designed and attached a "wing" to redirect and maintain the fish away from the ship: it worked well. However, at speeds of > 5 knots, the fish was "flying" and jumping over the water. Once again, Alan fixed the problem by adding two more wings at the rear of the fish and more weight underneath it. It then worked perfectly at full speed. We then flushed the all tubing with 5% HCl, and left it overnight. The fish stopped pumping during the night of the 6th of January. The fish was brought back immediately on deck. The problem was identified as being one break in the tube system close to the fish itself. The tubing had to be completely removed and refitted. Once the tubing had been refitted, the fish system worked correctly.

Overall the fish system worked well considering the frequently rough weather encountered, in providing a pulsed stream of clean water at a flow rate of about 5L min^{-1}. None of the samples seem to be contaminated.

15.2 Nutrients and Chlorophyll a

Nutrients samples were taken every hour whilst steaming, in clean Sterilin tubes. They were kept frozen at -20°C and will be analyzed back to NOCS by Mark Stinchcombe. Chlorophyll a samples were analyzed on board, please refer to Table 15.1 for the values.

Underway Chlorophyll measurements D300

Sample ID	Sample ID	Latitude (°S)	Value (ng/mL)	Sample ID	Latitude (°S)	Longitude (°E)	Value (ng/mL)
U001	35.95	38.53	3.3949	U028	43.280	48.520	5.65151
U002	36.19	38.84	3.07538	U029	43.450	48.720	7.40887
U003	36.43	39.13	2.93559	U030	43.590	48.890	5.37193
U004	36.64	39.40	2.77583	U031	43.730	49.050	4.81277
U005	36.860	39.690	0.61907	U032	43.820	49.220	7.44881
U006	37.090	39.470	2.07688	U033	44.000	49.380	5.51172
U007	37.270	40.200	1.97703	U034	44.150	49.560	22.5661
U008	37.470	40.460	2.11682	U035	44.320	49.770	7.46878
U009	37.670	40.730	2.85571	U036	44.290	49.720	3.03544
U010	37.900	41.020	4.13379	U037	44.500	50.070	56.77471
U011	38.070	41.024	5.17223	U038	44.510	50.120	94.01876
U012	38.280	41.520	3.23514	U039	44.570	50.350	40.75877
U013	38.440	41.720	3.11532	U040	44.640	50.620	5.77133
U014	38.640	41.980	3.05541	U041	44.680	50.820	3.63454
U015	38.840	42.240	3.5946	U042	44.750	51.100	7.5886
U016	39.050	42.520	8.72689	U043	44.810	51.380	80.09967
U017	41.470	46.290	24.44328	U044	44.850	51.580	29.5556
U018	41.640	46.540	6.11082	U045	44.940	51.970	26.91956
U019	41.820	46.770	14.51819	U046	44.970	52.200	191.05299
U020	41.900	46.860	12.5811	U047	45.030	52.470	0.77883
U021	42.040	47.030	12.10182	U048	45.100	52.780	28.09779
U022	42.190	47.200	9.20617	U049	45.150	52.980	118.84147
U023	42.320	47.360	8.22764	U050	45.220	53.310	13.63951
U024	42.440	47.500	5.61157	U051	45.280	53.540	11.74236
U025	42.830	47.960	11.32299	U052	45.320	53.740	123.59433
U026	42.960	48.110	14.19867				
Sample ID	Latitude (°S)	Longitude (°E)	Value (ng/mL)	Sample ID	Latitude (°S)	Longitude (°E)	Value (ng/mL)
U053	45.380	53.980	16.1757	U102	48.900	51.080	9.56563
U054	45.430	54.230	14.1787	U103	49.000	50.910	11.3829
U055	45.490	54.470	14.33846	U104	49.010	50.660	11.36293
U056	45.550	54.750	15.95603	U105	49.050	50.860	2.9955
U057	45.620	55.050	4.29355	U106	49.050	51.080	8.86668
U058	45.680	55.300	8.70692	U107	49.030	51.240	13.61954
U059	45.740	55.590	7.74836	U108	48.570	51.370	12.36143

U060	45.800	55.860	6.03094	U109	48.370	51.420	14.95753
U061	45.830	56.160	11.32299	U110	48.140	51.480	10.10482
U062	45.830	56.380	13.3799	U111	47.970	51.530	3.67448
U063	45.840	56.630	12.3814	U112	47.790	51.580	5.15226
U064	45.920	56.820	7.5886	U113	47.600	51.630	5.11232
U065	45.480	57.010	5.11232	U114	47.400	51.680	13.83921
U066	45.980	56.980	6.03094	U115	47.220	51.730	12.90062
U067	45.980	56.950	6.43034	U116	47.010	51.780	12.7808
U068	46.030	56.100	15.49672	U117	46.800	51.840	11.50272
U069	45.990	55.980	10.14476	U118	46.640	51.880	14.99747
U070	45.980	55.960	9.32599	U119	46.500	51.920	22.94553
U071	45.970	55.950	9.66548	U120	46.460	51.920	10.26458
U072	45.960	55.940	9.44581	U121	46.410	51.900	22.70589
U073	46.010	55.450	10.66398	U122	46.380	51.850	31.59254
U074	46.070	55.350	9.16623	U123	46.390	51.920	2.05691
U075	46.200	55.150	9.5856	U124	46.240	51.740	11.54266
U076	46.280	55.030	8.9865	U125	46.140	51.640	11.08335
U077	46.380	54.900	9.3859	U126	46.010	51.510	20.10979
U078	46.490	54.730	8.9865	U127	45.870	51.360	17.87315
U079	46.590	54.590	10.06488	U128	45.650	51.140	29.85515
U080	46.680	54.460	10.42434	U129	45.580	51.070	3.95406
U081	46.770	54.330	10.74386	U130	45.390	50.880	13.83921
U082	46.880	54.170	10.00497	U131	45.210	50.670	10.66398
U083	46.890	54.150	10.36443	U132	45.060	50.550	13.3799
U084	47.060	53.910	9.88515	U133	44.910	50.390	14.05888
U085	47.160	53.760	10.76383	U134	44.750	50.240	12.5811
U086	47.260	53.620	5.01247	U135	44.660	50.120	12.86068
U087	47.330	53.510	9.30602	U136	44.560	50.050	14.43831
U088	47.410	53.390	9.74536	U137	44.400	49.880	10.02494
U089	47.530	53.210	9.06638	U138	44.230	49.720	10.86368
U090	47.660	53.020	9.04641	U139	43.830	49.320	lost
U091	47.750	52.880	9.06638	U140	43.650	49.140	3.91412
U092	47.780	52.860	9.46578	U141	43.500	48.990	10.92359
U093	47.860	52.730	9.40587	U142	43.340	48.850	11.82224
U094	47.970	52.520	7.86818	U143	43.210	48.710	12.24161
U095	48.080	52.330	9.14626	U144	43.040	48.550	11.26308
U096	48.200	52.120	9.68545	U145	42.890	48.400	10.48425
U097	48.290	52.970	9.14626	U146	42.780	48.290	9.82524
U098	48.400	51.780	8.50722	U147	42.200	48.140	9.32599
U099	48.550	51.540	9.20617	U148	42.460	47.990	10.82374
U100	48.650	51.360	11.16323	U149	42.320	47.850	25.90109
U150	42.150	47.700	2.33649				
U151	41.980	47.530	1.67748				
U152	41.800	47.360	8.16773				
U153	41.640	47.210	8.1877				
U154	41.490	47.070	34.88759				
U155	41.370	46.930	31.05335				
U156	41.200	46.790	34.06882				
U157	41.090	46.680	33.98894				
U158	40.950	46.550	41.27799				

U159	**40.780**	**46.390**	40.49916
U160	**40.580**	**46.200**	18.1727
U161	**40.340**	**45.980**	28.53713

Table 15.1 Chlorophyll a values. Day of analysis: yellow on the 25th December, green on the 1st January, blue on the 11th January.

16. CTD Processing and calibration

Hugh Venables NOCS

16.1 Data Processing

Data was copied from the logging computer to the Dell PC (Blackbox) where initial processing with the SBE Data Processing program was carried out. Once the individuals programs were copied to the processing directory, edited to ensure the appropriate variables were processed with appropriate units; the set of scripts were run with a batch file D300Batch.txt:

```
Datcnv /i%1\%2.DAT /c%1\%2.CON /p%1\DatCnv.psu /o%1

Wildedit /i%1\%2.CNV /p%1\WildEdit.psu /o%1

Wildedit /i%1\%2.CNV /p%1\WildEdit.psu /o%1

Alignctd /i%1\%2.CNV /p%1\AlignCTD.psu /o%1

Celltm /i%1\%2.CNV /p%1\CellTM.psu /o%1

Rossum /i%1\%2.ROS /c%1\%2.CON /p%1\RosSum.psu /o%1

Trans /i%1\%2.CNV /p%1\Trans.psu /o%1
```

This was run with the command (with the final n being changed to the CTD cast number). The third part is read as %1 and the fourth as %2 in the above script.

```
sbebatch C:\D300\D300Batch1.txt c:\D300\raw D300_00n
```

This processing read in the raw data (Datcnv), removed the worst spikes (Wildedit), aligned the oxygen variable to account for the timelag (Alignctd), corrects for the thermal anomaly of the temperature censors (Celltm), creates a bottle file (Rossum) and outputs the data as ascii ready to read in to pstar (Trans). The files were renamed to ctdnnnnnhH(H).ext where nnnnn was the station number, H(H) the hash number and ext was cnv and btl. Data was then transferred to discovery2ng with ftp (pushing using windows explorer affects the ascii file). Care has to be taken with the batch script that no output files are saved within the programs called as these take precedence over those defined in the batch script.

The pstar scripts ctdn (n=0,1,2,3) were edited to account for the hash number. The ending hH(H) was added to the main bit of all filenames and the dataname changed to nnnnncH(H) due to the 8 character constraint. This method would fail if the hash number reached 100 but when this happened before, a new station number was used. As we only got to #40 it was fine for this cruise. These were called ctdnh (n=0,1,2,3). ctd1h was further modified to use the secondary temperature and conductivity for calculating sigma and was renamed ctd1h2. Ctd3h was cut down from ctd3 to make sure it worked. As usual, ctd0h was also edited to account for the set of input variables.

The files sam0, sam1 and passam had to be edited in a similar way to add the hash number extension to the filenames and change the data names to nnnnnsH(H) and

nnnnnfH(H) for sam and fir respectively. Variable values in the sam file did not include hash number information which would have been helpful once all files are appended together for calibration. There were problems with sam0h, despite it being the same as the version used on D285. Firstly, the avg$$ file was created with 3 header lines instead of 2 so line 254 had to be changed so the first 3 lines were skipped. Also, the data names and variables did not align. This was sorted by changing line 192 to read in names from the .24hz ctd file starting with time. This is definitely a fudge as it gives two variables called time but it aligns the rest of the variables and was the best that could be done without knowing awk commands. The results of 'diff sam0 sam0h' are given below. These problems were also present when the original sam0 was run (having edited input filenames appropriately).

```
101a102,104
>    echo -n "> Enter hash number: "
>    set hashno = $<
>    set hash = h$hashno
108,109c111,112
<    if (-e fir/fir$cruise$num) then
<      echo "> File fir/fir$cruise$num already exists";exit
---
>    if (-e fir/fir$cruise$num$hash) then
>      echo "> File fir/fir$cruise$num$hash already exists";exit
111,112c114,115
<    if (! -e ctd$cruise$num.btl) then
<      echo "> File ctd$cruise$num.btl does not exist";exit
---
>    if (! -e ctd$cruise$num$hash.btl) then
>      echo "> File ctd$cruise$num$hash.btl does not exist";exit
115,116c118,119
<    if (! -e $P_CTD/ctd$cruise$num$ext) then
<      echo "> File $P_CTD/ctd$cruise$num$ext does not exist";exit
---
>    if (! -e $P_CTD/ctd$cruise$num$hash$ext) then
>      echo(">File $P_CTD/ctd$cruise$num$hash$ext does not exist";exit
118c121
<    set infile = ctd$cruise$num.btl
---
>    set infile = ctd$cruise$num$hash.btl
121c124
<    set ctdin = $P_CTD/ctd$cruise$num$ext
---
>    set ctdin = $P_CTD/ctd$cruise$num$hash$ext
192c195
<   for(i=2;i<=NF;i++) {
---
>   for(i=1;i<=NF;i++) {
```

```
254c257
< pascin -head 2 -dname fir$cruise$nn firfile$$ avgfile$$ << ! >> samexec0.talk
---
> pascin -head 3 -dname $cruise${nn}f$hashno firfile$$ avgfile$$ << ! >> samexec0.talk
270c273
< fir$cruise$nn
---
> $cruise${nn}f$hashno
326c329
< fir/fir$cruise$num
---
> fir/fir$cruise$num$hash
334,335c337,338
< print_datnam fir/fir$cruise$num new
< chmod 444 fir/fir$cruise$num
---
> print_datnam fir/fir$cruise$num$hash new
> chmod 444 fir/fir$cruise$num$hash
354c357
<    echo "> files created:   fir/fir$cruise$num  "
---
>    echo "> files created:   fir/fir$cruise$num$hash  "
```

16.2 Salinity calibration for stainless CTD

There were two pairs of temperature and conductivity sensors on the CTD package. These were assigned arbitrarily to primary and secondary as there was no difference in terms of placement between them. The set of primary sensors (and oxygen, which was with them) often were noisy during casts so the 'secondary' sensors have been used through the processing for calculating sigma. I have therefore only tried to calibrate salin2 and have then compared across between salin and salin2 in good periods. On most stainless CTD casts four to eight calibration samples were drawn, trying to use depths where vertical salinity gradients were weak. Comparisons of bottle values (botsal) with sensor 2 initially suggested that sal2 did not need calibration. After the removal of 3 outliers, the mean of salin2-botsal was 0.0004 with an sd of 0.0039. Plotting the data however showed that there was a consistent 0.002 offset (salin2 greater than botsal) and occasional deviations below this. It was assumed these were due to botsal being too high due to sampling problems and a 0.002 offset was applied to salin2 with the script ctdcalsalh2 (h for hash number, 2 for using secondary sensors to calculate the sigmas). This edited the .1hz and sam files, ctd2h being re-run to recreate .ctu and .2db files. salin2-salin was calculated for all datapoints in the .2db files. There were problems with the reprocessed variables so ctdvar2 and samvar2 were written as ad hoc scripts to remove unwanted variables. Statistics for this are given below, suggesting a 0.12 offset but there are so many periods where salin falls out a calibration has not been applied. A comparison of sections of casts where salin appears good has not been carried out.

Table 16.1 Salinity calibration statistics

Range	no. in sample	outliers omitted	mean	standard deviation
-3-1	15464	0	0.0017	0.0513
0-0.02	11180	4284	0.0110	0.0028
sal1 - sal2	9182	6282	0.0119	0.0008

16.3 Oxygen values from CTD

No samples were taken for calibrating the oxygen sensor due to lack of personnel and equipment but the sensor rarely worked properly and so there would have been little value in calibrating it and little data to go on anyway.

16.4 Fluorimeter calibration

The fluorimeter was not calibrated during the cruise but chlorophyll samples were taken and worked up so it can be done later.

17. Lowered ADCP data

Hugh Venables, NOCS

The 150 kHz LADCP was mounted on the CTD frame and data downloaded to a PC. Due to there not being a proper working copy of Matlab on the ship's computers, the data were processed on a personal laptop and saved onto a Firewire drive. The directory structure was created on the drive to mostly repeat the structure from D285/6 and this is given below. The Visbeck processing scripts were used, with modifications developed on Marine Productivity cruises and updated a little on D285. As the Ocean Surveyor data could not be processed on board due to technical problems the initial runs were done without a surface ADCP constraint. These should be redone if the OS75 data can be processed ashore but, as before, the results of runs without a surface constraint should be retained for comparison (see the D285/6 cruise report for a discussion). Ascii files were created from the CTD data and the navigation stream for the duration of the cast. As with the CTD processing, slight adjustments were needed to the scripts (all originals kept) to account for different deployments with the same station number. doctdasc became doctdhasc and created ascii files containing the CTD data from the 1hz files. donavpro became donavproh and was used to create ascii files from the processed navigation files. donavraw was not used and so the is not a 'hash number' version. A master matlab script was left in ladcp/m and this was edited to create the first script ladnnnnnhH(H).m (where nnnnn is the 5 digit station number and H(H) the one or two digit hash number) but then these were recursively copied, renamed and edited in the matlab editor, using the find and replace function to change the cast numbers quickly. The data were copied to the appropriate directory: withoutSADCP.

On some casts the script getdephti.m fails, on the second loop, to find the bottom despite the first loop successfully identifying a bottom close to that expected from the CTD altimeter or PES depth. In order to make it create a bottom track in these cases the script was modified and renamed getdepthioneloop.m and this was called by laproconeloop.m and the ladnnnnnhH(H).m was modified to call this rather than laproc.m.

17.1 Removal of prompt for type

As on D285/6 only one instrument (300kHz) was used so the prompt for the type of instrument was commented out of the matlab script and set automatically to 'w'. This allowed casts to be run in one batch by listing the names of each script in an m-file and running that.

17.2 Directory structure

/ladcp/m: Location of all matlab scripts and pstar scripts to process ctd, navigation and SADCP data and the place where data and graphs were originally saved to.

/ladcp/m/withoutsadcp: Results without Ocean Surveyor data.

/ladcp/300khz/raw: Location of raw data ftp'ed from LADCP PC. Files renamed from nnnnn000.000 to wnnnnn.000 so they are found by matlab script.

/ladcp/nav: Location of ascii navigation files, put there when donavpro or donavraw run.

/ladcp/ctd: Location of ascii CTD data, put there when doctdasc run.

18. Underway measurements

Hugh Venables NOCS

18.1 Navigation and VM-ADCP

Since the FISHES cruise (D253) in May/June 2001, two RDI Vessel-Mounted Acoustic Doppler Current Profilers (VM-ADCPs) have been in operation on RRS *Discovery*; the narrowband 150kHz VM-ADCP and a 75 kHz Phased Array instrument (Ocean Surveyor). The vast majority of this report duplicates that of Penny Holliday and Helen Johnson for D253.

The 150 kHz ADCP is mounted in the hull 1.75 m to port of the keel, 33 m aft of the bow at the waterline and at an approximate depth of 5 m. The 75 kHz ADCP is also mounted in the hull, but in a second well 4.15 m forward and 2.5 m to starboard of the 150 kHz well.

This section describes the operation and data processing paths for both ADCPs. The navigation data processing is described first since it is key to the accuracy of the ADCP current data.

An expedient trick to create a vector plot is to append all 24 hour files together re-grid to 4 km distrun interval along track using padpav and then select a single depth using pcopyg. On the this cruise, due to problems with pstar, the same result was obtained by selecting a single depth with pcopyg and then using pavrge to average over 4km of distrun. To a considerable extent this quickly avoids the messy separation of "on-station" data.

18.2 Navigation

The ship's best determined position was calculated by the RVS process "bestnav" (10 second averaging period). The main data source for D300 was the GPS Trimble 4000 system. This had been determined to be the most accurate system on a number of preceding cruises, and D300 was no exception. Both of these systems had sufficient precision to enable a calculation of ship's velocities to better than 1 cms^{-1}, and therefore below the instrumental limits of the RDI ADCP systems.
If there were gaps in the GPS4000 data, the bestnav process used other inputs as necessary. These were turned to in the strict preference order, Ashtech G12, GPS Ashtech 3D, GPS Glonass (which uses a combination of Russian and American satellite networks). Or, as a last resort, if no GPS was available the Chernikeef electo-magnetic log velocity data and gyro heading would be used to dead-reckon the ship's position.
Data were transferred every other day from the RVS Level C bestnav stream to the pstar absolute navigation file, abnv3001. The G12, gps-4000, and gyro (gyronmea) data streams were also transferred at the same time. The gps_glos stream not logged.
Scripts:

navexec0: transferred data from the RVS bestnav stream to pstar, calculated the ships velocity, appended onto the absolute (master) navigation file and calculated the distance run from the start of the master file. Output: abnv3001.

gyroexec0: transferred data from the RVS gyronmea stream to pstar, a nominal edit was made for directions between 0-360° before the file was appended to a master file. Output: gyro30001

gp4exec0: transferred data from the RVS gps_4000 stream to pstar, edited out pdop (position dilution of precision) greater than 5 and appended the new file to a master file gps430001.

gpsexec0: this was identical to gp4exec0 but transferred the RVS gps_g12 data stream to pstar to the file gpsg1230001.

18.3 Heading

The ships attitude was determined every second with the ultra short baseline 3D GPS Ashtech ADU2 navigation system. Four antenna, two on the boat deck, two on the bridge top, measured the phase difference between incoming satellite signals from which the ship's heading, pitch and roll were determined. Configuration settings from previous calibrations (Trials cruise in April 2001) were used throughout the cruise, these were:

Adjusted Relative Antenna Positions (m), which require no pitch or roll offset angle.

	X(R)	Y(F)	Z(U)
1-2 Vector	0.000	6.492	0.167
1-3 Vector	-10.162	0.135	-4.337
1-4 Vector	-10.113	6.431	-4.193

The Ashtech data were used to calibrate the gyro heading information as follows:

ashexec0: transferred data from the RVS gps_ash stream to pstar.

ashexec1: merged the ashtech data from ashexec0 with the gyro data from gyroexec0 and calculated the difference in headings (hdg and gyroHdg); ashtech-gyro (a-ghdg).

ashexec2: edited the data from ashexec1 using the following criteria:

heading 0 < hdg < 360 (degrees)

pitch -5 < pitch < 5 (degrees)

roll -7 < roll < 7 (degrees)

attitude flag -0.5 < attf < 0.5

measurement RMS error 0.00001 < mrms < 0.01

baseline RMS error 0.00001 < brms < 0.1

ashtech-gyro heading -7 < a-ghdg < 7 (degrees)

The heading difference (a-ghdg) was then filtered with a running mean based on 5 data cycles and a maximum difference between median and data of 1 degree. The data were then averaged to 2 minutes and further edited for

-2 < pitch <2

0 < mrms < 0.004

The 2 minute averages were merged with the gyro data files to obtain spot gyro values. The ships velocity was calculated from position and time, and converted to speed and

direction. The resulting a-ghdg should be a smoothly varying trace that can be merged with ADCP data to correct the gyro heading. Diagnostic plots were produced to check this. During ship maneuvers, bad weather or around data gaps, there were spikes which were edited out manually (plxyed).

Unfortunately, the data quality was very low with the amplitude of the difference between gyro and ashtech much greater than normal (>10 rather than ≈3 for d298) and many data points were removed in ashexec2 due to the criteria detailed above. This left many periods of at least 15 minutes without any data points and other 2 minute periods only had very few data points to average over. A 'random' difference is expected between ashtech and gyro which goes away due to averaging over many data points but this does not happen due to the few data points, and those that do remain are more noisy than normal due to the greater variation. This means that the .ave files having many missing data values and considerable noise. The extreme spikes were removed with plxyed but the remaining data is suspect. The appended .ave file had 5454 datacycles rather than 26607 which it should have had.

18.4 RDI 150 kHz ADCP

The 150kHz RDI ADCP was logged using RDI Data Acquisition Software (DAS) version 2.48 with profiler firmware 17.20. The instrument was configured to sample over 120 second intervals with 64 bins of 8 m thickness, pulse length 4 m and a blank beyond transmit of 4m. Early in the cruise the ADCP was switched to bottom and water track mode over shallow ground to enable calibration but with the problems with ashtech and pstar early in the cruise this was never done. It is unlikely that a sensible calibration can be done unless ashtech accuracy is recovered. After closely inspecting the data from the two ADCPs without configuring them to synchronise their pings over the ensemble period, it was decided to leave them in this mode as little evidence of interference could be seen. To synchronise the instruments, the 150 kHz instrument has to be set as the "master" and the 75 as the "slave", as recommended by RDI and discussed by Penny Holliday in the D253 cruise report. The result is that each ADCP has only 40 water track pings in the 2 minute period. With no obvious evidence of interference this seemed an unacceptable compromise. Spot gyro heading data were fed into the transducer deck unit where they were incorporated into the individual ping profiles to correct the velocities to earth co-ordinates before being reduced to a 2 minute ensemble.

Following advice from RDI, the 150 KHz ADCP on RRS *Discovery* had been refitted in dry dock, several years ago, to a heading offset of ~45°. This offset was accounted for in the DAS software configuration on D300. On some previous cruises the ADCP PC clock had been synchronised with the ship's master clock, so removing the tedious need for logging the drift of the PC clock and correcting for it in the processing (old adpexec1). Sadly this was not available on D300 and adpexec1 was resurrected.

The ADCP data were logged continually by the level C computer. From there they were transferred every other day to the Pstar data structure and processed using standard processing scripts in Pstar; which are presented below.

Data processing:

adpexec0: transferred data from the RVS level C "adcp" data stream to pstar. The data were split into two; "gridded" depth dependent data were placed into "adp" files while "non-gridded" depth independent data were placed into "bot" files. Velocities were scaled to cm/s and amplitude by 0.42 to db. Nominal edits were made on all the velocity data to remove both bad data and to change the DAS defined absent data value to the pstar value. The depth of each bin was determined from the user supplied information. Output files: adp300##, bot300##

adpexec1: Clock correction applied to both, gridded and non-gridded files. For most of the cruise the PC clock was found to have a steady drift, ≈ 4 seconds per day, so time checks were made every 24 hours and these offset values were used in adpexec1 to create a clock correction file for calibrating adcp time. However at New Year the clock started to drift at an alarming 7 seconds/hour. This was at least consistent so clock corrections are still reliable. Extrapolations forwards and backwards of the two drift rates meet exactly at the year change and an extra time check was created then to reflect this. Output files: adp300##.corr, bot300##.corr

adpexec2: this merged the adcp data (both files) with the ashtech a-ghdg created by ashexec2. The adcp velocities were converted to speed and direction so that the heading correction could be applied and then returned to east and north. Note the renaming and ordering of variables. Output files: adp300##.true, bot300##.true.

adpexec3: applied the misalignment angle, ø, and scaling factor, A, to both adcp files. No calibration was done on this cruise so data from D285 was used as this was the most recent data available, details below. The adcp data were edited to delete all velocities where the percent good variable was 25% or less. Again, variables were renamed and re-ordered to preserve the original raw data. Output Files: adp258##.cal, bot258##.cal.

adpexec4: merged the adcp data (both files) with the bestnav navigation file (abnv2581) created by navexec0. Ship's velocity was calculated from spot positions taken from the abnv3001 file and applied to the adcp velocities: the bestnav averaging is now only 10 seconds, and therefore there is no requirement to take spot values from the raw 1 second GPS4000 dataset which still has the rare spike. The end product is the absolute velocity of the water. The time base of the ADCP profiles was then shifted to the centre of the 2 minute ensemble by subtracting 60 seconds and new positions were taken from abnv3001. Output Files: adp300##.abs, bot300##.abs.

A calibration of the 150 kHz ADCP was achieved on D285 using bottom tracking data available from our departure across the Agulhas Bank. Using long, straight, steady speed sections of standard two minute ensemble profiles we obtained a calibration of $\tan\phi = -0.0039\ (\pm s.d. = 0.0080), \therefore \phi = -0.22°$ and $A = 1.0034\ (\pm s.d. = 0.0064)$.

18.5 Ocean Surveyor 75 kHz ADCP

D253 was the first scientific cruise on which the new RDI Ocean Surveyor 75 kHz Phased Array ADCP was used and thus a new processing path was written. No significant changes were made to this path on D300. The instrument was configured to sample over 120 second intervals with 60 bins of 16m depth, pulse length 16m and a blank beyond transmit of 8m. The instrument is a narrow band phased array ADCP with 76.8 kHz frequency and a 30° beam angle. The PC was running RDI software VmDAS v1.3. What should have happened was that Gyro heading, and GPS Ashtech heading, location and time were fed as NMEA messages into the software which was configured to use the Gyro heading for co-ordinate transformation. Unfortunately the GPS input was not present initially and had to be restarted by the UKORS computer tech. Even after this it still appears that the gyro heading is not being recorded properly as the processing path does not seem to correct from parallel and perpendicular to the ship to E-W and N-S. The software logs the PC clock time, stamps the data (start of each ensemble) with that time, and records the offset of the PC clock from GPS time. This offset was applied to the data in the processing path before merging with navigation. The ADCP was fitted in the forward well as previously noted. It was known to have a heading alignment offset of 60°. Bottom tracking was switched on early in the cruise and at the end of the first leg for calibration purposes.

The 2 minute averaged data were written to the PC hard disk in files with a .STA extension, eg D300005_000000.STA, D300006_00000.STA etc. Sequentially numbered files were created whenever data logging was stopped and re-started. This either occurred once the file size reached 100MB in size or when the logging was manually stopped briefly to work on the settings or to keep the file size down. All files were transferred to the unix directory /data62/os75 and all were brought back so they could be processed ashore. Broadly speaking the new processing path followed the steps outlined for the 150 kHz ADCP. In the following script description, "##" indicates the file number.

In parallel with the 150 KHz ADCP, a calibration of the 75 kHz ADCP might be possible using bottom tracking data available from our passage to Durban or our return across the Agulhas Bank but the problems with the ashtech system may make this impossible.

surexec0: data read into pstar format from RDI binary file (psurvey, new program written on D253 by S. Alderson). Water track velocities were written into "sur" file, bottom track into "sbt" files if in bottom track mode. Velocities were scaled to cm/s and amplitude by 0.45 to db. The time variable was corrected to GPS time by combining the PC clock time and the PC-GPS offset. The depth of each bin was determined from the user supplied information. Output Files: sur300##.raw, sbt300##.raw.

surexec1: data edited according to status flags (flag of 1 indicated bad data). Velocity data replaced with absent data if variable "2+bmbad" was greater than 25% (% of pings where >1 beam bad therefore no velocity computed). Time of

ensemble moved to the end of the ensemble period(120 secs added with pcalib). Output files: sur300##, sbt300##.

surexec2: this merged the adcp data (both files) with the ashtech a-ghdg created by ashexec2. The adcp velocities were converted to speed and direction so that the heading correction could be applied and then returned to east and north. Note the renaming and ordering of variables. Output files: sur300##.true, sbt300##.true.

surexec3: applied the misalignment angle, ø, and scaling factor, A, to both files. Variables were renamed and re-ordered to preserve the original raw data. Output Files: sur300##.cal, sbt300##.cal.

surexec4: merged the adcp data (both files) with the bestnav navigation file (abnv2581) created by navexec0. Ship's velocity was calculated from spot positions taken from the abnv3001 file and applied to the adcp velocities: the bestnav averaging is now only 10 seconds, and therefore there is no requirement to take spot values from the raw 1 second GPS4000 dataset which still has the rare spike. The end product is the absolute velocity of the water. The time base of the ADCP profiles was then shifted to the centre of the 2 minute ensemble by subtracting 60 seconds and new positions were taken from abnv2581. Output Files: sur300##.abs, sbt300##.abs.

It is still noticeable from the real-time display that the 75 kHz depth penetration during steaming suffered very readily with the onset of anything other than calm conditions. It was postulated on D253 that the forward well is more prone to contamination by bubbles than the aft well, and if the 75 kHz ADCP is to become the standard ADCP for Discovery it may be appropriate to move the 75 kHz to the aft well.

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20. Cruise Track Plots

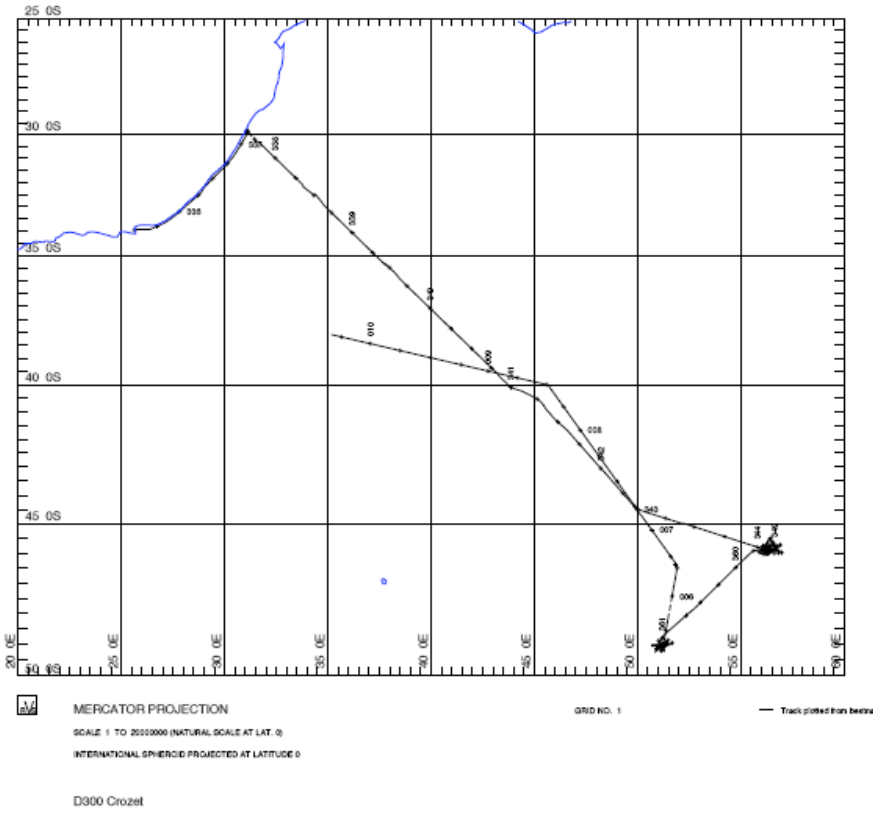


Figure 20.1 Benthic Crozet D300 Cruise Track

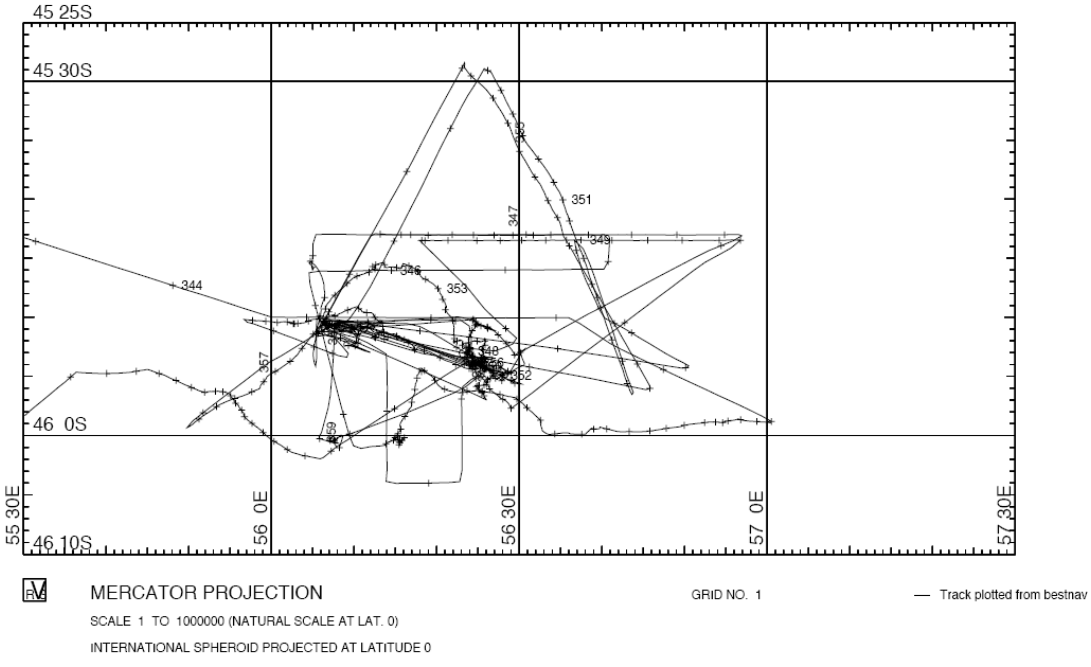


Figure 20.2 Station M5 track

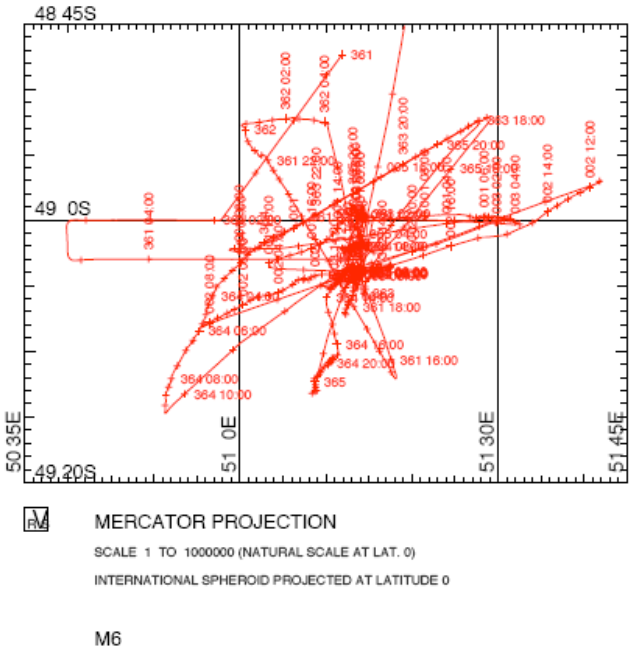


Figure 20.3 Station M6 track

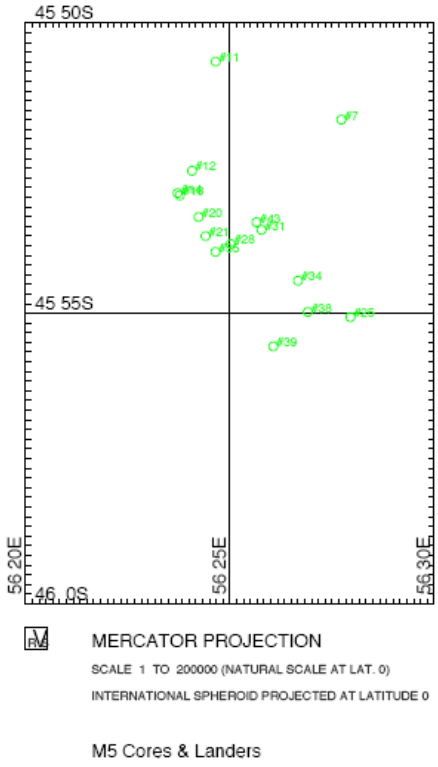


Figure 20.4 Core and Lander Deployments M5

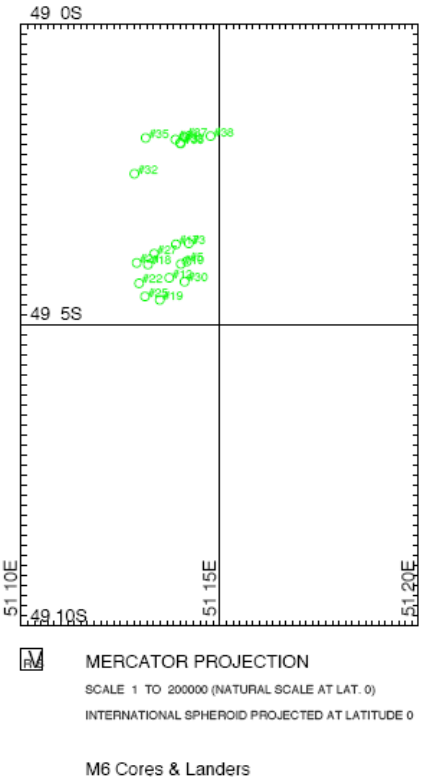
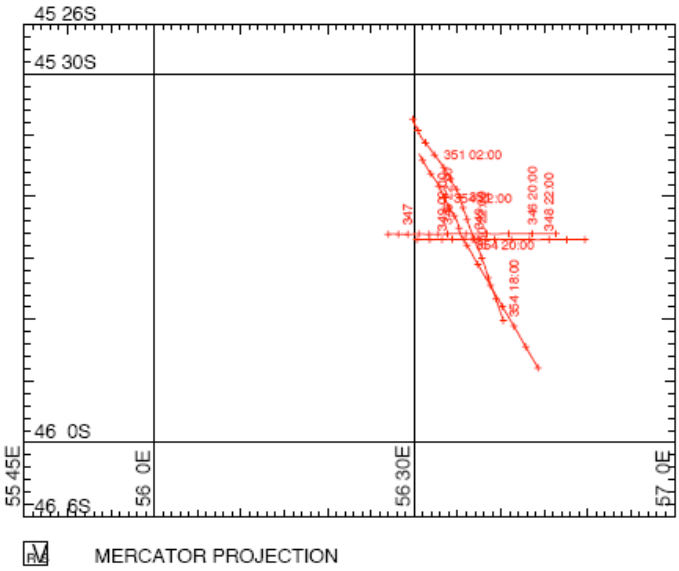
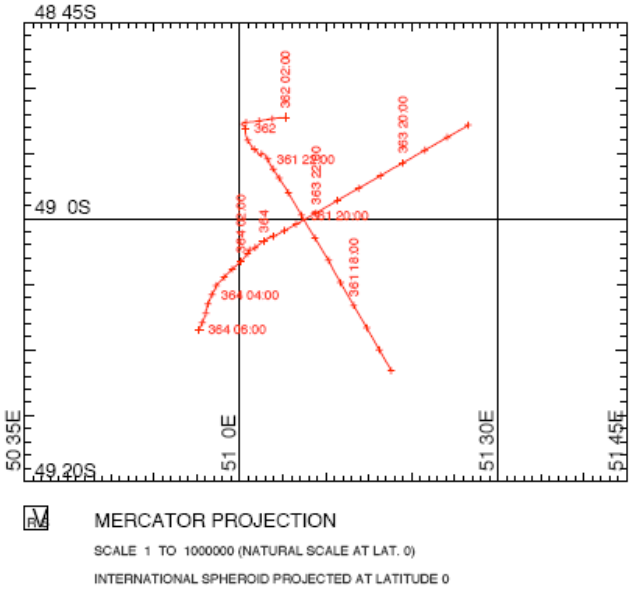


Figure 20.5 Cores and Landers M6



M5

Figure 20.6 Trawls M5



M6

Figure 20.7 Trawls M6

APPENDIX

Bathymetry

Echo-sounding was carried out with the ship's fitted Simrad EA500 unit, operating at 10 kHz through a PES tow fish. Transducer depth was set to 10 m during all operations (i.e. no corrections to depth have been made for ship's speed). Examination of initial echo sounding data in the vicinity of site M5 revealed a c. 30 m offset from the data recorded during cruises 285 and 286. This offset was traced to the sound velocity settings on the EA500, a sound velocity of 1485 ms^{-1} had presumably been set during a previous cruise. At 16:11 UTC on 9-XII-05 the sound velocity was reset to 1500 ms^{-1}. Data collected prior to that time were "un-corrected" (i.e. they had been corrected assuming 1500 ms^{-1}) then re-corrected using the alternative method provided in the Carter's Tables.

The bathymetric data were 'cleaned' (9-point running median) and edited (deletion of obviously bad data) prior to analysis. Data gridding (kriging method; linear, slope=1, aniso=1,0) and contouring (medium smoothing) were carried out using Surfer 7.00 (Golden Software Inc). Complete data were included from cruises 285 and 286, but only selected tracks were included from the present cruise.

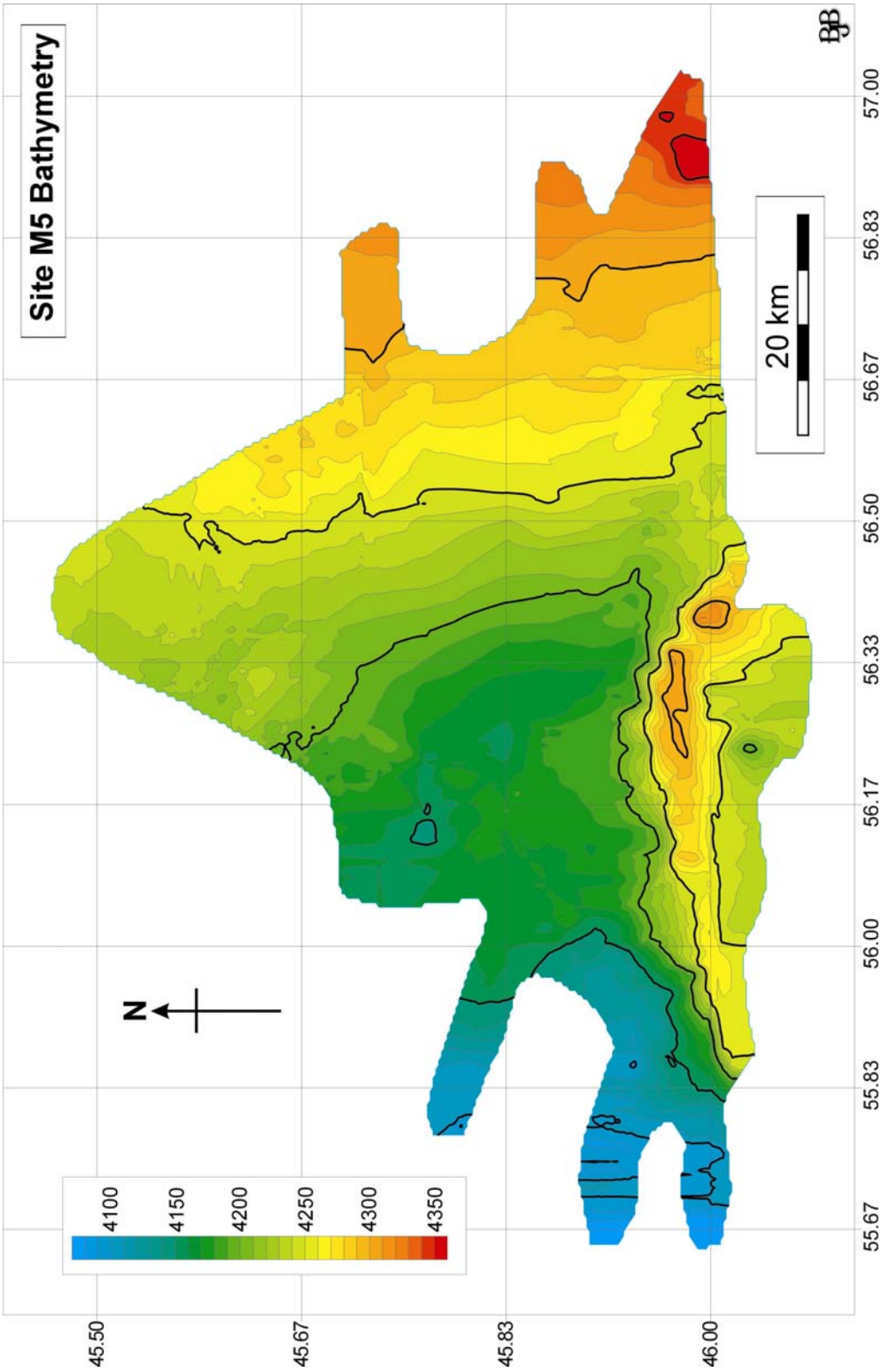
The figures that follow show the final version of the contour map, the underlying ship's tracks and the corresponding bathymetric profiles for both primary study sites (M5 and M6).

The M5 area was notable for a substantial channel located in the south of the study area, a channel is also apparent in the furthest east area surveyed. Much of the terrain was highly "corrugated", possibly an along-slope ridge/furrow system.

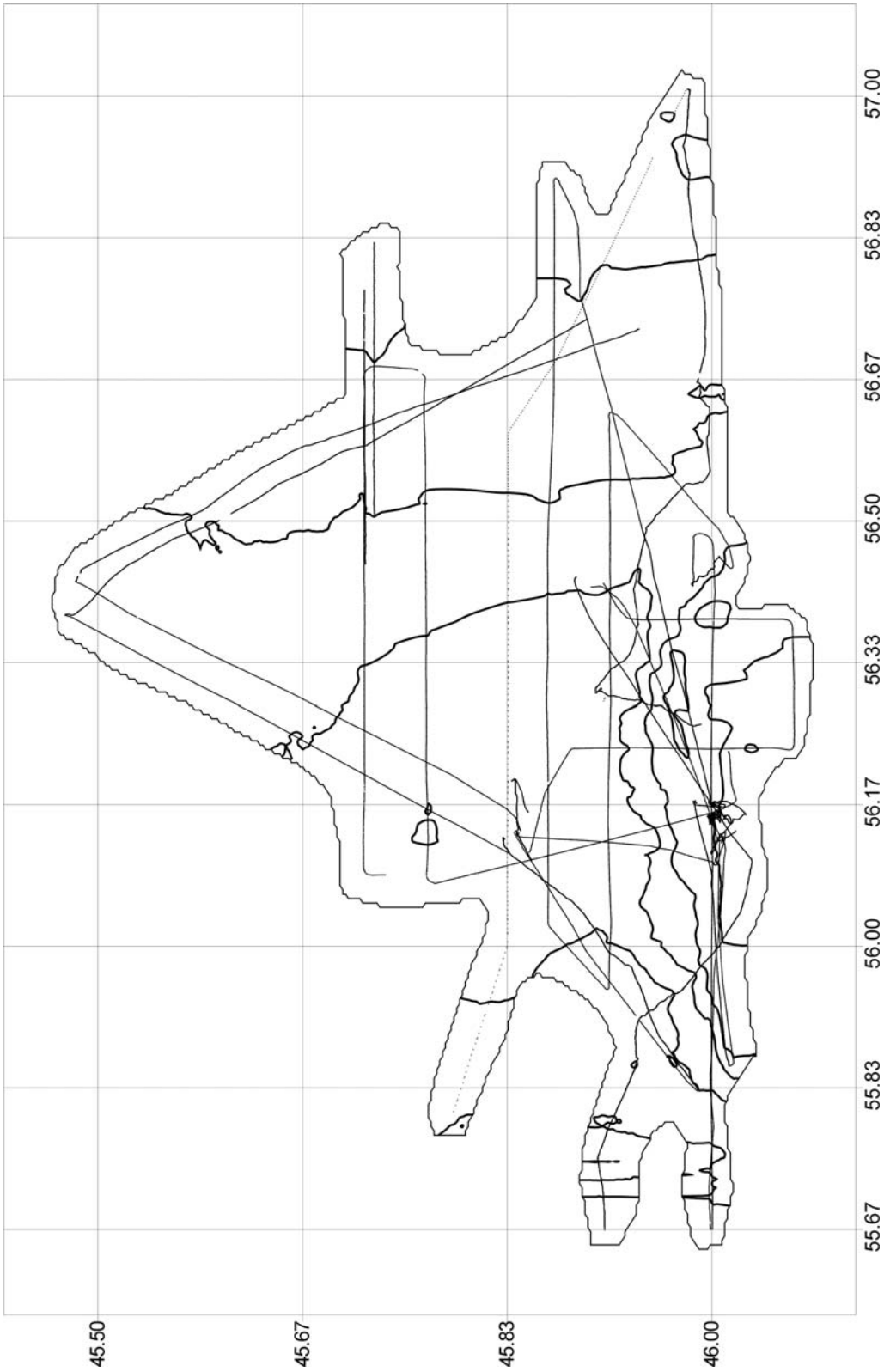
Much of the M6 area, particularly to the north and east, appeared to have a pronounced along-slope ridge/furrow system. There also appear to be some north-south trending ridge/furrow features to the west and south of the area. A number of small mound-like features are located in the south-central area.

The terrain at both sites is certainly not that of a simple continental rise and may reflect a history of mass wasting from the Crozet Plateau and reworking by contour currents.

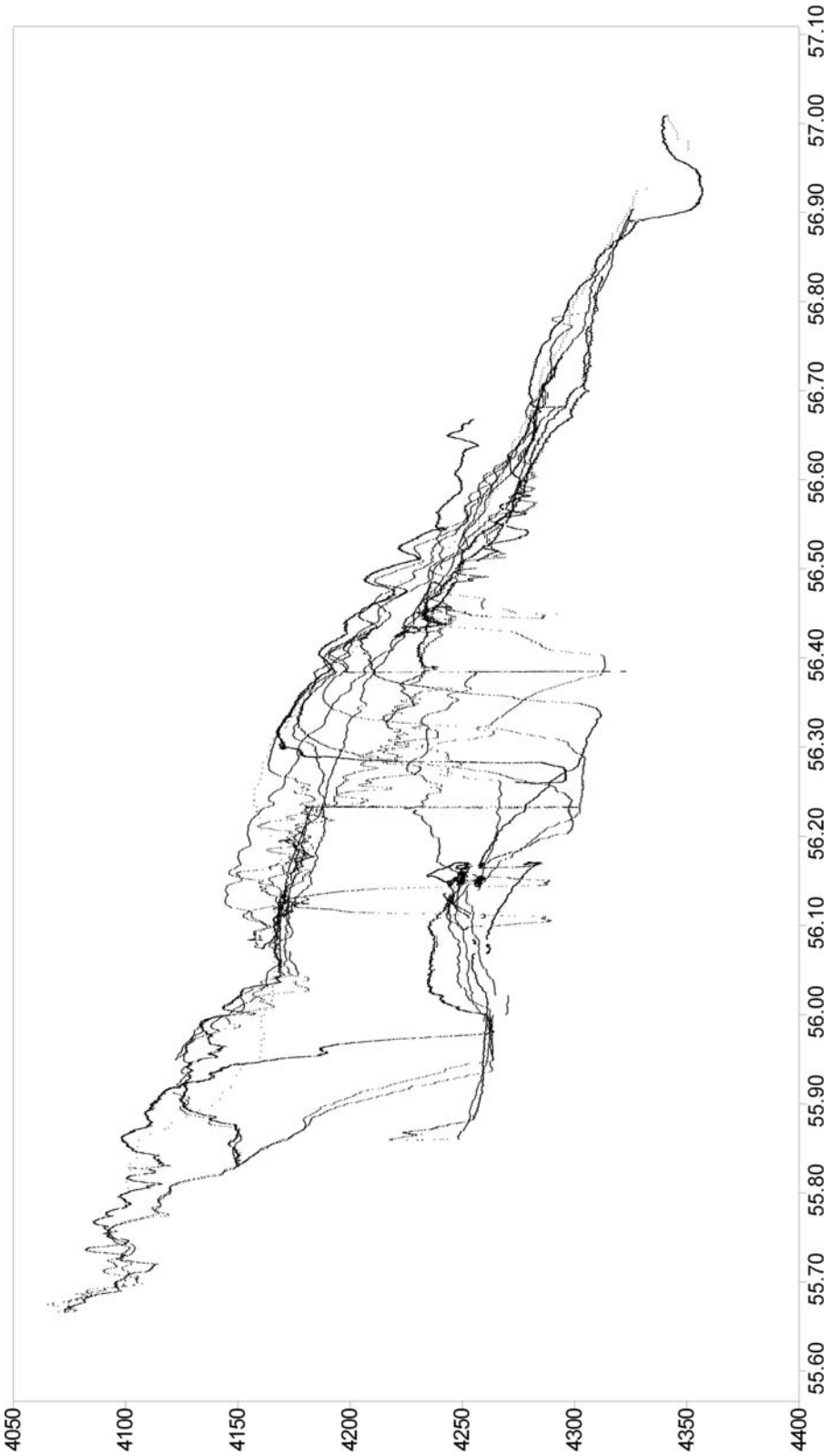
Brian Bett



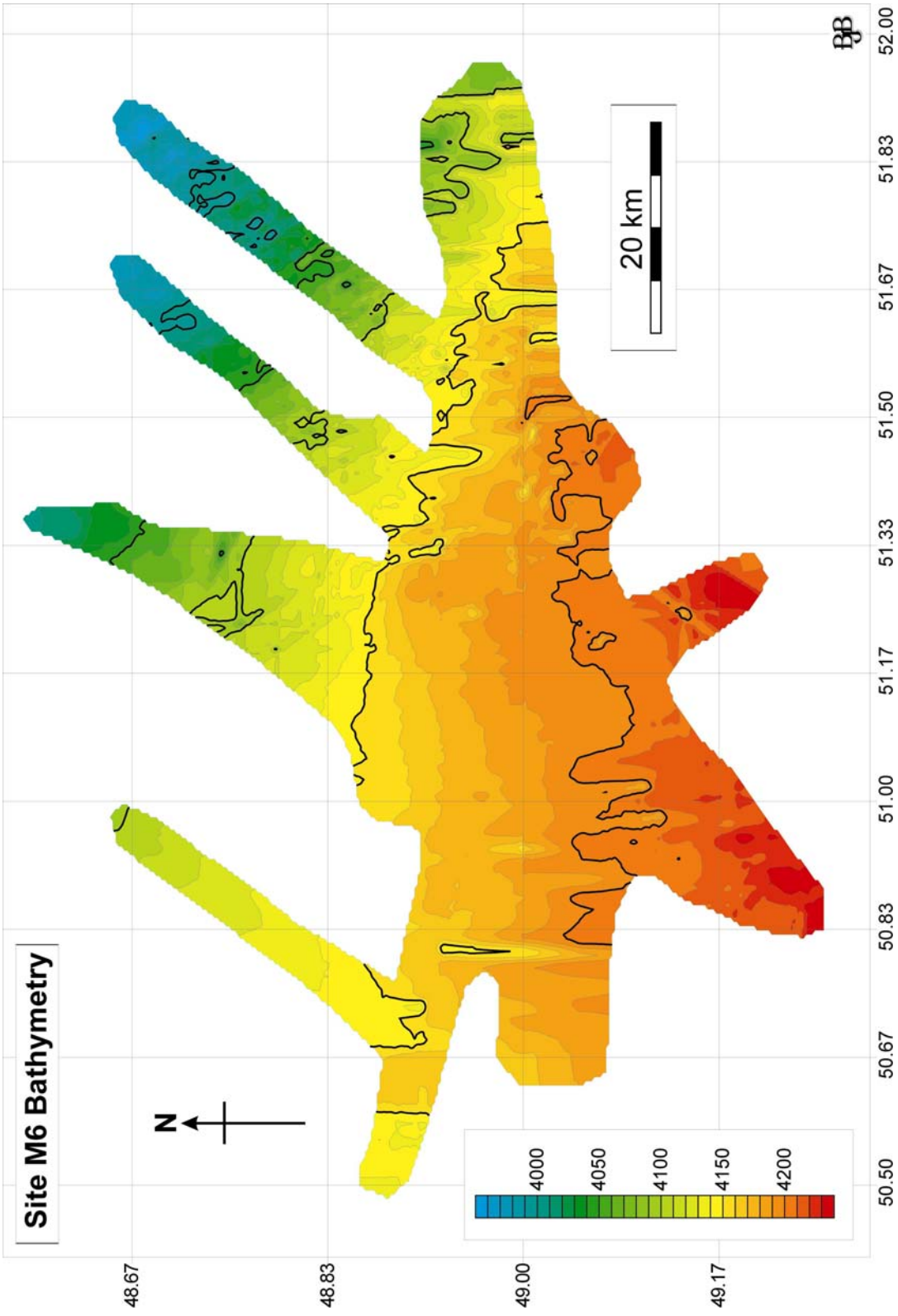
Site M5 contoured bathymetry.



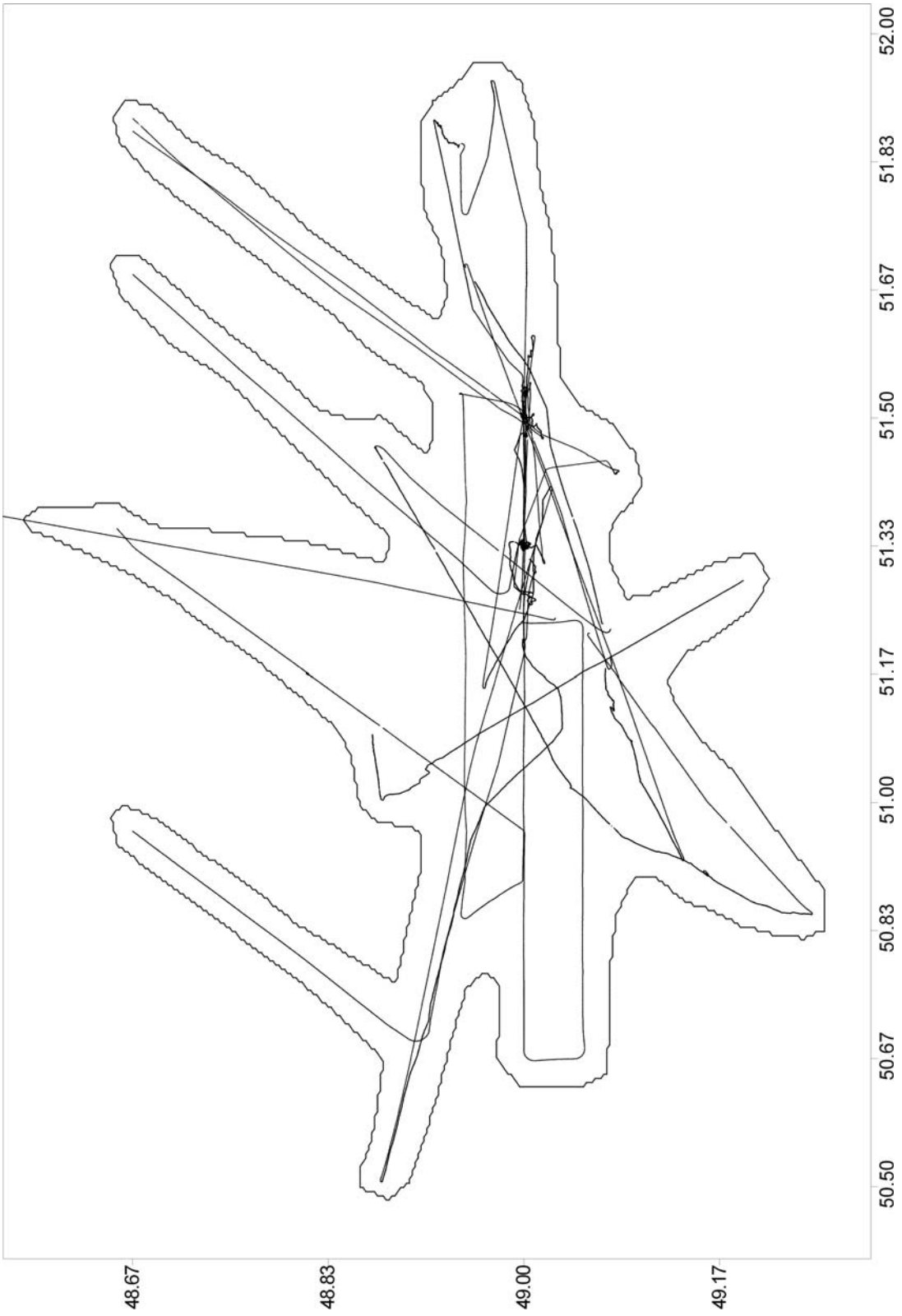
Site M5 bathymetric track data.



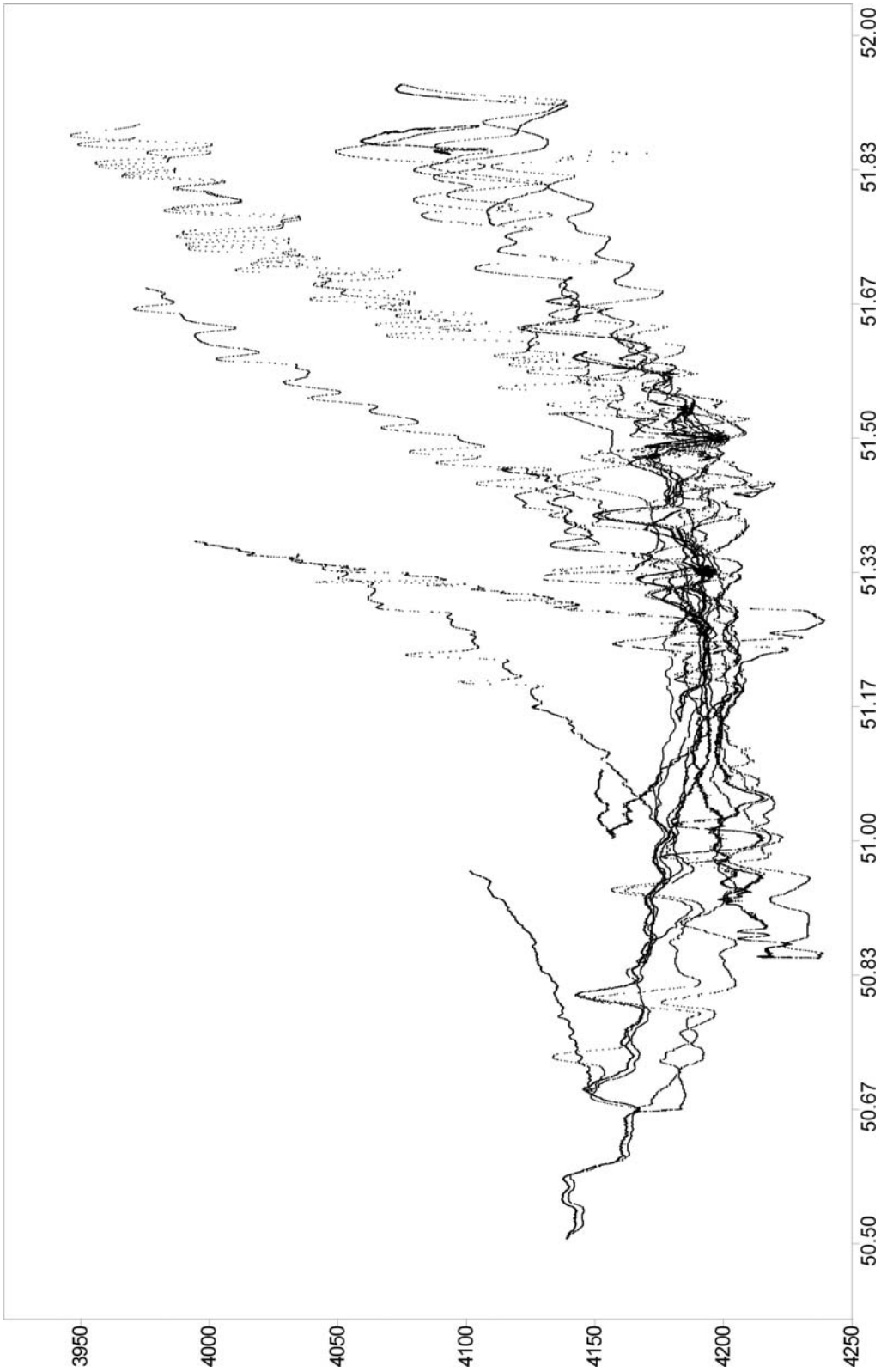
Site M5 bathymetric profiles.



Site M6 contoured bathymetry.



Site M6 bathymetric track data.



Site M6 bathymetric profiles.