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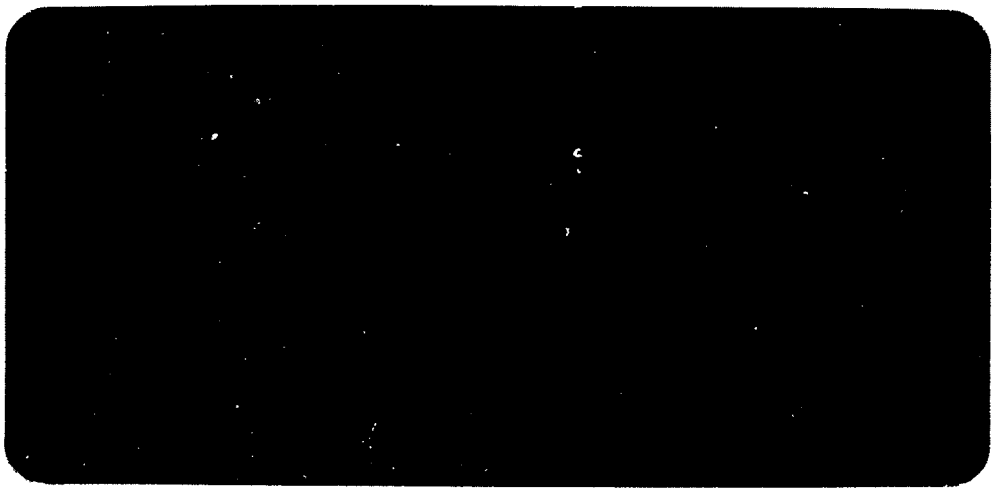
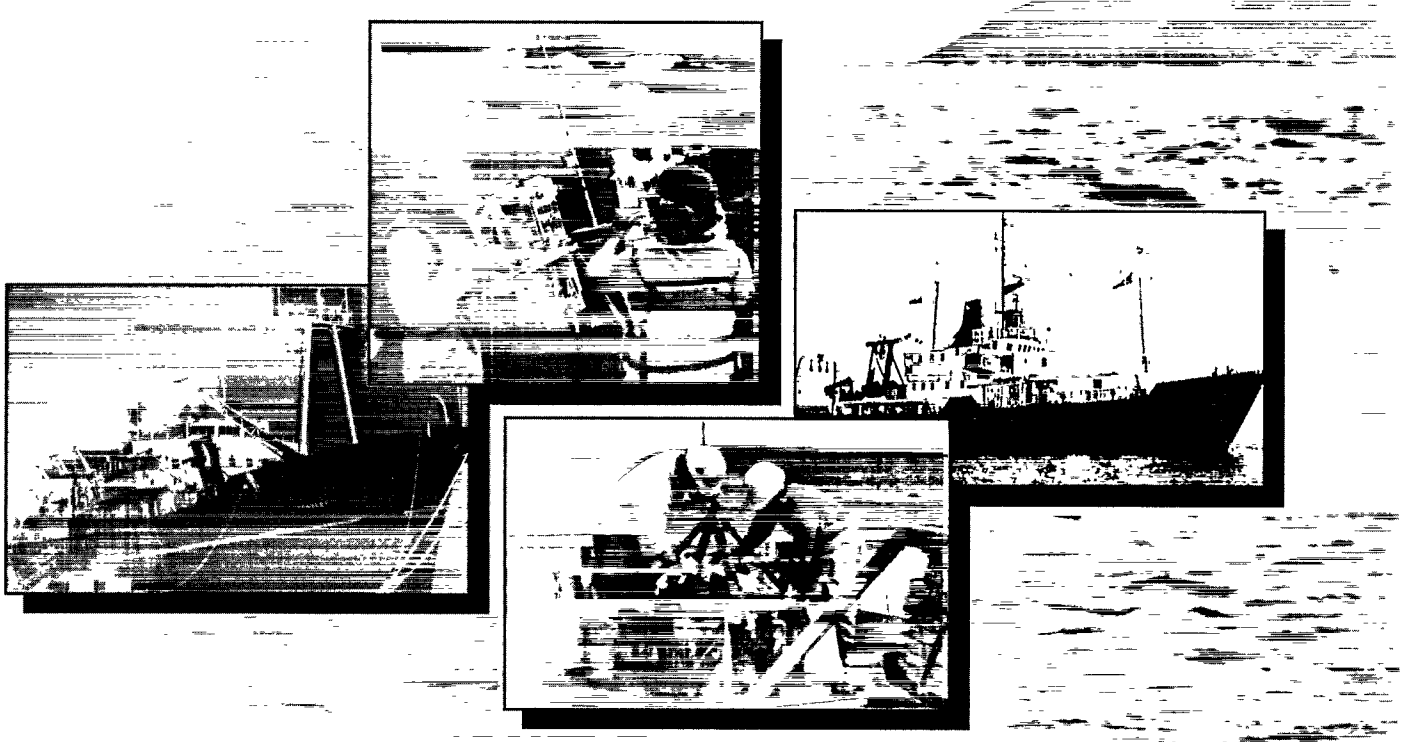
Cruise Report





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CRUISE REPORT

No. 4

RRS *DISCOVERY* CRUISE 222, Leg 2
29 AUG-24 SEP 1996

BENGAL
High resolution temporal and spatial study of the BENthic biology and Geochemistry of a north-eastern Atlantic abyssal Locality

Principal Scientist
A L Rice

1996

Challenger Division for Seafloor Processes
Southampton Oceanography Centre
European Way
Southampton SO14 3ZH
UK

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REFERENCE

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ABSTRACT

Discovery Cruise 222 (Leg 2) was the first of a series of cruises within a 3-year contract (MAS3 CT950018), BENGAL, funded under the MAST III programme of the EU and running from February 1996. The contract will concentrate on a single north-eastern Atlantic abyssal locality centred on 48°50'N: 16°30'W and will study in detail changes in the benthic system over one 12-month period from March 1997 to March 1998, particularly in relation to the seasonal deposition of phytodetritus.

This cruise was a lead-in to this series, with the objective of obtaining baseline data from benthic and mid-water sampling gears and from both short and long-term deployed moorings/landers. It was also an opportunity to test and refine new experimental procedures in preparation for the detailed studies in 1997-98.

KEYWORDS

BENTHIC COMMUNITIES, BIOTURBATION, CORING, CRUISE 222 1996, CURRENT METERS, DETRITUS, *DISCOVERY*/RRS, LANDERS, MICROBIOLOGY, NORTHEAST ATLANTIC, PHOTOGRAPHY, RESPIROMETRY, SEDIMENT CHEMISTRY, SEDIMENT TRAPS, TRAWLING, WATER SAMPLING

ISSUING ORGANISATION

Southampton Oceanography Centre
European Way
Southampton SO14 3ZH
UK

Director: Professor John Shepherd

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Sail Southampton 1330A Thursday 29 August 1996

Arrive work area 48°50'N 16°30'W 1948Z 31 August 1996

Depart work area 1100Z 22 September 1996

Arrive Falmouth 0900A 24 September 1996

SCIENTIFIC PERSONNEL

RICE, Anthony L.	SOC (Principal Scientist)
ANDERSON, Howard	RVS
BETT, Brian J.	SOC
BREY, Tom	AWI, Bremerhaven, Germany
CARTON, Micheal W.	Univ. Galway, Ireland
CRASSOUS, Philippe	IFREMER, Brest, France
GALERON, Joelle	IFREMER, Brest, France
GEARY, Andrew P.	SOC
GOODAY, Andrew J.	SOC
GRIFFIN, Nigel J.	SOC contractor
HAUVESPRE, Anne C.J.I.	IUEM, Brest, France
HORSFALL, Ian	Univ. Liverpool
IKEN, Katrin B.	AWI, Bremerhaven, Germany
KIRIAKOULAKIS, Kosta	Univ. Liverpool
LAAN, Martin	NIOZ, Texel, Netherlands
LAMONT, Peter	DML, Oban
L'HENORET, Pascal	CFR, Gif-sur-Yvette, France
PATCHING, John W.	Univ. Galway, Ireland
PAULSON, Christopher J.	RVS
POOLE, Anthony W.	RVS (Senior Technician)
ROBERTS, Rhys	RVS
SCOTT, Jason	RVS
THURSTON, Michael H.	SOC
VAN DER WEELE, Jacob A.	NIOZ, Texel, Netherlands
VANREUSEL , Ann J.C.	Univ. Ghent, Belgium
WADDINGTON, Ian	SOC
WITBAARD, Rob	NIOZ, Texel, Netherlands
WOLFF, George A	Univ. Liverpool

SHIP'S PERSONNEL

HARDING, M.A.	Master
NODEN, J.D.	Chief Officer
MORSE, J.T.	2nd Officer
WARNER, R.A.	3rd Officer
DONALDSON, B.	Radio Officer
BENNETT, I.R.	Chief Engineer
GREENHORN, A.	2nd Engineer
WALKER, B.R.	3rd Engineer
LUTEY, W.D.	Electrical Officer
POOK, G.A.	Bosun
BENNETT, P.R.	Bosun's mate
HANLON, D.J.	P.O. Motorman
COOK, S.C.	Rating
COOPER, G.	Rating
ALLISON, P.	Rating
MACLEAN, A.	Rating
HALLETT, R.C.	Rating
BELL, R.	Senior Catering Manager
PERRY, .C.K.	Chef
DUNCAN, A.S.	Steward
LINK, W.J.T.	Steward
ORSBORN, J.A.	Steward

INTRODUCTION

This cruise was the first of a series within a 3-year contract, BENGAL, funded under the MAST III programme of the EU and running from February 1996. BENGAL (High resolution temporal and spatial study of the benthic biology and geochemistry of a north-eastern Atlantic abyssal locality) has the general objective of understanding how the physics, chemistry and biology of the abyssal boundary layer respond to, and modify, the incoming chemical signal from the overlying surface layers and thus affect the palaeoceanographic record in the underlying sediment.

The specific area chosen for this study, centred on 48°50'N: 16°30'W in the Porcupine Abyssal Plain, is known to be affected by a regular seasonal deposition of phytodetritus arriving on the bottom in May-June each year. The BENGAL programme therefore intends to follow the temporal changes associated with this phenomenon in a series of cruises within a single 12-month period from March 1997 to March 1998. Discovery Cruise 222 (Leg 2) was a lead-in cruise to this series to obtain baseline data, to test and develop methodologies, and to service and/or emplace long-term moorings intended to gather background data through the study period.

SPECIFIC OBJECTIVES OF DISCOVERY CRUISE 222 (LEG 2)

1. To recover and redeploy a sediment trap mooring and a Bathysnap mooring, both originally laid in 1995.

2. To deploy an *in situ* recolonisation experiment (MAC - module autonome de colonisation) for recovery on a later cruise.

3. To deploy and recover a series of short-term moorings during the cruise:

   a) Up to seven deployments of the NIOZ lander, each of 2-3 days duration.
   b) Up to three deployments of the SOC amphipod trap.
   c) Two deployments of the SOC baited bathysnap (Bathysnack).
   d) Two deployments of the NIOZ near-bottom sediment trap.
   e) One deployment of a sediment enrichment experiment (BIOFEED).

4. To obtain a series of mid-water and benthic samples and data including:

   a) About ten multiple corer samples.
   b) About 15 box corer samples.
   c) About three samples each with the chalut a perche, SOC epibenthic sledge and the semi-balloon otter-trawl.

d) An indeterminate number of CTD casts to obtain water for bacterial studies, for incubation experiments and for oxygen determinations, and to carry the snow profiling camera.

e) A small number of SAPS (stand alone pump system) deployments, particularly to obtain samples from the same depths as the sediment traps on the long-term array.

To achieve these objectives the general plan for the cruise was to undertake long over-the-side deployments (e.g. OTSB, beam trawl, sledge and WASP) overnight wherever possible, restricting other activities (coring, CTDs, mooring deployments and recoveries) to the daytime. Superimposed on this general plan were a number of timing constraints. First, the NIOZ bottom time was expected to be of the order of 36-40 hours if the benthic activity (i.e. oxygen uptake rate) was sufficient. This would have involved deploying the lander on day one, and retrieving early and redeploying late every other day thereafter. However, the first deployment indicated that this would not result in sufficient oxygen uptake to provide good data and the pattern ultimately adopted was therefore to have two full days between deployment and retrieval. Second, 'dark' water (i.e. near surface water retrieved before sunrise) was required every two or three days for primary productivity incubations. Finally, 24 hour coverage of the surface 100m with the snow profiling camera was required at roughly 6 hour intervals but not necessarily in a single 24 hour period. These constraints, and the more routine ones of the need to retrieve moorings during the daylight hours, after deck logistics and the limited manpower to deal with specific samples, were taken into account in determining the order in which the various gears were used but are not regularly referred to in the following narrative.

NARRATIVE (SEE ALSO FIGURE 1-FIGURE 6)

Thursday 29 August

The ship was due to sail at 0900A, but mobilisation had not been completed on the previous day and therefore continued during the forenoon. Sailing was rescheduled for 1200A, but was delayed due to a minor problem with the ship's main engine control system and the ship finally sailed at 1330A. After dropping the pilot at the East Lepe and pausing in the Western Solent to secure gear in expectation of bad weather in the Channel, the Needles Channel was finally cleared at 1600A and course set for the main work area in moderate weather.

Friday 30 August

Clocks were retarded overnight to gmt. Passage continued through calm seas and light north-westerly winds.

Saturday 31 August

Winds continued light out of the northwest. The PES fish was deployed at 1100Z and a CTD cast (**12929 # 1**) was made to 500m to obtain water for the proposed long-term sediment trap deployment.

The vessel arrived at the main work station at 48°50'N 16°30'W at 1948Z and work commenced with a CTD and water bottle cast (**12930 # 1**) to 7mab (metres above the bottom).

Sunday 1st September

This was followed by a vertical plankton haul to 100m (# **2**) and a Stand Alone Pump (SAPS) deployment (# **3**) at 35m at the central position completed by 0244Z.

The vessel now moved some 6nm to the NNW, about 1nm to the west of the IFREMER Module Autonome Pluridisciplinaire (MAP) which had been deployed during the first (ALIPOR) leg of cruise 222. Here a multiple corer haul (# **4**) was made to obtain material for the BIOFEED experiment and the IFREMER Module Autonome de Colonisation (MAC) was deployed (# **5**) by 0754Z, with an ETA on the bottom of 0910Z.

The ship now moved about 1nm to the west for the first deployment of the NIOZ lander (# **6**) rapidly followed by a further move of 1nm to the west to deploy the BIOFEED experiment (# **7**) which was completed by 0958Z

A brief PAR (Photosynthetically Available Radiation) dip (# **8**) was undertaken at noon and this was followed by the deployment of the NIOZ sediment trap mooring (# **9**) which was completed by 1330Z.

The vessel now moved first to the centre position for a multiple corer drop (# **10**) to provide control samples for the BIOFEED experiment and then to the OMEX/BENGAL sediment trap mooring position at c49°N:16°21'W. This mooring (**12812 # 2**), which had been laid during *Discovery* cruise 217 in October 1995, was recovered successfully by 2149Z. All three traps had apparently worked correctly, though the surface (1000m down) trap samples were not properly preserved due to a known loss of preservative during deployment. The current meter associated with lower trap (100mab) had a complete record, but that associated with the upper trap contained no record (see specific report).

Discovery now returned to the centre position.

Monday 2 September

The first box corer deployment of the cruise (# **11**) was completed by 0230Z but the corer failed to trigger because the ferrule on the cocking lanyard had fouled on the sharp end

of the trigger bar, preventing full retraction. This was followed by a full depth CTD cast (# **12**) and release wire test, with bottles operated at 10 depths including the fluorescence maximum (29m) and completed by 0625.

In light southeasterly winds and a low swell the vessel now moved some 5nm to the east to make a haul with the IFREMER beam trawl (chalut a perche) (# **13**, rather providentially, as it turned out!) across the centre position towards the southwest.

The trawl consists of a 7m long beam mounted on 1m high shoes connected to 16m long bridles which, in turn, are connected to a 50m long pennant, a 400kg weight and thence to the main warp. Since the beam was too long to be fed through the ship's A-frame it had to be led out at an angle from the auxiliary winches on the poop. The gear was shot at 0944/12 with a pinger attached to the main warp 50m inboard of the weight, swivels and two tonne weak link. The pinger signal was lost after about 4000m of wire had been paid out, but the trawl was judged to have reached the bottom at 1236 having paid out 6500m. Hauling commenced at 1336, but at 1540, with only about 1200m of wire outboard, the tension suddenly decreased, indicating the loss of the trawl. This was confirmed when the swivel arrived inboard at 1607, the weak link having parted. Subsequent examination of the logged tension meter record revealed no evidence of any significant increase in load and therefore no explanation of the loss of the gear.

(Despite the consternation and embarrassment caused by this loss, the *entente cordiale* was maintained, partly by the *sang froid* of our IFREMER colleagues who dismissed the calamity with an expressive gallic shrug, and partly by the subsequent discovery that the chalut had, in fact, decided that it preferred the bottom of the deep ocean to life aboard a British ship. It had left the accomapanying farewell note and a case of rather fine wine to be shared among the whole ship's company during the evening meal on the following Sunday.)

The ship returned to the centre position for a box core deployment (#**14**) which was inboard by 2035Z with a good sample.

The day was completed with a multiple corer drop near the centre position (# **15**) which, as usual, obtained 12 good cores.

Tuesday 3 September

With the intention of popping up the NIOZ lander between 0700 and 0800Z, the first WASP (Wide Angle Seafloor Photography system) deployment was now undertaken (# **16**). However, at 0325Z, only some 7 minutes after the gear had reached within 10m of the bottom, the monitor record went haywire. The haul was aborted at 0332 and the gear was inboard at 0511 when the monitor was found to be flooded. Although the electronics were immediately washed in fresh water then distilled water, the system could not be salvaged and

Dear Joëlle, Philippe and all aboard the Discovery

I have to give you some explanation about my disappearance.

I am old and I feel tired of this cruel world: the sun is too strong, the wind so cold, and I don't understand the strange language used on this ship...

I think at the bottom of the sea life is cool, mermaids so charming that I choose to leave you and spend the rest of my life in the abyssal realm.

I leave French wine for all of you to celebrate the beginning of my new life and for you to remember me.

Don't cry and enjoy the cruise

Love to all.

Le Chalut à Perche

all subsequent WASP hauls were made using a conventional pinger, with consequent considerable difficulty.

The ship now moved to the NIOZ lander position (# **6**) and released the gear at 0625Z. The lander surfaced at 0748 and was safely inboard at 0827Z.

We now returned once more to the centre position for a plain box core (# 17) which was recovered at 1305Z. The sample was disturbed and was rejected, being used only as a qualitative macrofauna sample for AWI.

A multiple corer cast (# **18**) was completed by 1641Z, retrieving 12 good cores, and was immediately followed by a PAR cast (# **19**).

Tony Poole had previously expressed concern that the presence of the marine snow profiling camera on the CTD frame might impart damaging spin to the wire in the absence of a conducting swivel. Accordingly, a shallow (100m) CTD cast (# **20**) was now made and the gear was brought back through the surface at speed. No photographs were taken during this cast, but in the absence of any evidence of the feared 'spin' a further cast (# **21**) was now made to 2000m with all bottles fired in the fluorescence maximum at 40m and photographs taken throughout at 10 second intervals. With no evidence of the spinning effect once more, future CTD/camera casts to full ocean depth could be made with confidence.

The day's work ended with a further plain box core (# **22**) between 2041Z and 2342Z. Unfortunately, yet another disturbed sample was retrieved and rejected for the full treatment, undoubtedly to the relief of the sieving team who could now have a good night's sleep!

Wednesday 4 September

The vessel now moved some 8nm to the NE of the central position for the second deployment of the NIOZ lander (# **23**) which was completed by 0113 with an ETA on the bottom of 0245 and a commencement of the measuring cycle at 0245. (After recovery it was found that a programming error had been made and the functions had not been completed when the lander was released.)

The ship now made for the site of the first lander deployment to obtain a sample with the mega multiple corer to obtain sediment and near-bottom water for analysis in association with the lander results.

The resulting cast (# **24**) was inboard at 0530Z, but had retrieved only one good core, three of the cores not having closed and the remainder containing only short (c15cm long) cores which had slumped before the closing mechanism had operated. (Fortuitously, one of the 'slumped' core tubes had collected a large (c15 cm long) and perfect specimen of the semi-pelagic holothurian *Peniagone* which must have been 'hanging' more or less vertically close to the bottom.)

A second megacorer deployment (# **25**) was completed by 0916 but retrieved no good cores, apparently confirming the indications from the first cast that the bottom sediment in this area was not suitable for this gear.

The beam trawl having been lost and no megafaunal samples having been so far collected, the ship now moved some 20nm to the west of the centre position for a semi-balloon otter trawl (OTSB) haul into the light ESE winds.

The trawl (# **26**) was shot at 1121Z. The pinger depth trace was not working and all traces were lost at about 6000mwo. In this, and all subsequent OTSB hauls on the cruise, the trawl was fished entirely on the tension meter. In this case the indications were that the gear was on the bottom from 1545Z to 1835Z, covering almost 13km. It was retrieved at 2320Z with a rather good catch.

Thursday 5 September

The ship now returned to the centre position for a third (and as it turned out, final) megacorer cast (# **27**). When the gear was retrieved at 0410Z it contained only one reasonable and four slipped cores. With this further poor result the use of this gear was abandoned.

The vegematic box corer (# **28**) was now deployed, retrieving a good core at 0806Z.

The multiple corer (# **29**) retrieved 12 cores by 1130Z, but two had significant vertical cracks suggesting that the corer may have been pulled sideways during sampling although the winds were still light and the sea calm.

A PAR cast (# **30**) was completed at 1140Z and the WASP was fished (# **31**) within 10m of the bottom from 1357 to 1609Z, the gear being on board at 1733.

After the ship had again returned to the centre position a plain box corer haul was made (# **32**). Shortly after the gear was outboard at 1827 there was a 30 minute hiatus when a hydraulic union on the starboard gantry failed. But this had no bearing on the failure of the haul which resulted, at 2210, in the retrieval of another disturbed core which was used only for qualitative macrofauna (and another undisturbed night for the sievers!).

Friday 6 September

The ship now moved to the position which had been occupied by the OMEX/BENGAL sediment trap mooring for a full depth CTD/marine snow profiling camera cast (# **33**) which was completed at 0324Z, four bottles having been fired at 8mab.

SAPS samples (# **34**) were now collected at 40m and 150m (pumping from 0410 to 0510Z) and were recovered at 0545Z.

Discovery now returned to the NIOZ lander (# **23**) position, released it at 0705 and recovered it by 0855.

We now moved to the OMEX/BENGAL sediment trap mooring position at approximately 49°N 16°21'W to deploy its replacement. This deployment (# **35**) began at 1035 and the weight was released at 1329Z. The gear reached the bottom at 1412 and the pinger was switched off at 1416Z.

After returning to the centre position a multiple corer cast (# **36**) was completed by 1926, retrieving 12 good cores.

The winds during the 6th had been the freshest so far experienced on the cruise, around 25-30kts, mainly easterly. Since the overnight work was to be a further OTSB haul, the ship made for a position at 48°50'N:16°55'W to begin this haul on a roughly easterly course.

Saturday 7 September

The trawl (# **37**) was shot by 2150/6 and was inboard by 0915/7. It had apparently been on the bottom from 0122 to 0520, covering a calculated distance of some 18km and obtaining a rather small catch, with little clinker. There is some evidence to suggest that the net lifted off the bottom for part of the period between first and last bottom contacts.

The ship now moved to the proposed third NIOZ lander position, this time to the east of the centre position at 48°50'N:16°18'W, where the lander was deployed (# **38**) at 1037Z.

After returning to the centre position a plain box corer deployment (# **39**) recovered a good core with only slight cracking by 1339Z.

We now moved some 10nm to the northeast to recover a Bathysnap mooring (**12812 #3**) laid during cruise 217 in October 1995 at 48°58'N:16°20'W. The mooring was located and released without difficulty at 1632Z and successfully taken aboard at 1819Z.

The ship now moved some 3nm to the position of the second NIOZ lander deployment (# **23**) for the associated multiple corer drop (# **40**) which was completed successfully by 2200 after which we returned yet again to the centre position.

Sunday 8 September

The day began with a CTD/snow profiling camera cast to full ocean depth (# **41**) with 10 bottles fired at the bottom and 2 at a depth of 44m at the fluorescence maximum. This was completed at 0247 and was followed by a second cast, this time (# **42**) to only 100m as the first of an intended series of marine snow camera casts at approximately 4 hour intervals to cover the 24 hour cycle, but over several days.

This was followed by a WASP haul (# **43**), fished with the pinger and with the camera operation controlled internally (see WASP report). With about two hours worth of B/W film in the camera, hauling began at 0824 and the gear was inboard at 0951 and the ship then returned the short distance to the centre position.

A plain box corer haul (# **44**) resulted in a good core which was inboard by 1347.

The ship now moved to the east, to a position about 1nm from the current (# **38**) NIOZ lander position, for the associated multiple corer cast (# **45**) which was completed successfully by 1831Z.

In preparation for an overnight OTSB haul, the ship now moved to a start position at 48°45'N:16°55'W for a trawling course to the NE through the centre position.

Monday 9 September

The trawl (# **46**)was shot at 2120Z/8 and was brought inboard at 0836/9 in fresh easterly winds. It was estimated to have fished for almost 4 hours from 0045 to 0425, travelling 14.5 km and obtaining a good catch with considerable mud.

After returning to the centre position a WASP deployment (# **47**) was conducted, with a minor hiccup when the gear had to be brought back inboard temporarily shortly after it was initially shot because the trawl wire had snagged on a bolt on the midships A-frame. As during the previous WASP haul, the camera operation was timer controlled and near-bottom photographs were taken from 1315Z, the gear being brought inboard at 1646.

A return to the centre position was followed by a vegematic box corer drop (# **48**) which arrived back on board at 2100 with an acceptable sample.

A multiple corer drop (# **49**) was completed at 0041/10, as usual collecting 12 excellent cores.

Tuesday 10 September

The plan for today included the release of the NIOZ lander at about 0700Z and then to retrieve the baited AUDOS rig which had been deployed with a half dolphin during the first leg of cruise 222 to replace the LAFF (Large Food Fall) rig which had been lost. Having fully occupied the box core and multiple core teams in the last few hours, the possibilities for working overnight were limited. Accordingly, the PSO decided to get a decent night's sleep and to use the time available for an echosounding survey of the abyssal hill to the southeast of the central position which had been rather poorly surveyed previously (see Figure 2). This survey was completed in time to release the NIOZ lander at 0713. It was sighted on the surface at 0835 and was inboard at 0900.

The ship now moved to the AUDOS position 48°47'N:16°20.5W. Between 0945 and 1106, repeated attempts were made to contact and release the AUDOS rig, but with no success. Although we kept a visual and radio lookout for the rig whenever we were in the vicinity of the deployment site throughout the remainder of the cruise, all indications were that it had left the bottom much earlier, possibly shortly after the original deployment. (When the rig was visited at the end of leg 1 it could not be contacted. At the time this failure was interpreted as due to the rather poor prevailing weather conditions. In retrospect, it seems likely that the rig had already departed at that time.)

Having given the AUDOS rig a reasonable amount of effort, the retrieval attempt was abandoned and the ship returned to the centre position at 1151. A short midday CTD/MSP dip was made to 100m (# **50**) and this was followed by a PAR dip (# **51**).

A plain box corer haul (# **52**) produced yet another disturbed core.

A nominally 1600h CTD/MSP dip to 100m was taken between 1635 and 1655 (# **53**) and the vessel then moved about 5nm to the southwest for the fourth NIOZ lander deployment.

A WASP deployment (# **54**) was conducted between 1801 and 2242, the camera having operated on its timer from 1945 and the rig having been lifted from the bottom at 2118.

The NIOZ lander was now deployed at 2257 (# **55**), its ETA at the bottom being 0030/11 and its sampling programme due to begin at 0100/11. The lander on this occasion carried a video camera directed at a trawl-caught *Coryphaenoides armatus* mounted on a bar about 30cm above the bottom. The camera was timed to film for three hours from 0025/11

Wednesday 11 September

A deep CTD (# **56**) was conducted from 2328/10 to 0329/11, with water being taken at the bottom, at various mid-water depths and from the surface for a productivity incubation.

The ship now moved to the sediment trap position to obtain SAPS samples from the same levels as the traps. But to improve the bathymetry of the abyssal hill, the vessel sailed via this feature, arriving at 49°N:16°20'W at 0600Z.

A vertical plankton haul (# **57**) was completed by 0700, having required two attempts because the net became hung up on the wire on the first attempt.

The SAPS deployment (# **58**) was conducted between 0649 and 1302 and the vessel moved towards the centre position.

During recovery of the previous CTD deployment the wire had not relaid properly. Accordingly, the passage back to the centre position was interrupted from 1328 to 1645 to pay out and rewind 4790m of the CTD wire with only a weight on the end.

Having reached the centre position at 1800Z after an emergency fire drill and boat muster, a plain box corer haul (# **59**)was completed by 2113, retrieving an acceptable sample.

The vessel now moved to 48°52'N:16°50'W for the start of a proposed overnight OTSB haul on a course of c100° into continuing moderate easterly or northeasterly winds.

Thursday 12 September

The trawl (#**60**) was shot at 2315/11, appeared to be on the bottom from 0331 to 0620 and was estimated to have travelled some 15.6km. However, on retrieval at 1000 it contained a disappointingly small catch indicating that the gear had not fished effectively.

Having returned to the centre position, a plain box corer cast (# **61**) was completed at 1455 but had taken a disturbed core.

After a PAR cast (# **62**), the box corer was deployed again (# **63**). When it was retrieved at 1849 it was found yet again to have taken a core with some disturbance on one edge, but just acceptable for full analysis.

So far the day had not been a very good one. As we moved towards Friday 13 things didn't improve significantly!

Friday 13 September

In the very light easterly to northeasterly winds an overnight OTSB haul was to be made on a westerly course to save a little time in reaching a suitable start position. Accordingly the ship made for 48°47'N:16°10'W with a proposed trawling course of 283°. The trawl (# **64**) was shot at 2045/12, was apparently on the bottom from 2340/12 to 0317/13 and was inboard at 0722. The catch was rather better than the previous one, but still disappointingly small.

After returning to the centre position a vegematic box corer deployment (# **65**) was completed at 1252 with a usable core but with some edge disturbance.

A multiple corer cast (# **66**) fitted with two NIOZ tubes (see gear report) produced 12 good cores, as usual, and somewhat restored our faith!

Things improved dramatically when a PAR cast (# **67**) was followed by a plain box core (# **68**), fitted with stops to limit the penetration, and was recovered at 2015 with an excellent sample.

A shallow, and nominally 2000h, CTD/MSP dip (# **69**) was undertaken between 2041 and 2109.

Saturday 14 September

A WASP deployment (# **70**) was conducted between 2131/13 and 0250/14 carrying the previously flooded WASP monitor for a pressure test. When it came on deck the monitor was jetting water from around the main port revealing a serious and continuing problem (see gear report). The WASP camera seemed to have worked satisfactorily from 2305/13 to 0105/14.

The intention for later today was to retrieve the NIOZ lander (# **55**) and to redeploy it, and the amphipod trap, close to the northwestern edge of the small hill southeast of the centre position. In order to further improve the bathymetry of the hill in preparation for these deployments, the ship now made for the lander position via a short survey of the hill, to be in position to release the lander towards 0700Z. Accordingly, the lander was released at 0641, sighted at 0805 and retrieved successfully by 0836.

We now moved to the proposed amphipod trap deployment position, launched it at 0936 (# **71**) and watched it until it reached the bottom at 1135.

While the NIOZ lander was being serviced and prepared for redeployment the plan was to retrieve and redeploy the NIOZ sediment trap mooring and obtain a box core from the centre position. A minor communication failure resulted in the bridge making for the OMEX/BENGAL sediment trap position in error, the mistake coming to light only when contact could not be made with the NIOZ sediment trap, not surprisingly since we were some 10nm from the correct position!

Having corrected the error, the sediment trap mooring (# **9**) was finally release at 1509, reached the surface at 1600 and was safely taken inboard at 1652. After a rapid turn-round, the sediment trap was redeployed (# **72**) in more or less the same locality.

After returning to the centre position a good box core sample (# **73**) was obtained by 2134 and the ship move to the proposed fifth NIOZ lander deployment position.

This time the lander was again baited with a grenadier, but the video camera was raised to give a larger field of view and it was timed to record for 15 minutes every six hours during the three days of the proposed deployment. (In the event (see below) this turned out to be irrelevant, but it seemed a good idea at the time!).

Because of the very precise timing of the lander's programme, and particularly the video camera, the lander was to be launched as close as possible to 2230. Unfortunately, the deployment, so smoothly conducted on earlier occasions, went horribly wrong. It began when a handling line became tangled around one of the weights and went from bad to worse when

the release hook was operated inadvertently, dropping the whole rig into the sea from a height of some two metres. Fortunately, the main handling line was still secured and the situation was retrieved with the lander brought aboard beneath the A-frame.

The game plan now had to be changed to allow the lander to be checked over and re-programmed.

Sunday 15 September

A WASP deployment (# **74**)was completed by 0550 and a multiple corer cast at the centre position (# **75**) was completed by 0920. Unusually, this cast obtained only 11 good cores because the sample in one of the two NIOZ cores fitted to it had slipped.

During the multiple corer cast the south by easterly winds had freshened to near gale force, producing the worst sea state so far experienced since leaving Southampton. In the worsening conditions the NIOZ lander, now ready for deployment, was launched successfully at 1034Z at 48°48'N:16°27'W (# **76**), but the weather was by now too bad to retrieve the nearby amphipod trap. The ship accordingly returned to the centre position and was hove to awaiting an improvement.

The conditions had moderated sufficiently by late afternoon to contemplate recovery of the amphipod trap rig. Accordingly, the mooring was released at 1640, reached the surface by 1836 and was landed with some difficulty and with the loss of two buoyancy spheres by 1948.

A SAPS deployment was now undertaken in improving but still only moderate conditions. The intention was to position two pumps about 100 and 115mab with the clump weight on the main warp held about 20mab. Deployment (# **77**) began at 2008 and the pumps were in position in time for pumping to begin at 2202 and end at 0002/16. However, at 2315Z a complete power failure occurred throughout the ship. Inevitably, the ship drifted off position and the SAPS must have risen significantly as the wire adopted a considerable angle.

Monday 16 September

The main engines and bow thruster were back in service by 2349/15, allowing the wire to be straightened somewhat, but the winches could not be used until 0105/16. The SAPS were brought back inboard at 0227 after which power to the winches was intentionally removed briefly while the engine room situation was sorted out. In any case, the weather had deteriorated once more, with a strong gale and heavy swell preventing further work until late in the afternoon.

(The cause of the power loss problem was never satisfactorily identified. One possibility is that a power surge during adjustment of the height of the SAPS above the

seafloor had blown a fuse in the engine control gear, overloading the standby engine and causing that to be closed down also. The weather conditions at the time, together with the fact that insufficient wire had been paid out to allow the gear to reach the seafloor, meant that no harm came to any of the scientific equipment. With, for example, a trawl on the bottom and with 12000m of wire out the situation might have been very different!)

During the work lull, a formal meeting was held between the ship's staff and the Principal Scientist, reviewing the work achieved so far and confirming that excellent progress had been made on the cruise objectives.

Work recommenced with a final overnight OTSB. The wind having moderated somewhat and veered to the southwest, the ship moved to the northeast of the centre position for a trawling course of 250°. The gear (# **78**)was shot at 1951 and apparently reached the bottom at 2352/16.

Tuesday 17 September

All seemed to be going well, with a fairly consistent and gentle increase in the tension up to rather more than 7 tonnes by 0250/17 when hauling began at 10m/min. However, it soon became obvious that this was not going to be an easy trawl to retrieve. Over the next nine hours the bridge and winch drivers went through a tortuous series of manoeuvres, while a variety of suggestions were put forward to explain the high tension loadings and the probable outcome, most involving the loss of the gear and varying lengths of main warp. However, at 1045, and with the wire near vertical, the gear finally left the bottom and was successfully landed at 1242. The net was festooned with the remains of tuna longlines (two distinct rigs) but the probable explanation for the high tensions was that the net had fished particularly well. The catch consisted of an enormous bag of mud (probably well over a tonne) and an extremely good catch, much of it in very good condition despite its long journey back to the surface.

The vessel now moved slowly towards the centre position but the 30-35kt winds drastically reduced the work possibilities. A PAR cast was undertaken from 1445 to 1455 (# **79**) and the ship proceeded to the BIOFEED position (# **7**), but conditions were not suitable for its retrieval.

By 2230 the wind had moderated to 25-30kts and a shallow CTD cast (# **80**) was completed by 2310 after which the ship returned once more to the centre position for a plain box core cast.

Wednesday 18 September

This box corer deployment (# **81**) was to be for Gif rather than for the conventional sieving treatment. As it transpired, when it arrived back on deck at 0515/18 it contained probably the best sample obtained throughout the cruise; lucky Gif!

But unlucky NIOZ! In gradually improving conditions the ship now moved to the NIOZ lander position for an expected routine recovery.

The gear was released at 0710 but it became rapidly apparent that things were not well. Initially it appeared that the gear had not released at all, but it was soon realised that, although released, the rig was rising extremely slowly at 2-6m/minute. By about 0900 we decided to move off a few cables and obtain a multiple core sample while still close enough to keep an eye on the lander.

Multiple corer cast # **82** was completed by 1236, obtaining 12 cores but with some disturbance indicative of a double hit.

At 1400 the lander's position was again established, as was the fact that it was still rising extremely slowly, if at all.

The ship now moved to BIOFEED (# **7**) once more, but this time released it at 1542 and recovered it successfully at 1750.

The amphipod trap was now deployed once more (# **83**) at 1820 with an ETA on the bottom of 2005.

The position of the NIOZ lander was again fixed, confirming that it had stopped rising at a depth of some 3600m and was drifting northeastwards at about 200m/hour.

To complete the day's work the ship returned to the centre position for a vegematic box core (# **84**) which was shot at 2152 and recovered at 0100/19 with an excellent core.

Thursday 19 September

With the amphipod trap needing to be recovered early in the morning, the WASP system was now deployed, this time (# **85**) carrying the NIOZ video camera, both it and the WASP camera programmed to begin at 0300. This haul was completed at 0655 and the ship now proceeded to the amphipod trap position via the NIOZ lander for a further fix in freshening southeasterly winds.

The amphipod trap (# **83**) was released at 0935, surfaced at 1131 and was inboard by 1235 after one abortive pass!

The weather having deteriorated still further, the vessel was hove to on the centre position awaiting an improvement.

Friday 20 September

The weather moderated overnight, but with a cut-off time of 1100Z on Sunday 22 we now had only two days of science left. Although we had been extremely lucky with the weather and had achieved much of the proposed programme, we were still short of a number of wished for box cores, CTDs and WASP runs. We had also yet to deploy the baited bathysnap (Bathysnack) or the SOC epibenthic sledge, and needed to recover the NIOZ sediment trap and deploy the long-term bathysnap. In addition, the NIOZ team were understandably anxious to try to recover the lander despite the very poor chances of success. Accordingly, it was decided to abandon the use of the epibenthic sledge, to concentrate on the more essential sampling gears and to devote the last 11 hours of scientific time (that is from 0000Z/22) to a lander recovery attempt.

But the best laid plans of mice and men.....

At 0809/20 a plain box corer deployment was shot at the centre position (# **86**). It was retrieved at 1106 and, despite having been fitted with the penetration limiters, recovered a bad core. At this late stage in the cruise it became apparent that we had all along been using the wrong box (that for another corer) since this box did not fit the spade and, with limited penetration, had leaked badly at two corners. The box was changed!

A multiple corer cast (# **87**) was completed by 1445, obtaining 12 good cores including two in NIOZ tubes.

A PAR cast (# **88**) followed immediately after the multiple corer and the ship then returned to the NIOZ lander for yet a further fix and for the deployment of Bathysnack (# **89**) which was completed at 1710 with an ETA on the bottom of 1830.

After returning to the centre position, an attempt to launch the box corer was aborted because the wire had become snagged on a bolt. The wire had to be re-terminated and the corer (# **90**) was finally shot at 2100 and brought inboard at 0005/21. It had pretriggered and contained no sample. Things were not going well!

Saturday 21 September

A nominally midnight shallow CTD and snow profiler cast (# **91**)was completed by 0144 and was followed by a deep CTD (# **92**) completed by 0540.

A plain box core (#**93**) was completed by 0900, this time retrieving an acceptable sample

A shallow CTD/MSP cast (# **94**) was completed at 1005 and the ship then made for the NIOZ sediment trap mooring position (# **72**). This was released at 1044, surfaced at 1135 and was recovered by 1217.

Having returned to the centre position a plain box corer deployment (# **95**) was completed by 1608 but had again retrieved a poor sample which was not worth sieving out.

We now moved off to the Bathysnack (# **89**) position, released it at 1704 and retrieved it at 1850 with no traces of the mackerel with which it had been baited!

The long-term bathysnap (# **96**) was now deployed in more or less the same place as the Bathysnack with an ETA on the bottom of 2042.

With now only four hours left before the promised start of the NIOZ lander retrieval attempt the ship moved close to the lander for a short WASP deployment (# **97**). This was shot at 2037 and should have photographed the bottom from 2156 until it was hauled at 2237, to reach the surface at 2355.

Sunday 22 September

Over the previous couple of days the NIOZ team, together with the bridge and the deck personnel, had worked out a strategy for the retrieval attempt involving a drogue made from a bread basket to pull out some 800m of more or less neutrally buoyant rope carrying a number of grapnels and attached to a chain clump weight at the end of the main warp. The idea was to drop the clump weight to slightly below the level of the lander with its 60m of buoyed line and to make a series of perhaps three shallowing circuits in the hope of striking the lost gear. Despite all efforts, this gallant attempt was unsuccessful. Much to the natural chagrin of the NIOZ team, the Captain ordered the recovery of the gear at 0917 and, at 1100Z course was set for Falmouth, leaving in position perhaps the most expensive neutrally buoyant float ever deployed!

Monday 23 and Tuesday 24 September

The ship continued its relatively uneventful homeward passage in moderate weather, docking at Falmouth at 0900/24.

GEAR AND TOPIC REPORTS

Multiple corer (see **Figure 3** and **Figure 4**)

The multicorer was deployed 13 times and recovered a total of 155 cores out of a possible maximum of 156. The excellent performance of the corer during this cruise was probably due largely to the new core tubes. Unlike some previous tubes, they projected exactly the right distance above the upper collar (so that the top lids closed securely) and had rings which did not come unstuck.

Ten of the deployments were at the central coring site, the remainder (series 40, 45, 82) at NIOZ lander sites 2,3, and 5 (Table 1). One or two obvious lumps of phytodetritus were visible on the surfaces of about 20% of the cores, but phytodetritus was never observed in any greater quantity. Worm casts and tubes and open burrows, however, occurred fairly frequently, more so than on previous visits to the PAP site. The cores were generally between 25cm and 35cm long and had a fairly consistent stratigraphy. The upper 21-22cm consisted of brown mud which became darker and more mottled (bioturbated) with depth. Next came a darker brown horizon, 2-4cm thick, with distinct upper and lower margins and a layer of rather lighter material at the base. This darker horizon was also bioturbated with lighter coloured patches and streaks of material originating from the overlying sediment. The bottom part of the core consisted of lighter, greyish-cream coloured, sticky mud, sometimes with concentrations of *Globigerina* shells giving it a distinctly granular texture in places.

Table 1. Multiple corer deployments and their characteristics.

Deployment	Length (cm)	Cores	Remarks	Site
12930#4	24.0-28.0	12	BIOFEED set; worm casts on 4 cores	Centre
12930#10	31.5-35.0	12	Xeno on 1 core; worm casts on 4 cores; fluff lumps on 4 cores	Centre
12930#15	32.0-34.5	12	Tubes/worm casts on 2 cores; fluff lumps on 2 cores	Centre
12930#18	16; 30-32	12	Tube on 1 core; hole in 1 core; fluff lumps on 1 core	Centre
12930#29	31.5-33.0	12	Large worm tube on 1 core; fluff on 1 core	Centre
12930#36	31.0-32.5	12	Fluff lumps on 4 cores	Centre
12930#40	19.0-28.0	12	No observations	Lander 2
12930#45	25.0-30.0	12	Fluff lumps on 3 cores	Lander 3
12930#49	29.5-32.5	12	Worm casts/tubes on 3 cores; burrow in 1 core; fluff lumps on 6 cores	Centre
12930#66	23.5-32.0	12	Tube/hole/burrow on 3 cores; mound with holes on 1 core; fluff lumps on 4 cores	Centre
12930#75	31.5-34.0	11	Xeno on 1 core; large worm tube on 1 core; large burrow in 2 cores; fluff lumps on two cores; core 12 slipped, core 6 disturbed by top part of NIOZ tube	Centre
12930#82	29.0-33.5	12	All cores slightly disturbed (double touchdown), surface redeposited; no obvious worm casts or tubes; fluff lumps on some cores.	Lander 5
12930#87	30.0-35.0	12	Worm cast on 1 core; few fluff lumps on 1 core	Centre

The central site cores and their overlying water (sediment contact water) will be used for the following purposes (Table 2 and other parts of this report): organic chemical analyses, RNA/DNA extraction, studies of silicate, barite and enzymatic activity (Tasks 50/51), microbiological studies (Tasks 52-53), studies of the abundance, species diversity and population dynamics of foraminifera (Tasks 56-59) and metazoan meiofauna (Tasks 60-63), the BIOFEED experiment (Task 64), and to compare sediment and holothurian gut enzymatic activity (Task 68). Cores from the central station and the lander sites will be used for isotope measurements in order to estimate bioturbation rates (Task 40), to determine stable isotope

ratios of benthic organisms in order to establish trophic relationships (Task 71), biogenic opal studies (Tasks 74, 76), pigment measurements (Task 43), sediment porosity and measurement of oxygen profiles using microelectrodes (NIOZ), and for studies of enzymatic activity (UL).

Table 2. Fate of multicorer samples from Station 12930. The numbers in the columns are the core numbers (ie the positions of the core tubes on the coring head).

Haul Task	4	10	15	18	29	36	40	45	49	66	75	82	87
40: GIF						2	8, 9	2, 7	9		5,10		12
43: NIOZ Pigments[1] Pigments[2]							12,3 1,2, 4,5, 11	12,1 3,4		12		8,9	4,11
50/51: UL UNIVAN Patras		 4,6, 7,8 3		1, 3 2 4,11	5, 7 6 10,11	3,4,6 9 10,12			10,11 7 2,12	1,8, 11 5 2,9	4, 9 2 3,11		7, 8
52/53: UCG			4,5,8		8				5,8	3,4			5,6
56-59: SOC		12	3,9	6,8	4,9	1,5				7,10			
60-63: UGENT			2,7, 10	5,7	2,3	8,11			1,3,6		7,8		
64: UL et al	All cores	2,5, 9,11											
68: QUB			6	10		7							
71: AWI		1,10	1,11	12				6,8, 9,10				1-3, 5,7, 10, 11	9,10
74,76: IUEM							10	5			1	4	1,2
NIOZ: Oxygen Porosity			12 12		1,12 1,12		6 6	11 11		6 6		6 12	3 3
UL: Enzymes							7		4				
Mystery core				9									
Not used											6		
Failed											12[3]		

[1] Pigments - sections; [2] Pigments - surface; [3] slipped.

ANDY GOODAY

Multiple corer samples for meiofaunal analysis

(BENGAL tasks 60, 61, 62 and 63a; SOC, UGENT, SAMS, IFREMER)

Two cores of 25.5cm^2 from each of 6 multiple corer deployments were collected. Each core was sectioned into slices of 5mm for the first cm, and 1cm slices down to 5cm depth in the sediment. Sectioning took place in the CT room at *in situ* temperatures. From the second core from each deployment two subsamples of 1ml were taken respectively for estimating bacterial densities (UCG), and for the analysis of the organic carbon content. Each first core, as well as the remaining sediment from the second core, was fixed to a final concentration of 3 to 4% formaldehyde. Meiofaunal composition, standing stock and size spectra of the nematodes (tasks 61 and 63a) will be estimated from these cores. Some additional cores (four in total) were collected and sectioned in a similar way to that described above. Each horizon was stored in a Petri dish and frozen for later analysis of pigment and nutrient concentrations

ANN VANREUSEL

Sediment samples for radioactivity measurements

(BENGAL tasks 28 and 40; Gif, CFR)

The following cores were taken for bioturbation measurements:

Megacorer	#25	3 cores
Megacorer	#27	1 core
Multicorer	#36	1 core
Multicorer	#40	2 cores
Muticorer	#45	2 cores
Multicorer	#49	1 core
Multicorer	#75	2 cores
Muticorer	#87	1 core

These cores were sliced and stored in centrifuge tubes (to 13cm depth) or plastic bags (below 13 cm).

In addition, sub-cores (PVC tubes Ø 90mm) were taken from box cores (# 52 one subcore, #61 two subcores, #81 five subcores) and sealed with plastic lids for studies of the long-term sedimentary record.

PASCAL L'HENORET

Large agglutinated rhizopods

As on previous cruises, xenophyophores were picked from core surfaces. A total of 25 specimens was recovered from the surfaces of 20 box cores and single individuals were found on two multiple cores (12930#10, 75). Xenophyophore distribution appeared to be patchy, 7 specimens being found on the first box core recovered (12930#14) and none on 6 of the

subsequent cores. The overall density of epifaunal xenophyophores was 5 specimens per m^2, although this must be regarded as a minimum estimate since the disturbed surfaces of some cores made it difficult to see surface features. If the seven badly disturbed cores (none of which yielded any epifaunal xenophyophores) are disregarded, then the overall density is increased to 7.7 per m^2. In addition to these obvious epifaunal xenophyophores, small plate-like fragments of a possibly infaunal species were recovered from the 300μ residue of a disturbed core (12930/86; 0-2cm layer).

As expected at the PAP site, the most common species were *Reticulammina labyrinthica* (7 specimens, 6 from box core 12930#14) and *Galatheammina erecta* (5 specimens, 4 from box core 12930#44). However, the most interesting xenophyophores collected during this cruise were two large plate-like specimens (from box core 12930#14 and multicore 12930#75) which may belong to *Galatheammina irregularis*, a poorly known species described a few years ago from BIOTRANS material. At some other Atlantic sites plate-like xenophyophores occur infaunally, but both of these PAP specimens were clearly epifaunal. In addition to xenophyophores, clumps and strands of the large, tubular agglutinated foraminifer *Rhizammina* were picked off box core surfaces.

Eleven xenophyophores specimens (7 of *R. labyrinthica* and 4 of *G. erecta*) were preserved for DNA analysis. The main purpose of this analysis is to determine whether xenophyophores belong within the foraminifera or whether, as currently believed, they represent a distinct taxon. As soon as possible after their recovery, five of the specimens were placed in the -50°C freezer in plastic, zip-lock bags and 5 were dried on a hotplate at 25°C and stored in sealed Petri dishes. The remaining specimen was broken into two halves, one of which was frozen and the other dried. *Rhizammina* material was preserved in a similar way for DNA analysis.

ANDY GOODAY

Spade box corer (see Figure 5)

The spade box corer is a modified USNEL type, and samples an area of $0.25m^2$. The corer can be used with one or other of two different boxes. General sampling utilises a plain box with no subdivisions which produces a single core 50cm on a side. Examination of small scale variability depends on the use of a vegematic box, so-called because of its resemblance to the kitchen gadget for dicing vegetables, which encloses 25 subcore tubes in a 5x5 array.

The corer is deployed cocked and with the box free-venting. The latter arrangement reduces the bow-wave effect and thus disturbance when the corer reaches the sea floor. On bottom contact, the cocking mechanism is tripped, allowing the box to penetrate the sediment, closing the doors above the box, and freeing the spade arm. The act of hauling forces the spade underneath the box, thus enclosing a block of sediment. Depth of penetration of the

box is governed by the nature of the sediment. On the Porcupine Abyssal Plain cores of 45-52cm are the norm, but stops can be attached to the column of the corer to limit penetration.

The corer was deployed 22 times during the cruise, 18 times with the plain box and 4 with the vegematic box. Vents in the box cover had become blocked and were cleared after #63. Stops limiting penetration to 28-30cm were used for #65 and all subsequent hauls except #81. A mismatched box providing a poor seal against the spade was fitted inadvertently and was used for most hauls, but was replaced by the correct box for #90 and subsequent deployments.

Nine good cores, including 3 vegematic ones, were obtained, and a further 4 (3 plain, 1 vegematic) were accepted despite some degree of damage and disturbance (see Table 3). Successful box coring is recognised as being weather-dependent. As weather during the cruise was mostly good, the failure rate (9/22) was distressingly high. Two deployments (#11, #90) provided no sample, and the corer is presumed to have pre-triggered. Double bottom contact destroyed the surface of a third (#95), and the poor seal between box and spade resulted in a major wash-out in a fourth (#86). The remaining five cores were damaged to such an extent that subsample integrity would have been compromised. Damage consisted of lateral compression of core margins, ejection of subsurface sediment onto the core surface, and displacement or erosion of the soft surface layers. Some degree of compressional damage, particularly to deep cores, is inherent in the design of the corer, which has only a single arm and spade. Oblique pull-out can reinforce this asymmetry and result in unacceptable damage to the core.

Good and acceptable plain cores (except #81) were treated according to the SOC protocol. Surface features were described, and megafaunal organisms, macroscopic foraminiferans and xenophyophores picked off. Two subcores were taken, one of 57mm i.d. and the other with a 92x92mm vegematic core tube. Emplacement of the former generated data on hardness and compressibility of the main core and provided a subsample for sedimentary analysis, while the latter gave a subsample for comparison with the vegematic cores. The main core was cut into 0-1, 1-3, 3-5, 5-10, 10-15 and 15-20cm layers. Layers down to the 10cm horizon were sieved at 1000, 500, 300 and 250µm, and the deeper layers at 1000 and 500µm only.

Vegematic cores were treated according to the SAMS protocol. One of the central 9 subcores was cut into 0-1, 1-2, 2-3, 3-5, 5-10 and 10-20cm layers (as were subcores taken from plain box cores), and the remaining 24 were cut into 0-10cm layers. All subsamples were sieved at 300µm and 250µm.

The core from #81 was dedicated primarily to subsampling for calcite (CFR/CNRS, Gif). Damaged cores were variously subsampled with vegematic subcores (SAMS), for

macrofauna (AWI), megafauna (SAMS), foraminifera and xenophyophores (SOC) and/or calcite (CFR/CNRS, Gif) (see Table 3).

Table 3. Spade Box cores - Station 12930

Series	Box	Core rating*	Protocol	Sample fate	Remarks
11	P				No sample
14	P	2	SOC	IFREMER/SAMS (sc)	Good core; subcore without overlying water
17	P	0		SAMS (sc)	Disturbed core; disturbed subcore
22	P	0		AWI/SAMS (sc)	Disturbed core; 0-3cm sieved at 250µm
28	V	4	SAMS	SAMS	Excellent core; subcore C3 sectioned in detail; xenophyophore removed from C4 (Gooday)
32	P	0		AWI	Disturbed core; 0-3cm sieved at 250µm
39	P	2	SOC	IFREMER/SAMS (sc)	Good core, some cracking at front
44	P	2	SOC	IFREMER/SAMS (sc)	Good core; some burrows 4-10mm diameter
48	V	1	SAMS	SAMS	Adequate core, some boxes sloped; B4 sectioned in detail; xenophyophore removed from A4 (Gooday)
52	P	0		SAMS (sc)/GIF/AWI	Disturbed core; 90mm subcore (Gif); 0-2cm sieved at 250µm
59	P	1	SOC	IFREMER/SAMS (sc)	Adequate core, mound left front
61	P	0		AWI/GIF	Disturbed core; 2x 90mm subcores (Gif); 0-2cm sieved at 250µm
63	P	1	SOC	IFREMER/SAMS (sc)	Disturbed core
65	V	2	SAMS	SAMS	Depth limiter; disturbance in outer cores; C2 sectioned in detail; B2 spionid on surface, D3 crustacean on surface, D4 perforated tube projecting from surface
68	P	2	SOC	IFREMER/SAMS (sc)	Depth limiter; good core
73	P	2	SOC	IFREMER/SAMS (sc)	Depth limiter; good core; several burrows; pennatulacean loose on surface
81	P	3		SAMS (sc)/GIF/AWI	Very good core; several burrows; 5x 90mm subcores (Gif); perforated tube and worm (Lamont); 0-3cm sieved at 250µm
84	V	4	SAMS	SAMS/SOC	Depth limiter; excellent core; C3 sectioned in detail; xenophyophore removed from D4 (Gooday)
86	P	0		SAMS/SOC	Depth limiter; badly damaged core; 0-2cm sieved at 300µm, 2-8cm at 1000µm
90	P	0			Depth limiter; no sample
93	P	1	SOC	IFREMER/SAMS(sc)/ SOC	Depth limiter; adequate core, some cracking; echiuran, sipunculan and *Pourtalesia* in core
95	P	0		AWI/SAMS/SOC	Depth limiter; damaged core (double bottom contact); 0-2cm sieved at 300µm, 3-7cm at 500µm, 8-12cm at 1000µm

sc - subcore, either square or round: * core rating; 0 = not suitable, 1 = just acceptable, 2 = good, 3 = very good, 4 = excellent

In general, core surfaces were flat with no major biogenic structures, although low mounds <50mm high were present on one or two cores. Presumed worm tubes projecting from the surface, mostly with a lumen diameter of <2mm, were present in most cores, but were never abundant. Burrows, usually small, but occasionally up to 10mm diameter were common, occurring at densities of 2-20+ per core. Cores denuded of the top 2-3 cm of very soft sediment by washing or winnowing show burrows not apparent at the surface, indicating that burrows remain open for some time after they are vacated, suggesting that these densities may be an underestimate.

Core structure was consistent from sample to sample, and showed little variation among the cores sieved out using the SOC protocol. Core surfaces were noticeably greyer than the underlying creamy-beige sediment. The top 2-3cm of cores was very soft, but was noticeably firmer at greater depths, although no boundary was visible to the naked eye. Sediment became firmer with increasing depth, and tended to gain a very slight orange tinge at around 10-15cm depth. This slight colour change was gradual, irregular, and seemed to be influenced by bioturbation in that strands of paler sediment appeared to interdigitate with the underlying sediment. At a depth of 18-20cm a 4cm thick 'brown' layer was present in all cores examined. This layer had a fairly well defined upper limit, and a very sharp lower limit, and consisted of particularly fine-grained and sticky sediment. Below this layer sediment was much paler, whitish-grey in colour and with a coarser texture, resulting apparently from a higher *Globigerina* content. At about 40cm depth, sediment became darker in colour, usually tinged orange or brown, but without any clearly defined boundary.

Evidence for bioturbation was seen in most cores. Vertical, oblique or horizontal grey streaks were evident above the 'brown' layer, most commonly at depths of 3-10cm. These grey markings were sometimes associated with mounds or burrows, and were always present on the few occasions when occupied burrows were encountered.

Megafaunal organisms were found on or in five of the eight cores that were subjected to the SOC protocol. Ophiuroids with disc diameters of 4-5mm were found on the surface of #39 and #73, and a 40mm two-polyped pennatulacean was lying loose on the surface of #73. A large globular bivalve was embedded in the surface of #14, and a 40mm *Pourtalesia* (echinoid) was found vertical with head down and posterior end at the surface in #93. Sipunculans and echiurans were found in #59 and #93. All four individuals were 40-50mm in length. The sipunculan in #93 was vertical, 2-7cm below the surface in a burrow which extended at least 15cm down into the sediment. The echiuran in the same sample was partly bright green in colour, and was in an oblique gallery 7-9cm below the sediment surface at the bottom of a steeply oblique open burrow.

MIKE THURSTON, JOELLE GALERON, PETER LAMONT

Megafauna (See Figure 6 and Figure 7)

The megafauna was sampled with an otter trawl only following the loss of the chalut a perche and non-deployment of the epibenthic sledge as a result of time constraints The trawl (OTSB14) is a commercial shrimp trawl fished with otter boards and a deep-sea float on the headline. It has an effective width of 8.6m. The body of the net is made of 41 and 37mm stretch mesh netting and the cod-end has a 6mm mesh liner. The net is launched on two legs and then singled up onto the main warp. Recovery reverses this process.

The gear was deployed six times during the cruise (12930#26, #37, #46, #60, #64 and #78). There is some doubt whether the trawl fished effectively throughout deployments #37, #60 and #64 as the catches from these hauls were relatively small and contained very little clinker. #78 came fast on the bottom, and had to be sailed out by turning the ship onto a reciprocal course. The net came free six hours behind schedule. The catch, cushioned by large quantities of mud, was the largest of the six, and in the best condition. Back-triangulation gave a good last-bottom-contact position, providing a welcome cross-check on this methodology. Despite these problems, the relative proportions of the commoner organisms were very similar in all six deployments, and we can assume that the catches give a reasonable picture of the megafauna on the Porcupine Abyssal Plain.

The invertebrate megafauna was dominated by holothurians, of which *Oneirophanta mutabilis, Psychropotes longicauda* and *Pseudostichopus* spp. were most important in terms of biomass. *Amperima rosea* was very abundant and contributed significantly to total biomass even though the species does not attain a large size. Other genera represented included *Paroriza, Mesothuria, Molpadia* and the bentho-pelagic *Peniagone.* Compared to holothurians, other phyla were rather unimportant in terms of biomass, but somewhat more important in terms of abundance. Large pennatulaceans (*Umbellula*) up to 80cm length were spectacular but rare, whereas actiniarians, particularly *Actinauge abyssorum,* were relatively abundant but mostly quite small. Echiurans and annelids, including a 50mm polynoid species, were quite abundant, but contributed little to overall biomass. Annelid tubes, many empty, provided substrates for actiniarians and tunicates. As has been established previously, crustaceans were poorly represented. Much of the natantian decapod material consisted of midwater contaminants, and the remainder, together with a few *Stereomastis* and *Munidopsis,* formed the bulk of crustaceans collected. Molluscs were very poorly represented with cirrate octopods most obvious. Asteroids were among the more important non-holothurian taxa, with *Dytaster* and *Hyphalaster* prominent. The tunicate *Culeolus* was quite abundant, but contributed very little to total biomass. Fish, because of their large size, form an important part of the total biomass. *Coryphaenoides armatus,* other smaller macrourid species, and the eel *Histiobranchus bathybius* were present in all hauls. The only other fishes of note were a

very large unidentified macrourid, a single *Conocara salmonea* (Alepocephalidae), and a fine specimen of *Bathypterois longipes* (Chlorophthalmidae).

Qualitatively, these catches are very similar to those made on previous visits to this locality, but there are significant quantitative differences. The most obvious difference is the greatly reduced importance of *Oneirophanta* to the total invertebrate biomass. In the past, *Oneirophanta* has provided a consistent 40-45% of the total. We have had no means of bulk weighing available on this cruise, but it is unlikely that *Oneirophanta* biomass will exceed 20-25% of the invertebrate total in any haul. *Amperima* is more abundant in the present material than in previous collections, and the small transparent mucous holothurian species, quite abundant here, has featured not or hardly at all previously. The causes for these differences are not clear, but would appear to be interannual rather than seasonal.

MIKE THURSTON

Collection of megafaunal samples for non-BENGAL partners

A number of specimens were sampled to satisfy requests for material from Dr. Alex Rogers (AR, PML) and Prof. Paul Tyler (PT, SOC). These were exclusively taken from the OTSB catches, and are listed in Table 4.

Table 4. Megafaunal samples collected for Dr. Alex Rogers (PML) and Prof. Paul Tyler (SOC)

Station no.	Species	No. of Specimens	Fate
12930#26	*Oneirophanta mutabilis*	3	Whole animals to AR
12930#26	*Oneirophanta mutabilis*	10	Guts removed, remains to AR
12930#26	*Munidopsis crassa*	1	Tail tissue sample to AR
12930#26	*Munidopsis parfaiti*	2	Tail tissue sample to AR
12930#26	*Willemoesia leptodactyla*	2	Tail tissue sample to AR
12930#26	*Coryphaenoides armatus*	4	Muscle and liver tissue samples to AR
12930#37	*Coryphaenoides armatus*	6	Muscle and liver tissue samples to AR
12930#37	*Oneirophanta mutabilis*	9	Guts removed, remains to AR
12930#46	*Munidopsis crassa*	1	Tail tissue sample to AR
12930#46	*Munidopsis parfaiti*	2	Tail tissue sample to AR
12930#46	*Oneirophanta mutabilis*	3	Whole animals to AR
12930#64	*Plesiopenaeus armatus*	2	Tail tissue sample to AR
12930#64	*Munidopsis crassa*	2	Tail tissue sample to AR
12930#78	*Munidopsis parfaiti*	3	Tail tissue sample to AR
12930#78	*Amperima sp.*	20	Whole animals to AR
12930#78	*Oneirophanta mutabilis*	10	Tissue samples and gonads to AR/PT
12930#78	*Pseudostichopus sp.*	10	Tissue samples and gonads to AR/PT

IAN HORSFALL

Sediment Trap Mooring Recovery and Redeployment (see Figure 3).

General Introduction.

The use of the sediment traps part satisfies Activity 1.1, Objective (a), Tasks 6-10, in the BENGAL Technical Annexe. This cruise provided an ideal opportunity to recover a sediment trap array (Stn 12812#2), deployed on cruise D217 in October 1995. The aim is to quantify the temporal variability in the supply of particulate organic and inorganic material to the benthic environment. The samples collected have been taken back to the laboratory at SOC, divided, and distributed between collaborating laboratories where they will undergo relevant component analyses, (see. Technical Annexe, Workpackage 1, Activity 1.1 Tasks 11 -14).

Mooring Recovery. (Task 6)

Mooring position 48°59.98'N:16°21.11'W

Mooring recovery commenced on arrival at the site at 1849Z/1 September with the acoustic release pinger being activated. Release from the anchor was observed on the waterfall display at 1851Z with the mooring rising to the surface. Surfacing of the first buoyancy pack was indicated at 1905 and the mooring was sighted at 1909. The mooring was grappled and the first buoyancy brought aboard by 1929. Mooring line and instrument recovery was accomplished using the GDDOP double barrel winch and ship's crane. "Fishbite" damage was seen at 1200 metres depth with the polyester mooring line being cut half through. All instrumentation was recovered in good mechanical condition (but see below) with no corrosion. The recovery operation was completed by 2149 gmt.

Current meters

The mooring had carried two recording current meters, one close to the shallowest sediment trap and the other close to the deepest trap at a height of about 180m above the bottom. The upper meter failed to record any data for reasons that are still not apparent. The deeper trap, however, obtained good data throughout the deployment, recording relatively low current speeds up to a maximum of about 14cm/sec (Figure 7) and consistently northerly or northwesterly (Figure 9).

Recovered sediment traps and samples.

A total of three sediment traps (Rig.No.XV) were recovered successfully. The traps had been set at 1000m (Trap A, S/N 543), 3000m (Trap B, S/N 520) and 100mab (Trap C, S/N 532). On recovery a large indentation had appeared in one of the legs of Trap A and when the electronics of this trap were bench tested one of the pins on the computer port was

found to be corroded to excess. The downloading of data was difficult and, when it was accessed, it was found to have been only partially logged.

All traps appeared to have sampled well, but on inspection it was evident that the samples in Trap A were partially rotten, giving off a strong smell of H_2S, particularly from cups 5 and 8. This was undoubtedly a result of loss of preservative on initial deployment. All samples from this trap were therefore fixed with 25ml of 40% Formalin and those from Traps B and C with the standard 1ml. The total of 39 samples were stored at 4°C to await processing at SOC.

Redeployed sediment trap protocol.

Three sediment traps were redeployed (Rig.No. XVIII), utilising the same arrangement as that recovered. Given problems encountered with Trap A (S/N 543) on recovery, this trap was replaced with a 21 cup trap (S/N 1515). The trap array then became Trap A (S/N 1515) at 1000m, Trap B (S/N520) at 3000m and Trap C (S/N 532) at 100mab. Prior to deployment, traps were thoroughly cleaned, all batteries renewed and then reprogrammed. The sampling protocol was constructed to overlap sampling periods used by French collaborators deploying the MAP (Module Autonome Pluridisciplinaire) system on cruise D222 Leg1, so as to provide a more detailed insight into primary vertical particle flux over the next eight month period (Activity 1.1, Objective (a)). The sampling events were set as follows:

Event No.	Date.	Time.	Julian Day.	Duration.
1	15/09/96	12:00:00	259	7 days
2	22/09/96	12:00:00	266	7 days
3	29/09/96	12:00:00	273	14 days
4	13/10/96	12:00:00	287	28 days
5	10/11/96	12:00:00	315	28 days
6	08/12/96	12:00:00	343	28 days
7	05/01/97	12:00:00	5	28 days
8	02/02/97	12:00:00	33	27 days
9	01/03/97	12:00:00	60	14 days
10	15/03/97	12:00:00	74	7 days
11	22/03/97	12:00:00	81	7 days
12	29/03/97	12:00:00	88	7 days
13	05/04/97	12:00:00	95	7 days
14	12/04/97	CLOSE	102	

Mooring Deployment. (Task 7)

Mooring Position 49°00.48'N:16°18.02'W GPS, depth 4807ucm.

All equipment and sensors were assembled on the aft deck and deployment commenced, buoy first, at 1038Z/6 September with the main buoyancy being deployed. RCM

11217 was slipped by hand with the Parflux trap being winched overside by the DBC and ship's crane, ships speed being 0.5 knots.

With the sediment trap in the water, the ships speed was increased to 1.5 knots and mooring line payout commenced with the first 1500 metres being paid out from the storage drum. After this section was paid out, the remainder was paid out by hand from drum stands and coils.

Conventional buoy first techniques were then used for all succeeding instruments and buoyancy.

The RT661 no.283 was switched to pinger mode on deck to monitor descent.

With the mooring fully deployed astern, the anchor was lifted outboard by crane and release hook and, after several minutes of towing to tension the mooring, the anchor was released near to the sea surface at 1329Z. The descent of the mooring, at an overall rate of 1.8m/sec, was monitored on the waterfall display: anchor touch down was at 1412Z, with the release pinger indicating a 50 metre bottom echo. The pinger was then disabled and the ship left the site at 1416Z.

IAN WADDINGTON/ANDY GEARY

Bathysnap and Bathysnack (See Figure 3)

(BENGAL tasks 22-27 and 37)

Bathysnap is a time-lapse benthic photographic system which takes repeated photographs of about $2m^2$ of the seafloor at predetermined intervals over periods of hours to months. It can be used in the conventional mode, with or without a recording current meter, or in a baited 'Bathysnack' mode to study the behaviour of benthic scavengers.

On this cruise a Bathysnap which had been deployed in October 1995 (12812#3) was successfully recovered, but the camera had failed and no photographic record will therefore be forthcoming. A replacement Bathysnap mooring (12930#96) was deployed on 21 September, hopefully for retrieval during March/April 1997.

We also intended to deploy two short-term baited Bathysnacks during the cruise. In the past, such baited deployments have normally carried a single mackerel wrapped in muslin to prevent the attracted scavengers, mainly amphipods, from destroying the bait and thus reducing the attractiveness of the rig. This is a somewhat artificial situation since any large food fall on the seafloor would normally be consumed rapidly. The more natural situation had already been addressed on leg 1 of cruise 222 with the deployment of the Aberdeen LAFF (Large Food Fall) photographic rig baited with half a dolphin, the second attempt at this approach being the deployment which we failed to recover (see Narrative). On leg 2,

therefore, we hoped to conduct a complimentary small-scale experiment using the bathysnap system but with the bait unprotected. In the event we were able to complete only one deployment (12930#89) which was on the bottom from 1830/20 to 1704/21. On recovery, the two mackerel with which the rig had been baited had totally disappeared and the camera appears to have worked properly, as had the current meter fitted. We await the results with baited breath (ugh!).

The mooring was provided with an Aanderaa current meter (the one which had failed during the long-term sediment trap mooring. This time, it appeared to work perfectly, recording a very clear tidal variation in current speed up to a maximum of about 12cm/sec (Figure 10) (see also Figure 7) and Figure 12), and in an almost invariably northerly direction (Figure 11) (see also Figure 9).

TONY RICE

Amphipod trap

The free-fall amphipod trap rig (DEMAR) consists of a framework measuring 1.8x1.2x1.0m which encloses a release mechanism, electronics, balancing plate and baited trap. The trap itself measures 50x50x20cm, has a solid top and bottom, walls supporting 500µm mesh funnels with 40mm entrances, and a central coarse mesh bait container. Standard bait is a whole mackerel. A bottom time of 10-16 hours is normal, but not critical. The rig consists of the trap frame with a 136kg ballast weight, a 50m strop, buoyancy package, dhan buoy, and lazy line, and stands 70m high when on the sea floor. The rig is launched buoyancy first.

DEMAR was deployed twice. Catches were fixed unsorted, but appeared normal in that they contained 500-1000 individuals, and were dominated numerically by *Paralicella tenuipes* and *P. caperesca.* Second and third instars of *Eurythenes gryllus*, with modal lengths of 16 and 22 mm respectively were present, forming perhaps 5% of the catch. Specimens of *Orchomene* (s. lat.) were rare.

MIKE THURSTON

NIOZ lander and associated work (See Figure 3 & Figure 4)

Introduction

The NIOZ lander was deployed 5 times during the cruise. The success rate varied between deployments because of major mechanical and electronic problems in one of the two measurement units. We failed to recover the lander from its final deployment. For unknown

reasons it stopped rising at a depth of approximately 3648m. At the end of the cruise it was drifting in a northeasterly direction at an average speed of 200m/h.

Oxygen consumption

(BENGAL task 30; NIOZ)

The sediment oxygen consumption was determined from the change in oxygen concentration between the start and end of each *in situ* lander incubation. Winkler titration of bottom water samples taken by CTD or multicore showed that the near bottom concentration was on average 245.8µmol/l. The first lander deployment lasted 42 hours and the oxygen concentration in the measurement chamber decreased by 11.1µmol. Incubation time for the other deployments was increased to 76 hours. During these deployments the sediment oxygen demand resulted in a concentration decrease in the overlying water between 19 and 20.5µmol.

Sediment traps

The small sediment traps mounted on top of the lander yielded significant amounts of material, even though each deployment did not last more than 3 days. It is highly unlikely that this material was derived from resuspension caused by the lander, the sediment traps open one hour after the lander reaches the seafloor and video pictures taken during one of the deployments revealed that the resuspension caused by the lander settled within 10 minutes. The material collected consists of foraminifers and fluffy material. The lander sediment trap results are corroborated by the results of an 18 day deployment of a Technicap trap. Daily samples indicate a highly variable material flux. The pigment composition of this material will be compared with the pigment composition in sediment cores, bottom water and the composition of the deepwater chlorophyll maximum.

Near-bottom currents

The current meter data obtained at a height of approximately 30cm above the bottom indicated a strong tidal effect on velocity (Figure 12). Waterflow is directed northward with a small but maximum deviation of approximately 40°. Average bottom water temperature during the lander deployments was 2.3°C.

Near-bottom water transparency

The light transmission measured 1 metre above the bottom varied very little from the average of 95%. The small variations were not correlated with changes in current speed or current direction.

Downcore pigment distribution

One megacore was sliced for the downcore pigment distribution. Technical problems with the megacorer made it essential to switch to the multicore. A total of 8 multicores were sliced. From some other cores only the top mm was extracted. In addition to this core slicing several holothurian species caught during the OTSB trawls were dissected for gut contents.

Oxygen profiles

From four stations (#15, #29, #40, #45, #82 and #87) sediment oxygen depth profiles were determined. Usually the profiles were made within 20 minutes after the core had come aboard. The penetration depth and boundary layer thickness varied considerably between stations and cores, pointing to a large spatial variability. Maximum observed penetration depth was approximately 7cm below the sediment surface (Figure 13a). Minimum penetration depth was 4cm (Figure 13b). Boundary layer thickness varied between 0.2 and 0.5mm.

Experimental video films were made. During deployment #55 and #74 a baited rod was attached to the lander. During deployment #55 the first three hours after arrival at the seafloor was filmed. The fauna responded rapidly. Amphipods, rattails and an ophidioid fish species were attracted. After three days the bait was entirely stripped of flesh.

ROB WITBAARD, JACOB VAN DER WEELE, MARTIN LAAN

Marine Snow Profiler

Introduction.

Marine snow may be described as being particles of >0.5mm diameter and of principally biogenic origin. These particles are known to form in the Upper Mixed Layer of the water column during periods of phytoplankton abundance. Particles of this nature are of particular importance , since they are known to be the principal vehicles by which particulate material is transported to the deep sea floor, and so are of great importance in the oceans, biogeochemical cycles as well as supporting the deep sea fauna. The 'snow camera' system , therefore, is used to address BENGAL Workpackage 1, Activity 1.1, Objective (a), Task 15.

The Marine Snow Profiler

The camera system was deployed in 'CTD mode' on cruise D222 Leg2. This involves the construction of a scaffold frame, onto which is mounted a snow camera, 14v power supply, 300 microsecond Metz flash and Fresnel lens. The camera sits at right angles to the Fresnel lens which has the flash mounted behind it. When the flash fires, a columnated beam of light is produced by the fresnel lens and the camera takes a photograph. With the camera

set at a known distance from the centre of the beam, we can with confidence determine the volume of water photographed.

BENGAL Cruise 222 Leg 2 provided an opportunity to study temporal and, to a lesser extent, spatial marine snow distributions. A total of 8 casts were made, the majority to a depth of 100m, two to 4800m and one to 2000m. The camera was set to take shots at 15 second intervals, thus giving high resolution profile data through the water column on the production and fate of these particles following the period of major seasonal deposition. It was also possible to obtain data on diurnal patterns of particle distribution with casts to 100m depth approximately every 4 hours over a 24 hour period. All casts appeared to be successful. Details of casts are given in Table 5 below:

Table 5. Marine Snow Profiler Sampling Regime.

Date 1996	Julian Day	Series no	MSP no	Latitude N	Longitude W	Cast depth (m)	Total Depth (m)
03.09	247	#21	158	48 50.14	16 29.32	2001.9	4836.5
05.09	249	#33	159	49 00.10	16 20.79	4834.1	4841.7
07.09	251	#41	160	48 49.94	16 29.87	4833.4	4839.2
08.09	252	#42	161	48 49.82	16 29.94	102.7	4838.1
10.09	254	#50	162	48 50.26	16 30.21	102.0	4837.6
10.09	254	#53	163	48 50.97	16 30.40	103.8	4839.2
13.09	257	#69	164	48 50.22	16 29.25	103.2	4838.7
21.09	265	#94	165	48 50.78	16 29.99	302.3	4840.7

Image Analysis

The photographic images collected will be processed at SOC. The frames will be scanned individually using Kontron Image Analysis hardware and Vidas software. Each frame will be grabbed using video and scanned twice, once for smaller particles using a specially written macro 'Weesno' and again for larger particles using a macro 'Bigsno'. This stage produces raw data on abundance and volumes for each individual particle. The data are then placed into Lotus 123, where macros are used to produce the final data set. It is from this data that estimates of abundance, volume concentration and mass are made (Task 15). The results are then used in conjunction with CTD data and camera times to produce vertical profiles.

ANDY GEARY

MAC (Module Autonome de Colonisation)

The MAC experiment part satisfies Activity 3.5 in the BENGAL technical annexe, defined as an experimental approach to organic enrichment. The objective is to determine the rate of organic matter degradation, for which macrofaunal organisms are responsible, and whether the response is related to season.

The MAC lander was fitted with 16 experimental trays filled with an inert substrate (10-70 micron glass beads) enriched with ground particulate organic matter in various concentrations. For this deployment we had four sets of four trays enriched with 0, 5, 15 and 50 of ground organic matter.

The lander was deployed with success on Sunday 1st September, at 48°55.31N, 16°34.37W, 4838m. Hopefully it will be recovered in March 1997 during *Discovery* cruise 226.

PHILIPPE CRASSOUS

Benthic gut content analysis and stable isotope ratios (Tasks 69 and 71 of Activity 3.6)

Eighty different species were identified in BC, MC, amphipod trap and OTSB samples (Table 6). These were sampled repeatedly (340 specimens in total), the samples being freeze dried for stable isotope analysis. Reference specimens were preserved in formalin for definitive taxonomic identification and gut content analysis. Smaller organisms were pooled at higher taxonomic levels to achieve sufficient mass for isotope analysis. Detritus (from multiple corer samples) as well as POM in the watercolumn (from SAPS samples) were collected to determine stable isotope ratios in the main food source of the benthic community.

Table 6 Stable isotope analysis samples.

Species Samples	No. of Species
Porifera	1
Cnidaria	11
Echiura	3
Sipuncula	1
Nematoda	1
Mollusca	6
Polychaeta	13
Arthropoda	14
Echinodermata	21
Tunicata	1
Pisces	8
Pooled Samples	
Foraminifera spp.	-
Nematoda spp.	-
Harpacticoidea spp.	-
Isopoda spp.	-
Amphipoda spp.	-
Detritus (Bottom)	-
POM (Surface layer)	-
POM (7450 m depth)	-

TOM BREY & KATRIN IKEN

Organic chemistry of water column particulates

(BENGAL Task 11; UL, SOC)

Background.

Water column particulates are to be collected throughout the duration of BENGAL using sediment traps (see above). Samples from depths equivalent to the two deeper sediment traps deployed by SOC (namely 1800 mab and 100 mab) were collected using a stand alone pumping system (SAPS), in order to compare the quality of formalin preserved samples obtained from the sediment traps with those of fresh particulate material.

Methodology.

The SAPS were deployed as shown in Table 7. Pre-cleaned (dichloromethane-washed) glass-fibre filters (GFD, Whatman, 1.2 μm, 292 mm diameter) were placed in the filter housing prior to deployment. On recovery, the filters were immediately wrapped in clean aluminium foil (methanol wash) and frozen (-50°C).

Table 7: Details of SAPS deployment

Station no.	Position	Water depth (mab)	Pumping time	Volume water (L)
12930#58	48°50.11'N 16°17.16'W	1800	2 h	3000
12930#58	48°50.11'N 16°17.16'W	100	2 h	517

Sediment geochemistry

(BENGAL tasks 50/51; UL, UNIVAN, PATRAS)

Background.

Sediment and pore water samples were collected for the determination of organic (total carbon, organic carbon and nitrogen, lipids, hydrolyzable amino acids and sugars, RNA/DNA) and inorganic (silicates, barite) constituents.

Methodology.

Cores were obtained using the multicorer (SOC), replicates being taken from 7 deployments, as shown in Table 2. Once on board, cores were immediately transferred to the CT laboratory (4°C) and sliced as soon as possible. The cores were sliced using a perspex graduated slicing ring and brass plate as follows: 0-5 mm, 5-10 mm, 10-20 mm, 20-30 mm, 30-40 mm, 40-50 mm, 50-60 mm, 60-100 mm, 100-150 mm, 150-200 mm. Samples were transferred to appropriate containers and immediately frozen (-50°C or -20°C). Sediments to

be analysed for RNA/DNA (UNIVAN) were further sub-sampled (3 replicates from 4 cores) prior to freezing, the sub-samples (*ca.* 1 ml) being fixed in formalin (3%; 3 ml). Whole cores were frozen in order to provide reference material (UL). Pore waters were extracted by centrifugation (2000 rpm, 30 min). Details of the sampling programme are shown in Table 8

Table 8. Fate of sediment samples collected from multicorer as part of BENGAL deliverables 50/51. Key: [a] RNA/DNA, frozen -50°C; [b] Barite, silicates, frozen -20°C; [c] Organic matter analyses, frozen -50°C; [d] Pore-waters extracted, frozen -50°C; [e] Sub-samples for microscopy, fixed formalin, 4°C; [f] Whole core frozen as reference, -20°C.

Date	Station No.	Water Depth (m)	Position	No. of cores	Fate
01/09/96	12930#10	4805	48°49.9'N 16°29.5'W	5	Univan (4)[a] , Patras (1)[b]
03/09/96	12930#18	4804	48°50.3'N 16°29.0'W	5	Univan (1)[a], Patras (2)[b] UL (2)[c,d]
05/09/96	12930#29	4806	48°50.2'N 16°29.2'W	5	Univan (1)[a], Patras (2)[b] UL (2)[c,d]
06/09/96	12930#36	4804	48°51.3'N 16°19.7'W	6	Univan (1)[a,e], Patras (2)[b] UL (3)[c,d,f]
09/09/96	12930#49	4804.5	48°50.8'N 16°29.8'W	5	Univan (1)[a,e], Patras (2)[b] UL (2)[c,d]
13/09/96	12930#66	4806	48°50.2'N 16°30.7'W	6	Univan (1)[a,e], Patras (2)[b] UL (3)[c,d,f]
15/09/96	12930#76	4806	48°50.2'N 16°29.9'W	5	Univan (1)[a,e], Patras (2)[b] UL (2)[c,f]

GEORGE WOLFF, IAN HORSFALL, KOSTAS KIRIAKOULAKIS

Biofeed

BENGAL tasks 64/65; SOC, UL, UCG, UGENT)

Background.

The BIOFEED experiment consisted of a series of artificial enrichments under *in situ* conditions. The experimental objectives were:

1. To determine the response, if any, of micro-organisms, foraminifera and metazoan meiofauna to the influx of organic matter (OM) to the sediments.

2. To establish the degree of sediment mixing (bioturbation) resulting from this response.

3. To assess the rate of degradation of different organic compounds.

Of these, objective 1 is seen as primary, whilst 2 and 3 are desirable. The first deployment of BIOFEED was designed as a trial run for experiments to be conducted throughout the period of the project.

Preparation and Deployment.

The preparation and deployment of BIOFEED was carried out in four stages:

- Collection of particulate material as phytodetritus substrate (SAPS, 12930#3).
- Collection of sediments for incubation (MC, 12930#4).
- Addition of the phytodetritus to core samples.
- Deployment of the BIOFEED lander (12930#7).

Full positions and times are given in Table 9.

Methodology

1. Four SAPS were deployed in the mixed layer at a depth of *ca.* 35 to 40 m (approximately at fluorescence maximum). The SAPS were fitted with large nitro-cellulose filters (1.2 µm; 292 mm diameter; Sartorius). Glass-fibre filters (GFD; 1.2 µm; Whatman) were placed below these. The pumps were run for 1 hour prior to recovery. On recovery, the filters were scraped using a scalpel and the residues transferred to a glass beaker. On completion, the filtered material was washed into centrifuge tubes with the minimum of microbially filtered sea-water. The slurry was centrifuged (2000 rpm, 10 min), and made up to 30 ml, total volume. A portion (3 ml) was frozen (-50°C) for chemical analysis.

2. Twelve good cores were collected using the standard multicorer (12930#4). The core surfaces showed evidence of considerable activity, especially worm casts, but there were only isolated lumps of fluff on the surface. A second set of four cores was collected from a subsequent drop (12930#10) and used as a non-enriched control.

3. The phytodetritus was added to the cores (see Table 10) using an Eppendorf pipette with a modified tip (end cut off). This caused some problems as the pipette did not perform well, hence the volumes added to each tube were probably not accurate and a number of tubes received less material than desired. However, visual inspection of the tubes prior to deployment on the lander showed that the sediment surface was finely covered in a thin layer of detritus.

4. BIOFEED (Figure 14) was deployed successfully on the fish trap frame, reaching the bottom at 1149Z on 1/9/96 (Table 9).

5. BIOFEED was recovered successfully on 18/9/1996 at 1750Z. Sea conditions were calm, and there was no evidence of disturbance at the surface of the cores. Visual inspection showed that features of the original cores (*e.g.* worm casts or mounds) were preserved. Two cores were immediately stoppered and the water was taken for Winkler titration (NIOZ; Table 8). The cores were taken immediately to the CT Lab (4°C). One of the

enriched and one of the control cores were profiled for O_2 using the profiling electrode (NIOZ; Table 10). The other cores were sliced at 5mm intervals to 20mm and at 10mm intervals to 50mm (except UCG who sliced at 10mm intervals to 50mm).

6. Cores incubated at atmospheric pressure were treated in the same way as those from the BIOFEED deployment, except that water oxygen concentrations were not measured.

Table 9: Gear deployments for BIOFEED

Station No.	Date	Gear	Latitude	Longitude	Water Depth (m)	Comments
12930#3	1/9/96	SAPS	48°50'N	16°32'W	35-40	Running time, 1 h
12930#4	1/9/96	MC	48°56'N	16°32.5'W	4782	12 good cores
12930#7	1/9/96	BIOFEED	48°55.3'N	16°36'W	4806	1/9/96 to 18/9/96

Table 10: BIOFEED enrichment experiments

Core	Enrichment	Conditions	Comments	Fate
A1	3 ml SAPS slurry	Atmospheric, 3°C	12930#4 No. 7	UCG - bacteria
A2	3 ml SAPS slurry	Atmospheric, 3°C	12930#4 No. 12	UL - chemistry
A3	3 ml SAPS slurry	Atmospheric, 3°C	12930#4 No. 3	SOC - forams
A4	3 ml SAPS slurry	Atmospheric, 3°C	12930#4 No. 9	UGENT - meiofauna, sedimentary O_2
B1	2.4 ml SAPS slurry	In situ	12930#4 No. 1	UCG - bacteria
B2	1.2 ml SAPS slurry	In situ	12930#4 No. 2	SOC - forams
B3	3 ml SAPS slurry	In situ	12930#4 No. 5	UL - chemistry
B4	2.4 ml SAPS slurry	In situ	12930#4 No. 8	UGENT - meiofauna, water O_2 , sedimentary O_2
C1	No fluff	In situ	12930#4 No. 11	UL - chemistry
C2	No fluff	In situ	12930#4 No. 6	UCG - bacteria
C3	No fluff	In situ	12930#4 No. 10	SOC - forams
C4	No fluff	In situ	12930#4 No. 4	UGENT - meiofauna, water O_2 , sedimentary O_2
D1	No fluff	Atmospheric, 3°C	12930#10 No. 2	UGENT - meiofauna, sedimentary O_2
D2	No fluff	Atmospheric, 3°C	12930#10 No. 5	SOC - forams
D3	No fluff	Atmospheric, 3°C	12930#10 No. 9	UL - chemistry
D4	No fluff	Atmospheric, 3°C	12930#10 No. 11	UCG - bacteria, UGENT - meiofauna

Results and Discussion.

Sediment cores were successfully incubated under *in situ* conditions and, more importantly, recovered intact with no visual sign of disturbance. Enriched cores showed evidence of 'artificial' phytodetritus on their surfaces; this had apparently altered in nature from a thin film to flocculent aggregated material. Phytodetritus also appeared on some of the controls, possibly because material re-suspended by the impact of the landing settled into the core tubes, although there was no evidence of sedimentation of heavier material.

Oxygen profiles of the sediments showed that there had been significant depletion in both enriched and control cores, when compared to fresh cores (Figure 15; Witbaard, personal communication). The gradient of depletion was enhanced, albeit slightly, in the enriched cores. Although oxygen diffusion to the surface of the sediment was presumably impaired and may have been limiting, its concentrations in the overlying water taken from the incubated cores were similar to those measured in bottom-water samples throughout the cruise (Witbaard and van der Weele, personal communication). It should be noted that the overlying water in the cores may have been stratified, in which case oxygen may have been depleted immediately above the sediment surface. Nevertheless, the oxygen profiles suggest that biological activity had continued in the sediments, despite decompression and re-compression of the samples during their recovery and re-deployment on the sea-floor.

Cores incubated at atmospheric pressure were visually different from the cores incubated *in situ*. There was a distinct, thin green/brown film on the surface of the sediment that had apparently not significantly changed in character over the course of the experiment (*cf. in situ* cores, see above). Furthermore, the sedimentary oxygen profiles were distinctly different from those of the cores incubated *in situ* (Figure 16), being comparable to profiles carried out on fresh cores throughout the cruise (Witbaard and van der Weele, personal communication). These observations imply that sedimentary biological activity declined and ceased rapidly in the cores at atmospheric pressure. It is also possible that in these cores, oxygen supply to the sediment surface was not limited, as overlying water was aerated by the cold room fan and by the movement of the ship.

GEORGE WOLFF, IAN HORSFALL, KOSTAS KIRIAKOULAKIS

Holothurian feeding

Three species with differing feeding strategies, *Oneirophanta mutabilis, Pseudostichopus* sp., *Psychropotes longicauda*, were sampled for enzyme profiles and meiofauna. In each case, five replicate specimens of each species were sampled. For enzyme studies, sections of gut were taken from the pharynx/oesophagus, anterior intestine, posterior intestine, and rectum. The contents of each gut section was placed in an Eppendorf and frozen

at -50°C. The corresponding gut tissue was washed with 0.25micron filtered seawater and also frozen. For meiofauna, 1ml of gut content was taken from the pharynx/oesophagus and the rectum, using a cut off 5ml syringe, and stored in plastic vials in 4% formalin.

In addition to these gut samples, the top 5mm of sediment from three multiple corer samples (12930 # 15, 18, 36) was removed and frozen for enzyme studies.

ANN VANREUSEL, ANDY GOODAY

Holothurian gut residence times

(BENGAL task 38)

Background

Holothurians have been shown to have a considerable impact on surficial sediments on the Porcupine Abyssal Plain, and on the organic carbon (OC) contained within them. In order to quantify fully the effect of holothurian feeding activity on the OC, three parameters have to be established. Firstly, the abundance of holothurians needs to be elucidated; this can be achieved by means of trawls, epibenthic sledges and photography. Secondly, the assimilation efficiency of OC through the gut of holothurians needs to be determined by quantification of OC through the sectioned guts. Finally, the feeding rates should be estimated. There have been a number of attempts to assess the feeding rates of deep-sea holothurians, either directly using a submersible to count fresh faecal casts, or indirectly by using doubling times of enteric bacteria.

On this cruise a new method for determining the feeding rate of abyssal holothurians was assessed (NERC GR3/9708). Experimental conditions were varied in order to optimise the procedure.

Method

The gut contents were removed from freshly collected animals (*Oneirophanta mutabilis* and *Pseudostichopus* sp., 4°C) by dissection. The following sections were used in the experiments: complete gut contents, complete gut contents minus the oesophagus, fore gut (oesophagus and anterior gut) contents, hind gut (posterior gut and rectum) contents and also oesophagus gut wall. Gut contents (25-30 ml; pooled from more than one animal if necessary) were diluted to 50 ml with chilled (4°C) artificial sea-water (ASW) in order to facilitate the pipetting procedure. The diluted material (1 ml) was pipetted into screw top centrifuge tubes (1.7 ml capacity; tops modified so as to reduce trapped air bubbles). To these was added leucine-4-amido-7-methylcourmarin (Leu-AMC; diluted with chilled ASW; four additions in the range 2 - 620 nmoles, three replicates per concentration plus two blanks). The sealed tubes were then incubated under *in situ* conditions (1-2 hr, 4°C, 480 bar). Samples with the highest added concentration of Leu-AMC were also incubated at 1 bar (4°C and room

temperature). Blanks were heated (150°C, 5 mins) prior to the addition of Leu-AMC in order to destroy any enzymes. After incubation, tubes were heated (150°C, 5 mins) to kill enzyme activity and were then centrifuged (10 min, 2000 rpm). The fluorescence of the supernatant was then measured (λ_{ex} 375 nm, λ_{em} 440 nm; sample volume, 20-100 µL; borate buffer, pH 10, 1-3 mL). V_{max} values were then calculated using a Lineweaver-Burke plot (Figure 17). Incubations were also carried out on surficial sediments collected using a multicorer.

Gut contents were collected by dissection of other specimens of the same species. Three gut regions were sampled: fore gut (first half of anterior gut), hind gut (rectum and last part of the posterior gut) and the mid gut (remainder of anterior and posterior gut). Oesophagus gut content was not used because of the high probability of contamination from the gut wall. All gut sections were placed into pre-weighed jars and were frozen immediately (-50°C). These will be freeze dried and re-weighed to determine the weight of the gut contents. Material from the fore and hind gut will be analysed for combined leucine. Feeding rates can then be calculated using the following equation:

$$\text{Feeding rate (g/hr)} = V_{max} \times 1/([leu]_{fore}-[leu]_{hind}) \times (½(W_{fore} + W_{hind}) + W_{mid})$$

where:

$[leu]_{fore/hind}$ = combined leucine concentration in the fore/hind gut contents.

$W_{fore/mid/hind}$ = weight of fore/mid/hind gut contents.

Results

Table 11. Gut content incubation experiments.

EXP	Species	Gut sections	No. Animals	Incubation Time (hr)	Other	V_{max} (µmol/hr)	Activity at highest conc.*
1	*O. mutabilis*	All	2	2		0.82	0.969
1	*O. mutabilis*	All	2	2	1 bar, 4°C	n.d	0.843
1	*O. mutabilis*	All	2	2	1 bar, 20°C	n.d.	4.278
1	*O. mutabilis*	All	1	2		n.d.	1.392
2	*O. mutabilis*	All	2	2		1.79	1.427
3	*O. mutabilis*	Oes+Ant	2	1		17.14	4.260
3	*O. mutabilis*	Post+Rect	2	1		4.99	4.438
3	*O. mutabilis*	Oes gut wall	1	1			0.082
4	*O. mutabilis*	All-Oes	2	1		6.15	5.464
4	*Pseudostichopus*	All-Oes	1	1		35.37	18.231
5	Sediment	0-1 cm		2		28.29	3.46

* The activities shown for the highest substrate concentration used can only be compared with values from the same experiment. n.d. = Not determined

Discussion

The higher enzyme activity shown by gut contents incubated at 20°C when compared to those incubated at 4°C implies that the enzymes involved are robust enough to survive the increase in temperature encountered during sampling. The slightly higher activity of incubations at 500 bar compared with 1 bar may suggest a degree of barophilism, although this certainly needs to be tested further. The higher value for gut contents in experiment 1 *vs.* 2 could be due to natural variability in the amount of enzyme in guts. Alternatively it could be due to a significant depletion of substrate within the incubation vials during the course of the incubation which suggests that incubation times should be kept to a minimum. The difference in V_{max} between experiments 1 and 2 might be accounted for through natural variability in the amount of enzyme in gut content.

Experiment 3 showed that enzyme activity (V_{max}) decreased along the gut, most probably as a result of a lower amount of enzyme present in the hind gut section. The activity for the oesophagus gut wall was much lower than for gut content; this is a little surprising, although the two values are perhaps not directly comparable. The low value for gut wall material might increase if the gut wall were homogenised, allowing release of enzymes.

Pseudostichopus showed a much higher V_{max} than did *Oneirophanta;* this could either be due to *Pseudostichopus* having different, more active enzymes than *O. mutabilis*, or simply to the former having higher amounts of the enzyme in its guts. The higher V_{max} for *Pseudostichopus* might also reflect its feeding on more refractory material than *Oneirophanta* and having to process larger volumes of sediment.

Determination of leucine concentrations in fore and hind guts will allow the assessment of the gut residence times. Using data from Horsfall (1995), and the current V_{max} calculations, gut residence times were crudely estimated to be *ca.* 1-6 h. The shorter times are undoubtedly an underestimate, but the longer times are not totally unrealistic for *O. mutabilis*.

IAN HORSFALL

Microbiology

(BENGAL Activities 3.1 and 3.5; UCG)

Objectives

The main objectives of the microbiological studies were to assess techniques to be used on subsequent BENGAL cruises and to provide initial data for the BENGAL series. Specific BENGAL objectives were:

1) To collect sediment and sediment contact water samples (Task 52)

2) To carry out microbial activity determinations on samples and to preserve material for determinations of bacterial abundance and analyses of community structure. (Task 53)

3) To obtain gut content samples from holothurians obtained by OTSB (Samples to be treated as per objective 2: Task 68a)

4) To participate in the BIOFEED experiment (Tasks 64, 65)

In addition, sediment samples taken by Anne Vanreusel (UGent: Task 62) in association with Activity 3.4 "Bulk seasonal dynamics of the total BBL community" were subsampled to provide material for subsequent analyses of bacterial abundance (task 63a).

An additional objective was to study changes in bacterial abundance and activity in a near surface water sample held under deep sea conditions in order to assess the possibility of adaptation in bacteria carried to the sea bed by phytodetritus.

Methodology

Sediment samples were obtained by multicorer and sectioned in 1cm intervals to 5cm. Analyses of community structure in deep ocean water samples by nucleic-acid-based-methods requires the harvesting of bacteria from large volumes of water (40-60 litres). This may be achieved by *in situ* filtering using stand alone pumping systems (SAPS) or by filtering on board using a tangential flow filtration system. Previous studies by us have shown that the unique bacterial community of the sediment contact water (SCW) is closely confined to the bottom metre or two of the water column. It was hoped that the large tube diameter multicorer (megacorer) could be used to obtain sufficient quantities of SCW for on deck filtration, but deployments were unsuccessful. In the event, both SAPS and tangential flow concentration of samples obtained with the CTD rosette were used to obtain material for community structure analyses from near surface and deep waters. SAPS were also used to provide near surface particulate material as substrate for the BIOFEED experiment. Vertical hauls with a phytoplankton net (12930#2 and #57) were carried out over the top 100m of the water column. Subsequent study of the material obtained will indicate the type of phytoplankton material used for BIOFEED.

Samples were preserved for subsequent onshore study of bacterial abundance by epifluorescence microscopy and photomicrography in order to determine the numbers and biovolume of bacteria present. Samples for bacterial counts were routinely taken as part of activity measurements and during sampling (other than by SAPS) for material for community structure analyses.

Bacterial activity was investigated by observing the incorporation of radiolabelled compounds by samples incubated at both surface (1at) and sea bed (480at) pressures. All incubations were carried out at the near - bottom temperature of 3^{o}C and were for intervals

up to approximately 18hrs. Bacterial DNA production was followed by the incorporation of [methyl-^{3}H] thymidine, and protein production by the incorporation of L-[4,5 -^{3}H] leucine. Modifications were incorporated into our previous methods to improve sample homogenisation and cut down on the quantity of material used. In the case of thymidine incorporation, modifications of technique also included the use of an on-filter washing technique to decrease background radioactivity and the incorporation of Garet and Moriarty's improved method of DNA extraction (Garet and Moriarty 1996, *Journal of Microbiological Methods* **25:** 1-4). It was hoped to carry out all processing of samples and counting of incorporated radioactivity on board. A limited number of sediment samples were processed, before it became impossible to carry out centrifugation due to disintegration of the centrifuge buckets. This has been a recurring problem which we believe is associated with the ship's motion and operation at low temperatures. Subsequently, all samples other than water were taken to the post-incubation fix step and stored for processing onshore. Comparison between these and the limited number of samples processed on board will determine the viability of this procedure which, if successful, will be used on future cruises.

The three species of holothurian examined were *Oneirophanta mutabilis, Psychropotes longicauda* and *Pseudostichopus sp.* Dissections concentrated on the gut contents in each case. These were divided into four sections; the oesophagus, the anterior intestine (foregut), the posterior intestine (Midgut) and the rectum (hindgut). The oesophagus is the shortest section and consequently has the least amount of material. Activity studies were thus confined to the other three regions where it was possible to combine the gut contents of several members of the same species in order to get enough material to perform uptake experiments.

Full details of BIOFEED are given elsewhere. Horizons at 1cm intervals to 5cm were sampled for thymidine and leucine incorporation and bacterial biomass determinations (cores A1, B1 and C2) and for bacterial biomass determinations only (core D4).

Results and discussion

Activity

Table 12 lists the samples on which activity determinations were carried out.

Table 13 presents preliminary results of those thymidine incorporation experiments which were processed on board. It should be noted that rates quoted here are calculated per unit volume of sample, and expression of these results in the more meaningful biomass - specific form must await the onshore determination of bacterial numbers and biovolumes.

Table 12. Samples for bacterial activity determinations. All samples from station 12930. Thy = thymidine incorporation. Leu = leucine incorporation. on board = processed and counted during cruise. stored = preserved for on-shore processing.

Series	Gear	Sample	Subsequent processing
15	Multicorer	2 cores	Thy (on board), Leu (stored)
37	OTSB	*Oneirophanta mutabilis* gut contents	Thy (on board), Leu (stored)
64	OTSB	*Pseudostichopus* gut contents	Thy (stored), Leu (stored)
66	Multicorer	1 core	Thy (stored), Leu (stored)
66	Multicorer	SCW	Thy (on board)
78	OTSB	*Psychropotes longicauda* gut contents	Thy (stored)

Bacterial activity appears to be barophilic at the community level in both sediment and SCW. Incorporation rates exhibited by sediment samples at *in situ* temperature and pressure are approximately an order of magnitude higher than those measured at this site in samples taken immediately prior (10/4/1994) to the main spring-bloom-associated deposition of phytodetritus. They are also an order of magnitude higher than those determined for the oligotrophic Southern site (4560m deep: 21°3'N:31°11.5'W) studied as part of the MAST 2 project "Community structure and processes in the deep sea benthos." Deep water at the southern site does not appear to receive any strong seasonal input of organic material. Incorporation rates by bacteria in gut content samples are surprisingly low, and show at best a baroduric response at community level. It is possible that delays during trawl recovery and holothurian dissection allowed warming of the samples with consequent partial destruction of the bacterial flora. Alternatively, delays during post incubation processing, caused by problems with centrifugation, may have had some effect.

Table 13. Thymidine incorporation by sediment, SCW and holothurian gut contents. For definitions of fore, mid and hindgut see methods.

Material	Sample horizon/type	Thymidine incorporation (fmol/cc/hr) at 1 at.	Thymidine incorporation (fmol/cc/hr) at 480 at.
Sediment (#15)	0-1cm	6	19
	1-2 cm	6	37
	2-3 cm	7	23
	3-4 cm	11	40
	4-5 cm	22	20
SCW (#66)		$6x10^{-3}$	$12x10^{-3}$
Oneirophanta gut contents (#37)	foregut	1	1
	midgut	2	2
	hindgut	5	7

Adaptation of a surface water bacterial community

Water was obtained from a depth of 150 metres by CTD rosette (12930#1) and stored at 3°C and at both 1 and 480 atmospheres pressure. Samples were retrieved at intervals and their short term (12hr) rate of thymidine incorporation determined at both 1 and 480ats. Samples were also preserved for subsequent analyses of bacterial biomass. Thymidine incorporation results are presented in Table 14.

Table 14 Rates of thymidine incorporation (in fmols/l/hr measured over 12 hrs) surface water samples stored at deep ocean and surface pressures.

Storage period (days)	Stored at 480ats Incorp. at 1at	Stored at 480ats Incorp. at 480at	Stored at 1at Incorp. at 1at	Stored at 1at Incorp. at 480ats
0	5	0	5	0
4.4	0	0	3	0
8.3	0	0	77	0
12.3	0	0	213	0
15.8	28	81	3481	89

Samples stored at surface pressure showed an exponential increase (after a lag of approx. 4 days) in incorporation at 1at. This probably represents growth of the bacterial community which was stored at approximately its *in situ* pressure. Both initially, and after storage at 1at for up to 12 days, no uptake could be detected at 480at. The uptake at 480at shown by samples stored at 1at for 16 days may be the resultant of this exponential increase in bacterial numbers and may be insignificant on a cell-specific basis. Storage at 480at completely suppressed uptake at both 1at and 480at for up to 12 days. The barophilic community response exhibited after 16 days could be the beginning of adaptation. Alternatively it is possible that the surface sample was contaminated with deep water since the cast from which the sample was obtained was a deep one. The subsequent calculation of cell specific rates may shed more light on this.

Samples for community structure analyses

Samples of holothurian gut contents were preserved in 40% glycerol and frozen at -20°C for community structure analysis using nucleic acid - based techniques. The gut walls from the four gut sections were also preserved in 40% Glycerol as well as in 2% Gluteraldehyde for Electron microscopy and Fluorescent *In Situ* Hybridisation Analysis.

SAPS filters were also frozen at -20°C in 40% Glycerol for community structure analysis.

CTD rosette water was taken and the bacterial fraction concentrated using the Tangential Flow Apparatus with a 2µM cartridge filter. Although the sample volume varied, the concentrate in each case was about 250ml and this was frozen in glycerol as above for community structure analyses.

The following list summarises the samples taken and their preservation.

Haul	Gear	Sample Taken	Preservation
15	Multicorer	One core was sectioned every cm to a depth of 10 cm.	Sediment was frozen @ -20°C
26	OTSB	Gut Contents and gut walls from all 4 sections of gut in all three species of holothurian	In 40% Glycerol @ -20°C [& several Gut Walls in 2 % Gluteraldehyde @ -20°C]
33	CTD Rosette	25L Water taken @ 8 MAB and concentrated using the Tangential Flow apparatus	In 40% Glycerol @ -20°C
34	SAPS	878L were filtered @ 150M.	In 40% Glycerol @ -20°C
36	Multicorer	One core was sectioned every cm to a depth of 10 cm.	Sediment was frozen @ -20°C
37	OTSB	Gut Contents and gut walls from all 4 sections of gut in Oneirophanta	In 40% Glycerol @ -20°C
41	CTD Rosette	50L Water taken @ 8 MAB and concentrated using the Tangential Flow apparatus	In 40% Glycerol @ -20°C
46	OTSB	Gut Contents and gut walls from all 4 sections of gut in all three species of holothurian	In 40% Glycerol @ -20°C [& several Gut Walls in 2 % Gluteraldehyde @ -20°C]
49	Multicorer	two cores were sectioned every cm to a depth of 10 cm.	Sediment was frozen @ -20°C
58	SAPS	1050L were filtered @ 3000M & 514L were filtered @ 100MAB	In 40% Glycerol @ -20°C
64	OTSB	Gut Contents and gut walls from all 4 sections of gut in Pseudostichopus	In 40% Glycerol @ -20°C
66	Multicorer	One core was sectioned every cm to a depth of 10 cm.	Sediment was frozen @ -20°C
77	SAPS	1645L were filtered @ 100MAB	In 40% Glycerol @ -20°C
78	OTSB	Gut Contents and gut walls from all 4 sections of gut in Psychropotes .	In 40% Glycerol @ -20°C
92	CTD Rosette	25L Water taken @ 8 MAB and concentrated using the Tangential Flow apparatus	In 40% Glycerol @ -20°C
94	CTD Rosette	30L Water taken @ 150M and concentrated using the Tangential Flow apparatus	In 40% Glycerol @ -20°C

SAPS

Four RVS Stand Alone Pumping Systems were used in four deployments. All pumps worked successfully and no problems were experienced.

12930#3 48 50N, 16 29W

All Filters were 1.2µM cellulose Nitrate.

Pump	Sample	Depth	Delay	On Time	L pumped
SAPS 1	Biofeed	30M	0.5 Hr	1 Hr	574L
SAPS 2	Biofeed	34M	0.5 Hr	1 Hr	583L
SAPS 3	Biofeed	37M	0.5 Hr	1 Hr	501L
SAPS 4	Biofeed	40M	0.5 Hr	1 Hr	650L

12930#34 deployment; 49 2N, 16 19W

Pump	Sample	Filter	Depth	Delay	On Time	L pumped
SAPS 1	Stable Isotopes (Bremerhaven)	Glass Fibre (Whatman GFF)	40M	0.5 Hr	1 Hr	927L
SAPS 2	Community Structure (UCG)	cellulose nitrate 1.2µM	150M	0.5 Hr	1 Hr	878L

12930#58 deployment; 49 1.5N, 16 20W

Pump	Sample	Filter	Depth	Delay	On Time	L Pumped
SAPS 1	Chemical Analyses (UL)	Glass Fibre (Whatman GFF)	3000 M	2 Hr	2Hr	3151L
SAPS 2	Community Structure (UCG)	cellulose nitrate 1.2µM	3000 M	2 Hr	2 Hr	1050L
SAPS 3	Chemical Analyses (UL)	Glass Fibre (Whatman GFF)	100 MAB	2 Hr	2 Hr	1874L
SAPS 4	Community Structure (UCG)	cellulose nitrate 1.2µM	100 MAB	2 Hr	2Hr	514L

12930#77 deployment; 48 48N, 16 29W

Pump	Sample	Filter	Depth	Delay	On Time	L pumped
SAPS 2	Stable Isotopes (Bremerhaven)	Glass Fibre (Whatman GFF)	100 MAB	2 Hr	2 Hr	2420L
SAPS 3	Community Structure (UCG)	cellulose nitrate 1.2µM	100 MAB	2 Hr	2 Hr	1645L

JOHN PATCHING, MICHAEL CARTON

Opal as a productivity proxy

(BENGAL Activity 4.2; IUEM)

The objective of these studies is to characterise the levels of silica in the water column and sediment at the BENGAL station and to use the resulting data to construct a model of the silica cycle.

Water column samples

Seven deployments of the PNF300 to determine PAR (Photosynthetically Available Radiation) were made to a depth of about 100m. The data from these deployments were used to determine the depths from which shallow water samples were collected from the CTD casts.

Eight CTD casts were made; four shallow (water samples from 5 depths down to 80m) and four deep (water from 5 depths between 100m and 4880m). All CTD casts were made during the night

The water samples from each depth will be analysed for ammonium, silicate and nitrate. Water samples for particulate biogenic silica, chlorophyll and particulate organic carbon were first filtered.

Water samples from shallow depths were taken for on deck-productivity experiments. Water samples were inoculated with ^{14}C labelled sodium bicarbonate for total productivity determinations and ^{30}Si labelled silicate for biogenic silica production determinations. The water samples were incubated on deck for 24 hours and then filtered.

Sediment and pore water samples

Six sediment cores were taken from five multicorer deployments. They were sliced on board (every 0.5cm for the first two centimetres, every 1cm down to 10cm and every 2cm to the bottom). The sediment samples were centrifuged and the pore water extracted. The sediment samples were then frozen and will be analysed in the lab for biogenic silica. The pore water samples were stored at 4°C and will be analysed for silicate.

ANN HAUVESPRE

Ornithology

Standard ten-minute bird observations were made from the bridge throughout the cruise as and when other commitments allowed. Casual sightings were noted as appropriate. In all, 155 observations were made over 25 days, an average of 6.2/day, somewhat short of the target of 8/day, and 45 casual sightings recorded.

Weather during the cruise was fine for the most part. Winds were light to moderate with gales (≥34knots≡17.4m/sec) recorded on three days only (16, 17, 19 September). The wind spectrum was unusual in that for almost half of the period (12 days: 2-12, 19-20 September), winds were from NE, E or SE. Visibility was mainly good, with persistent rain only on 22 September.

The cruise falls into three parts; passage out to the work area, occupation of the EC Station, and the return passage. The two passage legs were short, and can be considered together.

Passage to and from the EC Station (29-31 August, 22-24 September; 19 observations)

Seven species of seabird were recorded. On both passage legs procellariiforms (shearwaters, petrels, etc) dominated over deep water and other seabirds occurred mainly over the shelf. In August Cory's shearwater (*Calonectris diomedea)* was the commonest species beyond the shelf break. Gannets (*Sula bassana*) and herring gulls (*Larus argentatus*), the latter in September only, were the most abundant species over more inshore waters.

European Community Station, 48°50'N 16°30'W (31 August-22 September; 136 observations)

Nineteen species of seabird were recorded. Despite the relatively high species diversity, numbers of birds were low in general, with 42 observations (30%) producing no sightings. The only exception was the greater shearwater (*Puffinus gravis)* which occurred more frequently (26% of observations) and in greater numbers (350, 7 September; 300, 10 September; 1000 21 September) than any other species. Other relatively common entities were fulmar (*Fulmarus glacialis*) and lesser black-backed gull (*Larus fuscus)* (30 observations, 22%), Cory's shearwater (26 observations, 19%), and gannet (18 observations, 13%), but only rarely were as many as ten individuals seen at any one time. Almost all gannets and lesser black-backed gulls seen were birds of the year, conforming to patterns of more extensive dispersion or migration among young birds than adults. Low numbers of fulmars and near-absence of kittiwakes (*Rissa tridactyla*) together with a marked trend among both shearwater species to fly in southerly rather than northerly directions suggests that the cruise covered the transition from late summer to autumn bird communities at this locality.

The prevalence of generally easterly winds during the cruise resulted in high numbers and diversity of land birds on the ship. A minimum of 16 species occurred, of which meadow pipit (*Anthus pratensis*) and wheatear (*Oeanthe oeanthe*) were the most abundant, short-eared owl (*Asio flammeus*) and kestrel (*Falco tinnunculus*) the most spectacular, and a female/juvenile red-breasted flycatcher (*Ficedula parva*) the most surprising. The latter

breeds in central and eastern Europe and into Asia, and migrates SE to winter in India and SE Asia.

MIKE THURSTON

WASP (Wide Angle Seafloor Photographic) System (Figure 7)

(BENGAL tasks 37 and 39)

The WASP system consists of a camera and flash unit which are controlled using an acoustic telemetry unit. Mounted on a frame which is suspended from the ship to within a few metres of the seafloor, WASP takes photographs at preset intervals as the ship drifts slowly over the bottom. The acoustic monitor relays height information to the ship and switches on the camera system when within a pre-set range of the seabed. The camera system is fitted with a near-bottom altimeter which sends time (acoustic pulse to bottom and back to altimeter) data to the camera which is converted into height (cm) and logged onto the film to provide a scale for film analysis.

The system had been used on *Charles Darwin* cruise 101c but had never worked properly. Accordingly, the camera system designer and supplier (NJG) participated in this cruise with the objective of sorting out the problems.

Nine WASP deployments were made during the cruise. Considerable progress was made, but although some usable frames were obtained, the system never worked to its full specification. This was not helped by the flooding of the monitor on the first deployment (see below). But irrespective of this, faults in the altimeter and camera control software would have precluded a significant improvement. Clearly, the system needs considerable attention before it can be relied upon to produce the results required.

Deployment 1. (#16) The gear was shot at 0105/3 and reached the bottom at 0319. All appeared to be well, the monitor working satisfactorily for the first few minutes. But rapidly the trace went haywire and hauling began at 0332. When the gear came aboard at 0511 the monitor was found to be flooded. Although the PCB set was immediately washed in fresh water, then distilled water and allowed to dry overnight, one of the three boards was irreparable because the surface mount IC legs were corroded off and some of the tracks had dissolved. The monitor was therefore unusable on subsequent deployments.

No usable photographs were obtained.

Deployment 2. (#31) The frame was fitted with a conventional pinger in place of the monitor. In the absence of the monitor, the camera "Range Gate" was enabled. This is one of the many added features in the camera system software which allows data from the altimeter to control the camera operation directly, rather than via the monitor (but see below).

The gear was shot at 1159/5 and reached the bottom at 1357. Although the direct and reflected traces from the pinger merged at an altitude of 10-15m, by judicious choice of pallets on the waterfall display it proved possible to fish the gear with some confidence. The system was fished in this way within ten metres of the bottom until hauling began at 1609.

On retrieval it transpired that the camera had taken some tens of frames, but all long before the gear had reached the bottom. The problem appeared to be a fault in the camera-altimeter software. When the range gate in the camera software is enabled, but the camera fails to set up the altimeter and no meaningful altimeter data is therefore received, a photograph is taken anyway. A failure rate due to this problem should result in an approximately 5% of the photographs taken in this way. When the gear is within the desired altitude range of the bottom this would be acceptable. However, during this haul all of the photographs taken were triggered in this way and the camera failed before reaching the bottom. Consequently the haul was a total failure.

Deployment 3 (#43) On this deployment the camera was controlled by an internal timer (alarm) to exclude any useless frames (as above). Range gate disabled. The altimeter was therefore simply to supply data to the camera for logging on each frame. The gear was shot at 0438/8, reached the bottom at 0615 and was fished on the pinger until hauling began at 0824 and the gear was retrieved at 0951. No usable frames were obtained; the altimeter had caused a lock-up of the camera software when an unknown character was received. This deployment was another total failure and the ME altimeter was not functional for the remainder of the cruise.

Deployment 4 (#47) The gear was shot at 1136/9, with no altimeter fitted and with the camera timed to start at 1315. The system reached the bottom "window" at 1309 and was fished until 1520, being inboard by 1646. Instead of the expected c800 frames, the camera had actually taken only about 200 because a lack of back-tension on the take-up spool had caused a slack turn to gather around the capstan until the motor overcurrent limit trip turned the camera off. The best run so far, but of limited use with no altimeter data and therefore no scale.

After this haul the camera was fitted with a new clutch and several spools of film were run through on the bench in an attempt to run it in.

Deployment 5 (#54) Since no altimeter was again available, a buoyancy sphere hard-hat (c 300mm diameter), weighted with chain, was suspended 3m below the WASP frame to be in the field of view of the camera and to cast a shadow on the bottom within the frame area from an altitude of about 10m. The gear was shot at 1801/10 with the camera timed to start at 1945. The WASP reached the bottom window at 1932, was fished until 2118 and was inboard at 2242. Again the camera stopped prematurely, was bench tested again, and some of the defaults changed (see below). The B/W film developed showed that the target and

shadow were clearly visible and would give an acceptable range in the absence of altimeter data, though obscuring large parts of the photographed area.

Deployment 6 (#70) Fished as in the previous deployment, but with new defaults.

Gear shot at 2131/13, camera started on internal timer at 2305, reached bottom window 2308, hauled at 0105/14, inboard 0250. The camera had again been loaded with B/W film and, from the sections developed (start and end), appeared to have worked satisfactorily throughout.

The acoustic monitor pressure casing was sent down on this deployment for a pressure test and was found to be flooded when retrieved.

Deployment 7 (# 74) Following the relative success of the previous deployment, the same arrangement was used on this deployment, that is with the suspended target but no altimeter, and this time with E5297 colour film. The gear was deployed at 2325/15, reached the near bottom window at 0100/16 at the same time that the camera was programmed to start, was fished until 0330, and was all in at 0450.

The film had passed through the camera which therefore seems to have operated correctly within the limits of the technique used.

Deployment 8 (# 85) Although the ME altimeter was unusable, we also had on board the Simrad Altimeter from the SHRIMP system. Over the couple of days prior to this deployment we had ascertained that this altimeter could output RS 232 data suitable for logging by the WASP camera. Accordingly, on deployment 8 the Simrad altimeter was fitted, together with the suspended target, though the camera's internal timer again controlled the start time. The frame was also fitted with an NIOZ video camera directed forwards and downwards at about 20 degrees from the vertical. Both the video camera and the still camera were programmed to start at 0300.

The gear was shot at 0145/19, reached the bottom window at 0315, was fished until 0530, and was all in at 0655. The camera appeared to have worked satisfactorily, exposing about 30m of film. The B/W film was part developed on board and confirmed that the altimeter data printed on the frame edges appeared to agree with the indications of altitude from the suspended target and shadow.

Deployment 9 (#97) Having reached the point where we appeared to be able to record reliable altitude data on the film, we now used the same arrangement as that on deployment 8, but without the suspended target and with the camera loaded with E5297 colour film. The video camera was also used, but with fixed focus instead of autofocus as on the previous deployment. Unfortunately, since this was the final scientific operation of the cruise apart from the attempt to retrieve the NIOZ lander, it was tightly constrained for time. The gear

was shot at 2037/21, reached the near-bottom window at 2156 and had to be hauled at 2237. On retrieval, the camera again seemed to have worked satisfactorily.

Conclusions and future actions

Despite having invested in excess of £60K in this WASP system it still does not work to specification. There were, and still are, a number of significant problems.

Acoustic monitor needs to be rebuilt and tested.

At the beginning of the cruise the M7 camera software had a number of faults, the following now corrected:

1. Take-up spool Clutch Tension set initially too low - now increased.

2. Motor overcurrent limit set too low. (was 300mA, - now 400mA)

3. Supply voltage limit set too high. (was 9v - now 7v)

4. Supply voltage maximum drop set too low. (was 2v - now 3v)

5. Flash charge time too short (was 5 sec - now 10sec)

In addition, the ME altimeter needs attention and a time-out loop will be added to the camera software to cope with incoming altimeter data strings - any unknown characters will be ignored. All of these faults will be dealt with before the next BENGAL cruise.

TONY RICE, BRIAN BETT AND NIGEL GRIFFIN

EPILOGUE

In general, the cruise was rather successful. The weather was unexpectedly good for this time of year and, accordingly, we lost only 44 hours to this cause and only 49 hours in all. The ship and crew worked extremely efficiently and relationships between the scientific personnel and the ship's side were as good as I can remember on any cruise. Accordingly, most of the scientific party enjoyed the cruise and obtained most of what they hoped for in terms of data, samples and valuable experience for future BENGAL cruises.

The down side was the failure to obtain as many good box cores as we had hoped, our lack of success with the megacorer, the problems with the WASP system, the failure of the long term Bathysnap camera, the lack of time to use the SOC epibenthic sledge and particularly, of course, the loss of the IFREMER beam trawl and the NIOZ lander.

The loss of the beam trawl meant that we are still unable to compare directly the catches of this gear with those from the otter trawl and sledge. But a replacement beam trawl is available and the comparison will hopefully be made on future cruises. The loss of the

NIOZ lander is potentially much more serious. Several BENGAL objectives, involving a number of partners, are dependent upon results from this lander system. Although, at the time of writing (October, 1996) plans are already underway to replace the lander itself, it may be impossible within the life time of BENGAL to replace the wide range of instrumentation which the original lander carried.

Finally, the cruise demonstrated that very diverse groups with extremely variable objectives and technology can work efficiently and harmoniously on *Discovery*. However, several BENGAL partners, and several pieces of over-the-side BENGAL gear, were not present on this cruise. It would be difficult, if not impossible, to accommodate them all. This problem needs to be considered carefully in planning the main series of cruises in 1997 and 1998.

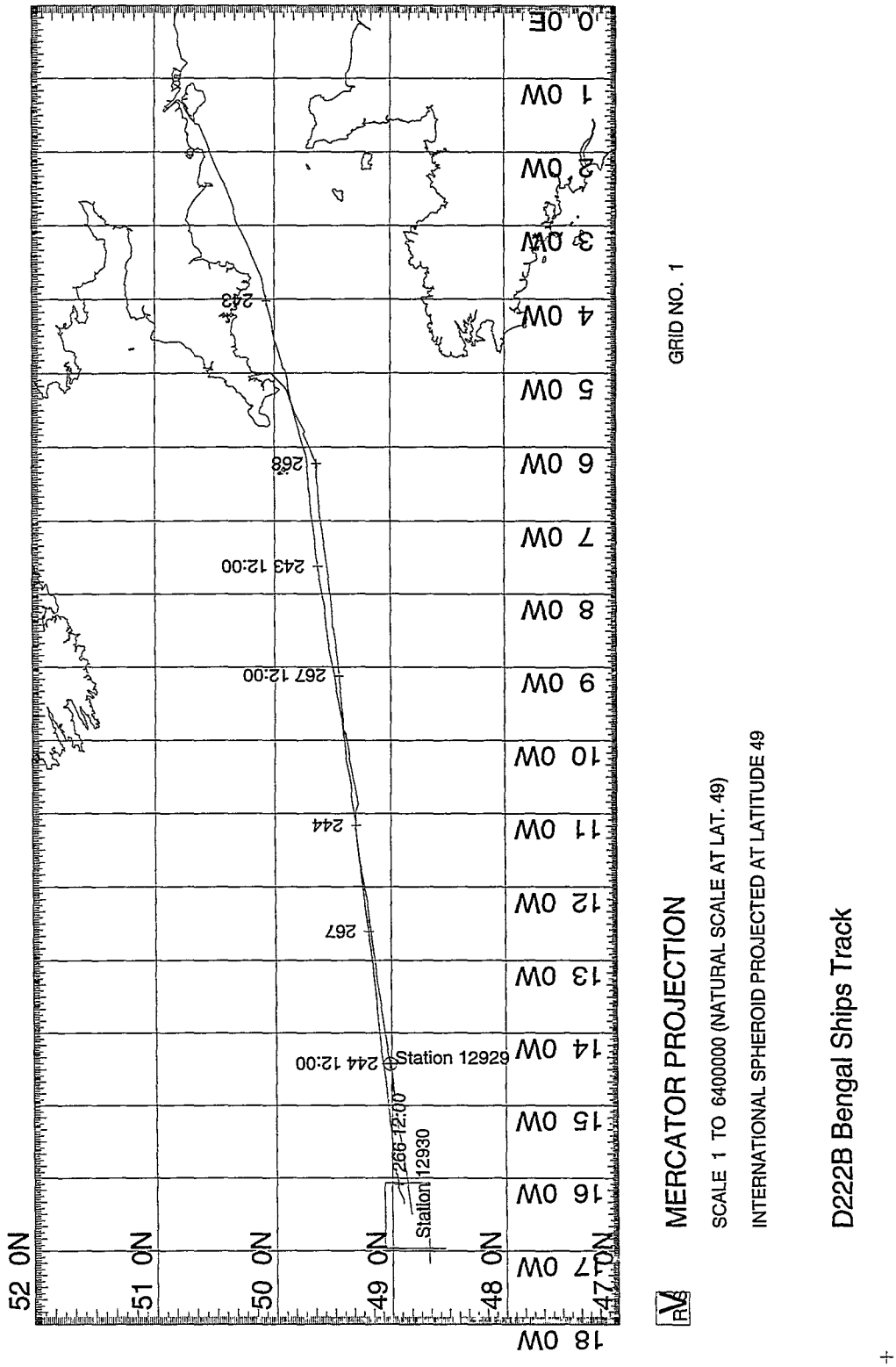


Figure 1 Discovery cruise 222, leg 2, track chart and main working area.

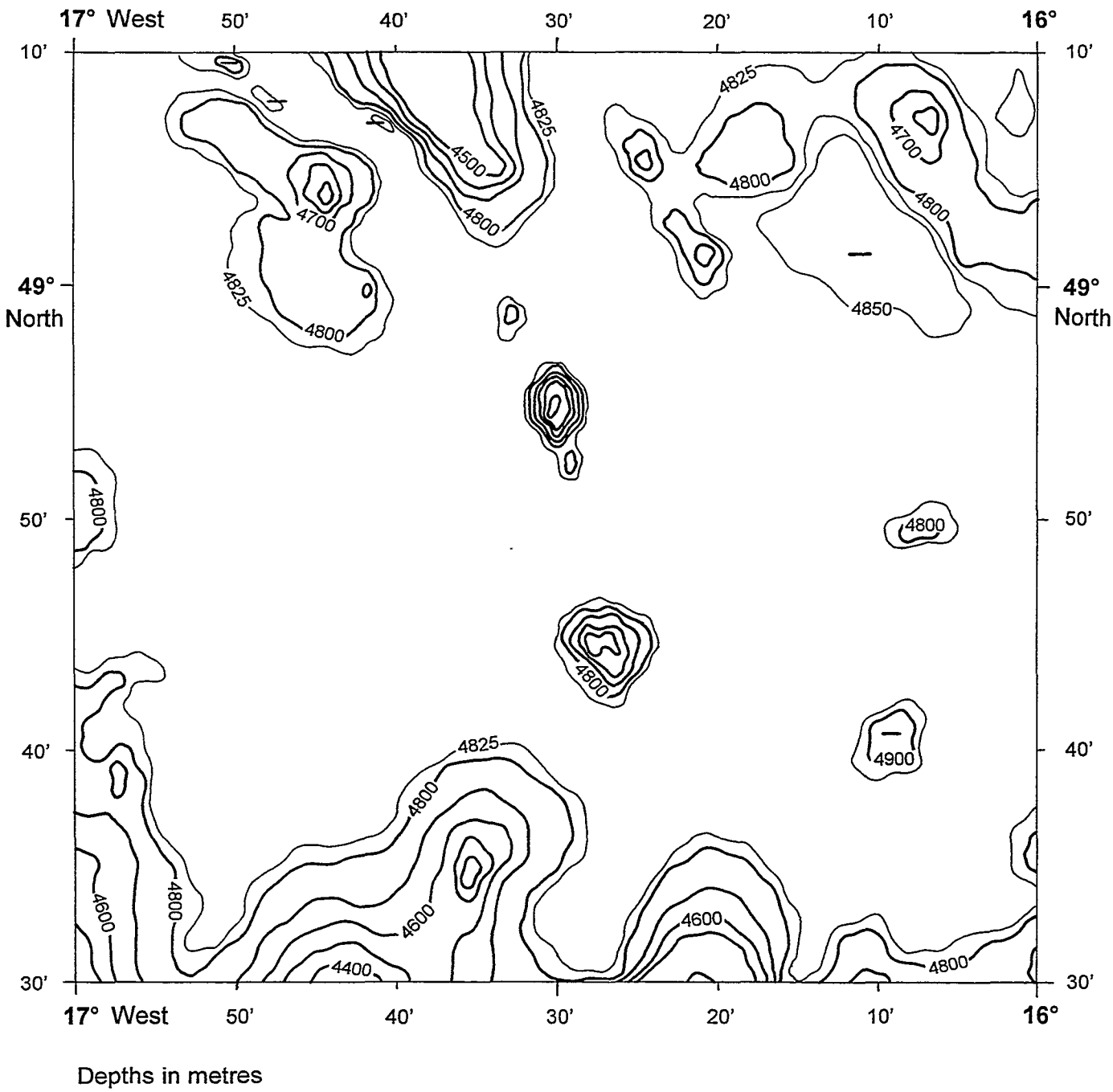


Figure 2 Bathymetry of the Porcupine Abyssal Plain in the vicinity of the BENGAL study site, based on data collected up to and including Discovery cruise 222. [*We are grateful to Peter Hunter for providing this up to date version of the bathymetric chart.*]

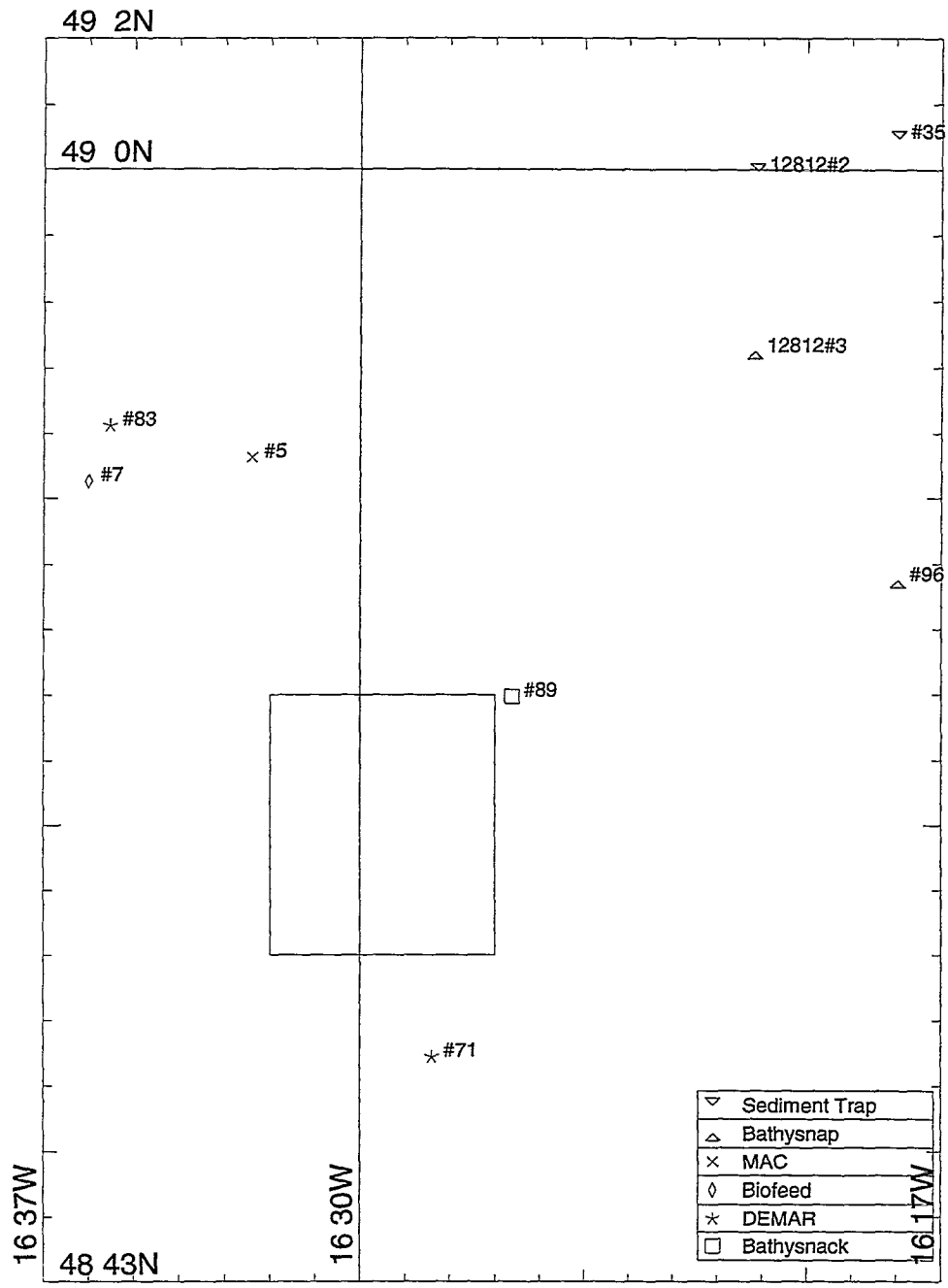


Figure 3 Positions of the short-term and long-term moorings other than the NIOZ lander deployments.

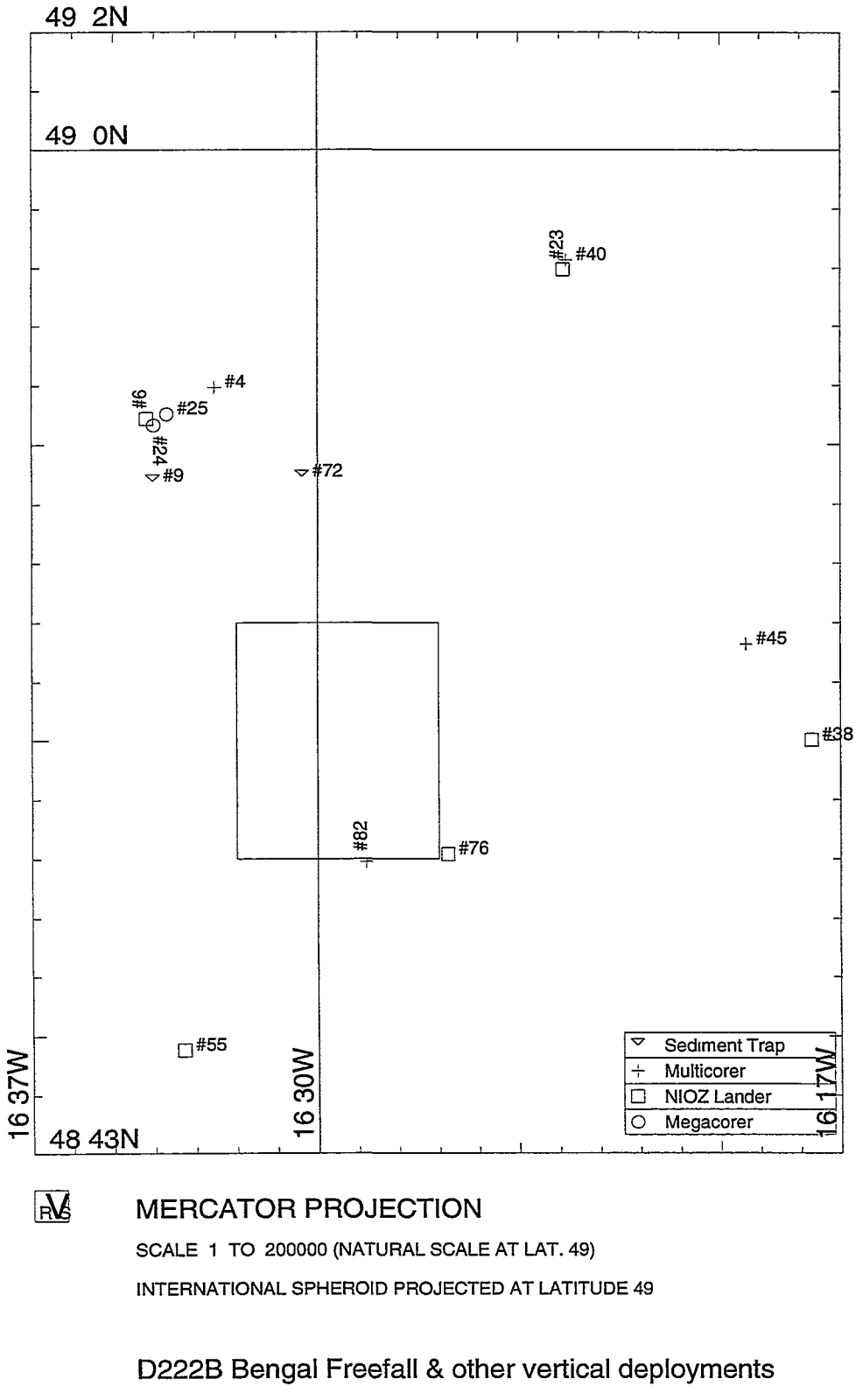
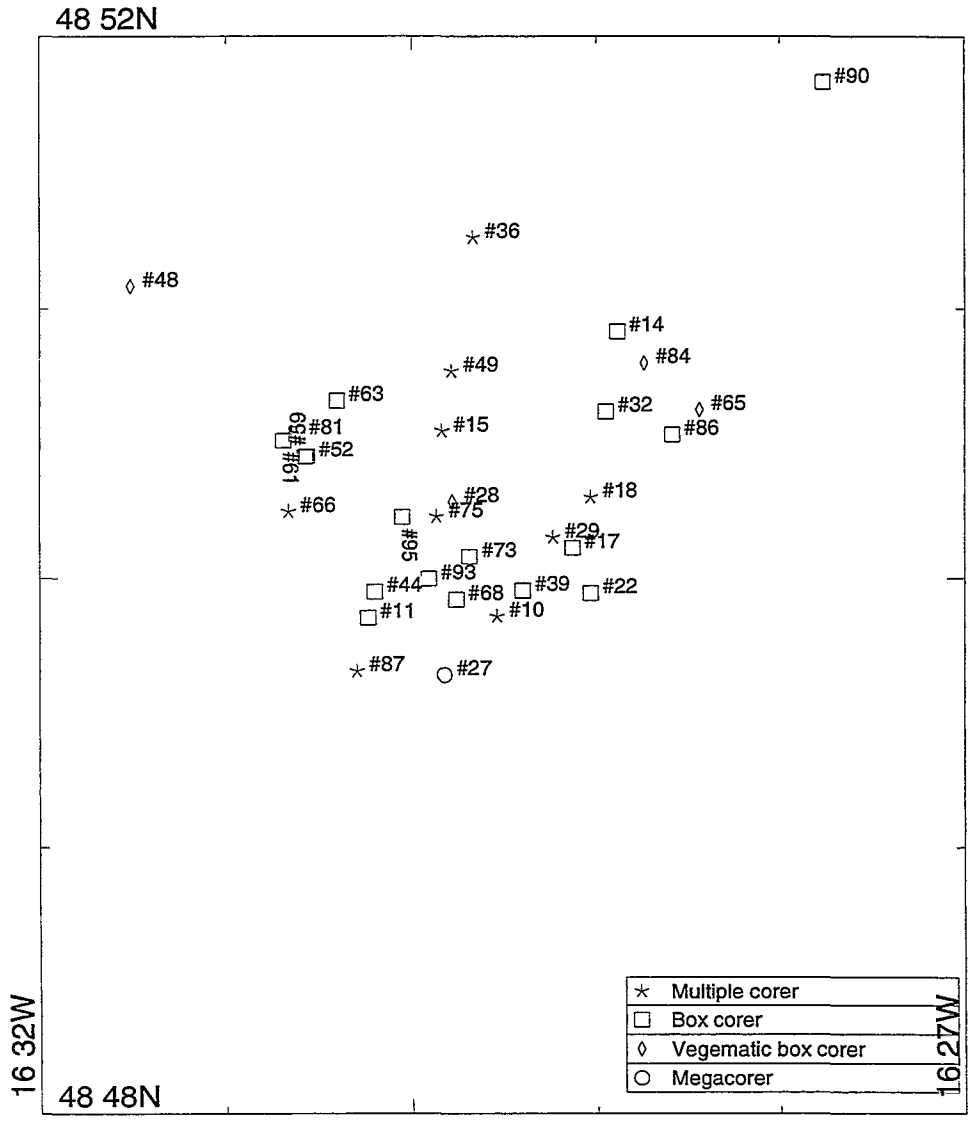


Figure 4. Positions of the NIOZ lander deployments and the associated multicorer, megacorer and short-term sediment trap deployments.



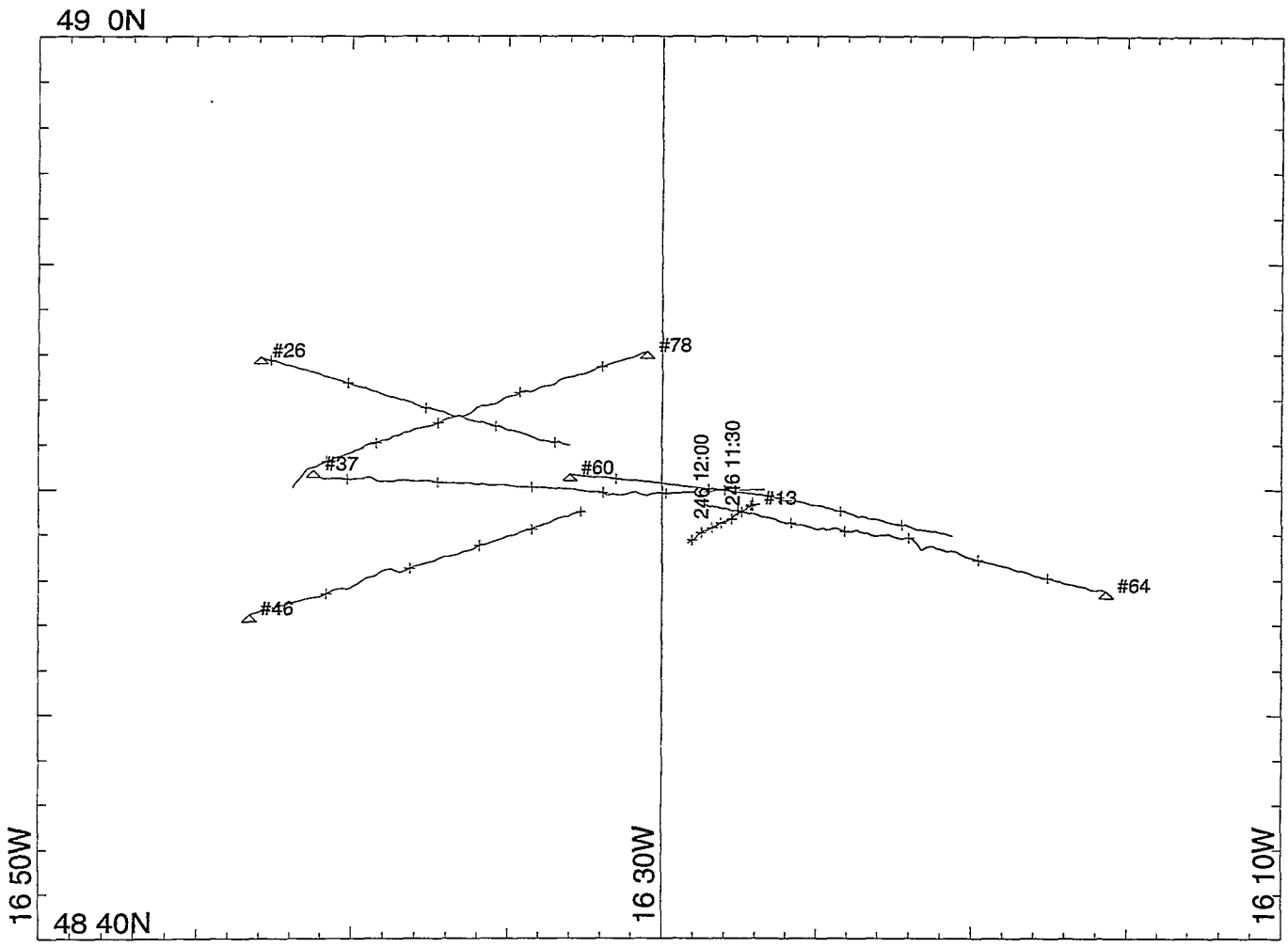
MERCATOR PROJECTION

SCALE 1 TO 50000 (NATURAL SCALE AT LAT. 49)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 49

D222B Bengal Freefall & other vertical deployments

Figure 5 Positions of the multiple corer and box corer deployments close to the station centre position.



MERCATOR PROJECTION

GRID NO. 1

SCALE 1 TO 280000 (NATURAL SCALE AT LAT. 49)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 49

D222B Bengal Towed Gear (OTSB 14 & Chalut)

Figure 6 Estimated bottom tracks covered by the OTSB deployments and the beam trawl.

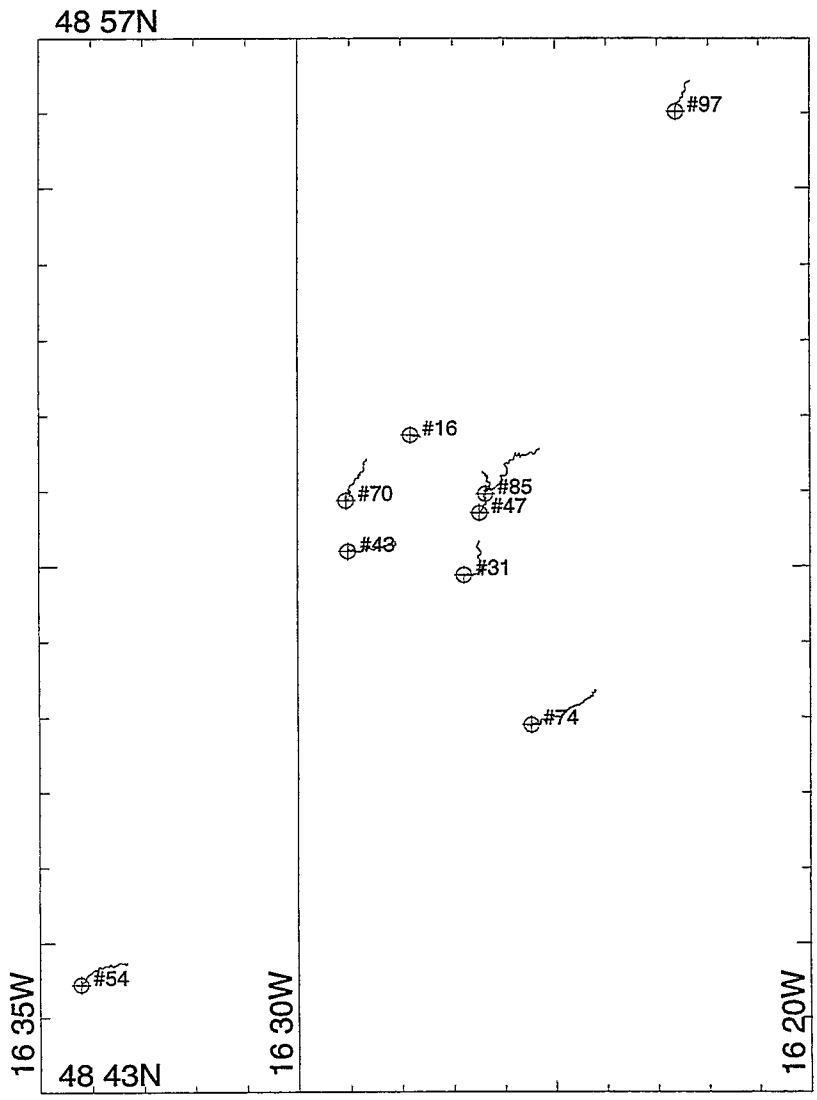


Figure 7. Positions of the WASP deployments.

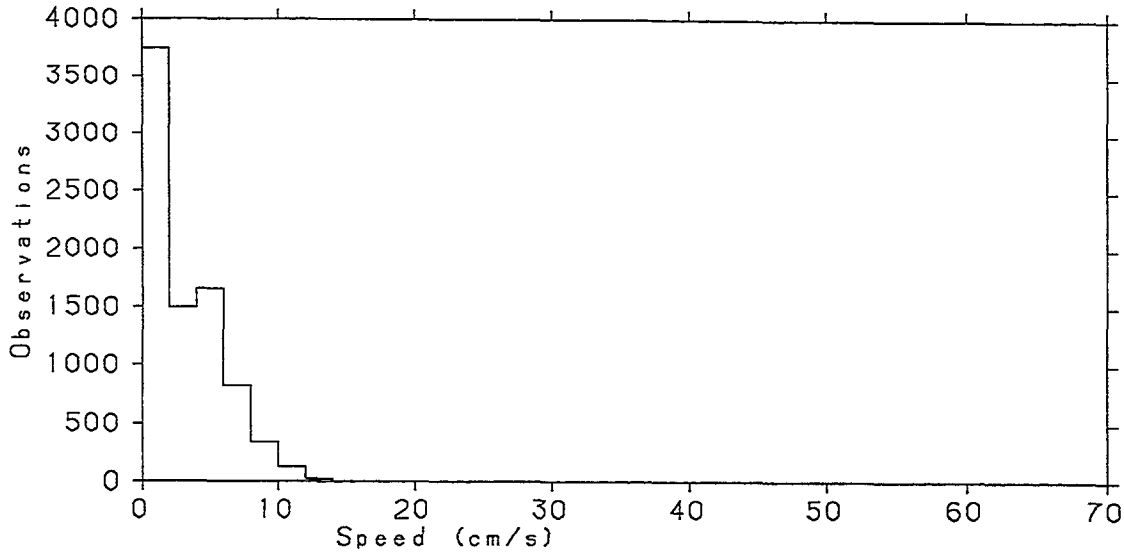


Figure 8 Sediment trap mooring 12812#2; current meter data from c180mab. Distribution of recorded current speeds.

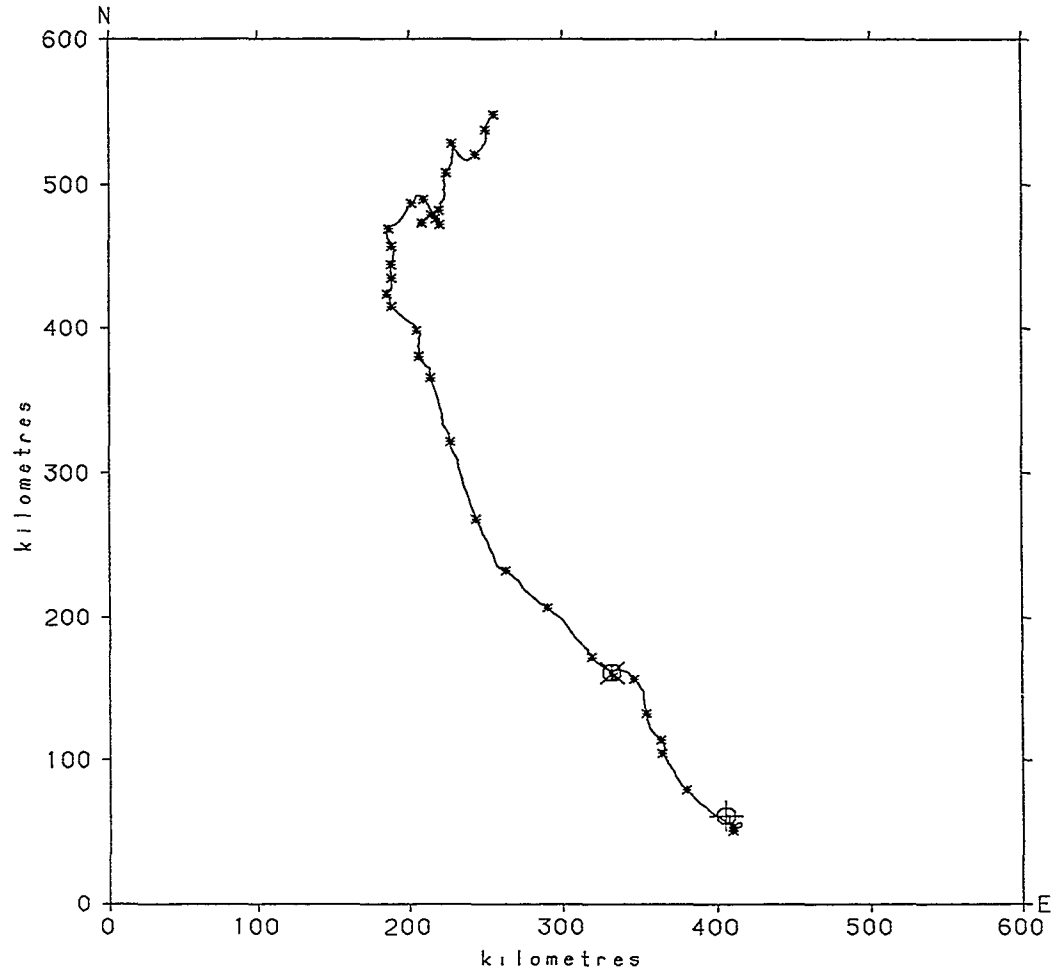


Figure 9 Sediment trap mooring 12812#2; current meter data from c180mab. Progressive vector diagram.

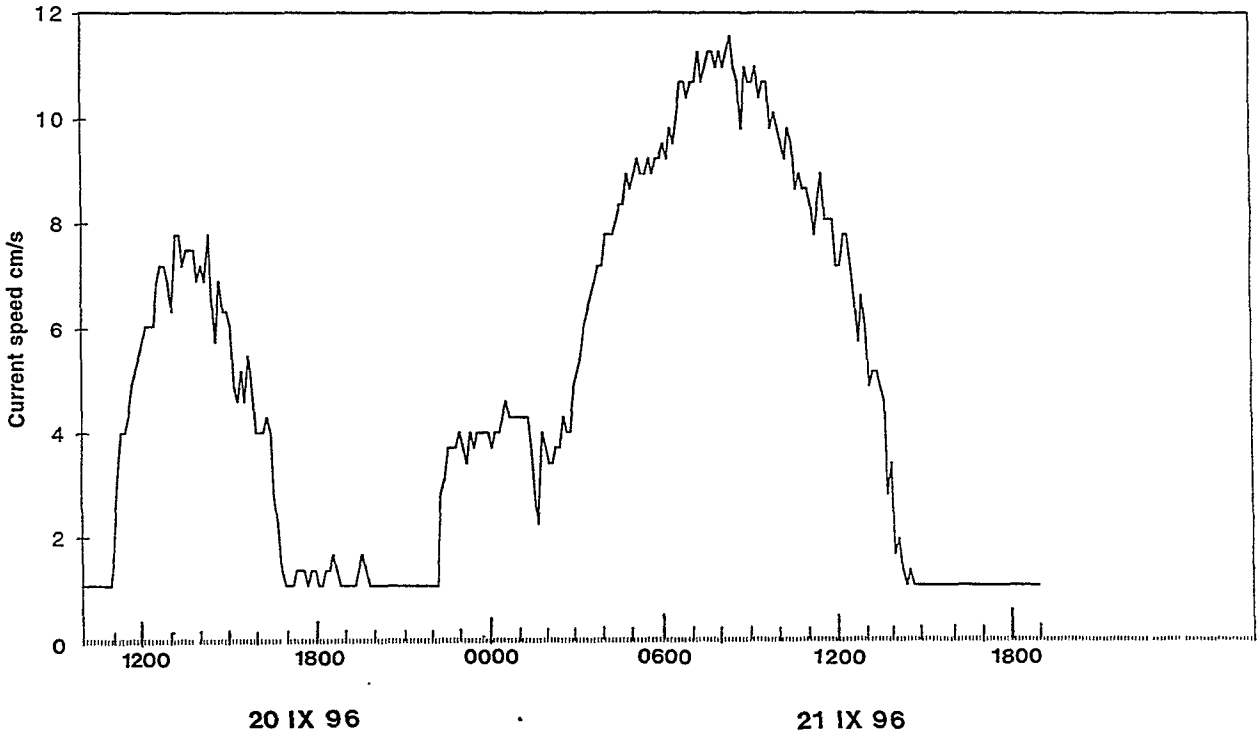


Figure 10 Bathysnack deployment 12930#89 current meter data; variations in current speed with time.

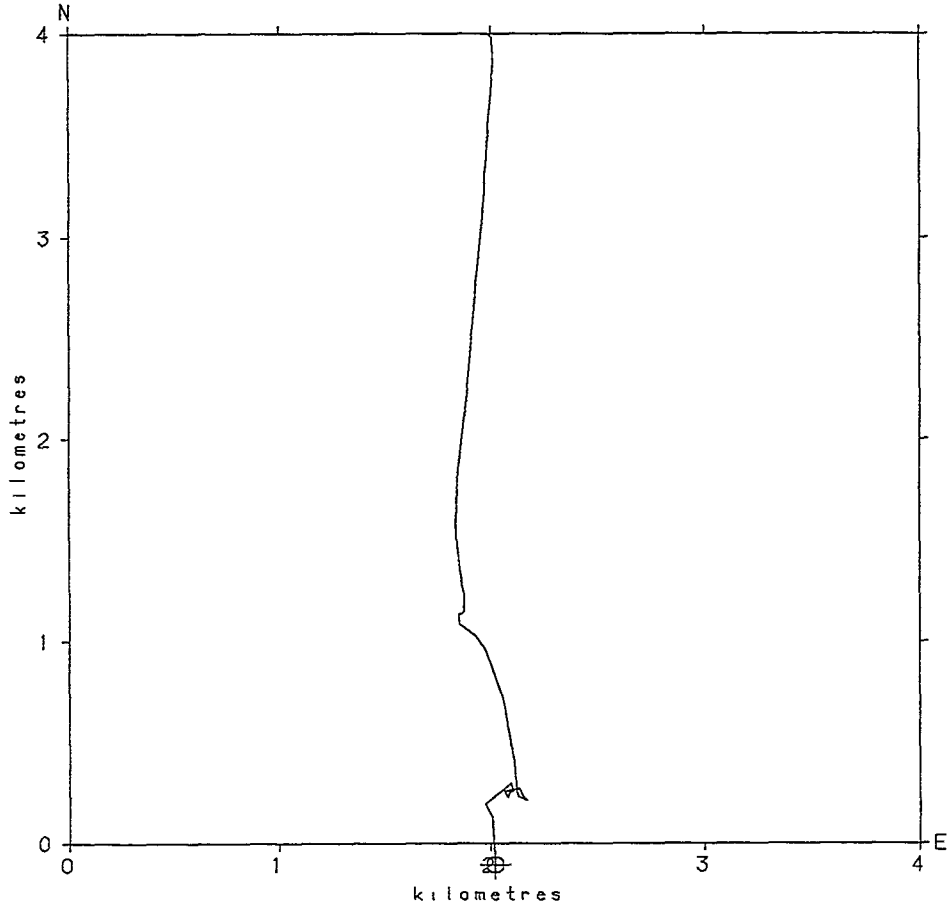


Figure 11 Bathysnack deployment 12930#89 current meter data; progressive vector diagram.

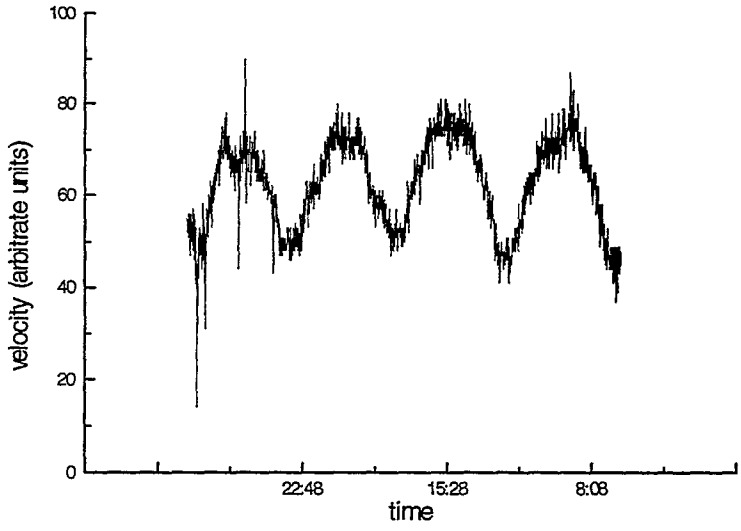


Figure 12 Variations in current speed c30cm above the bottom measured during the NIOZ lander deployment #23.

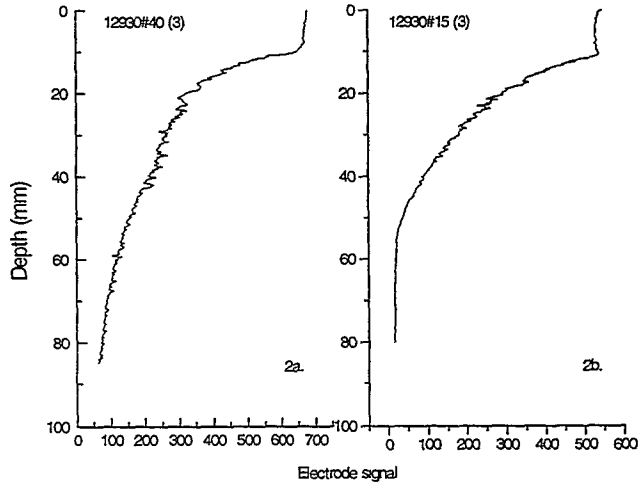


Figure 13 Two oxygen profiles from multiple corer samples illustrating differences in the oxygen penetration depth.

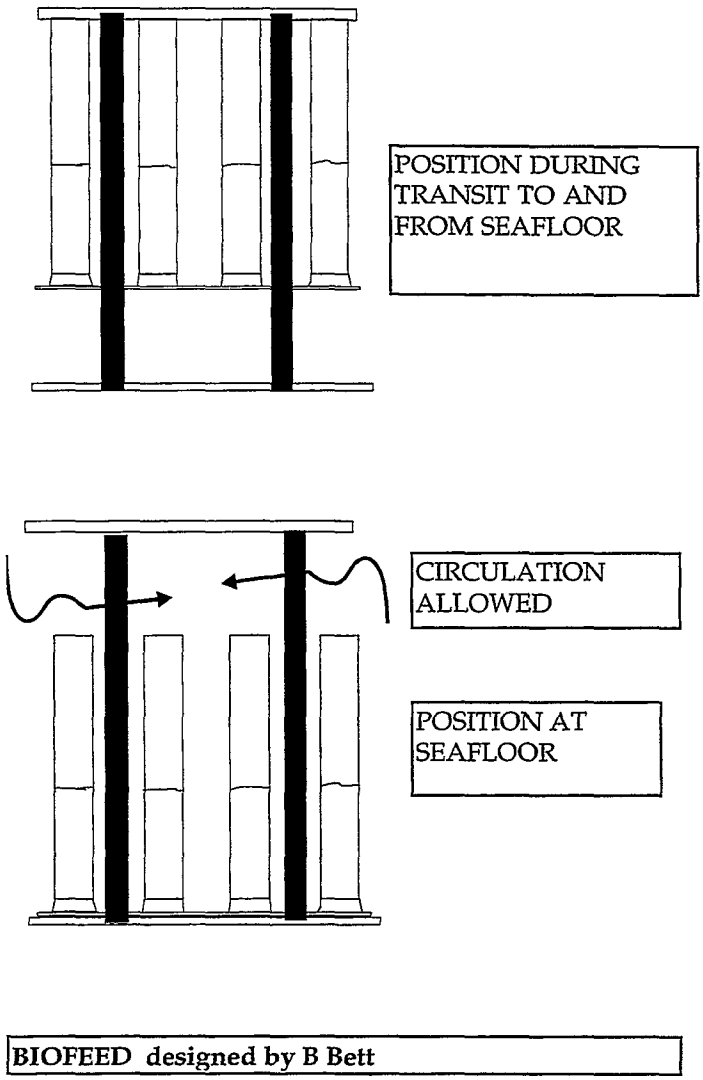


Figure 14. Schematic representation of BIOFEED core rig.

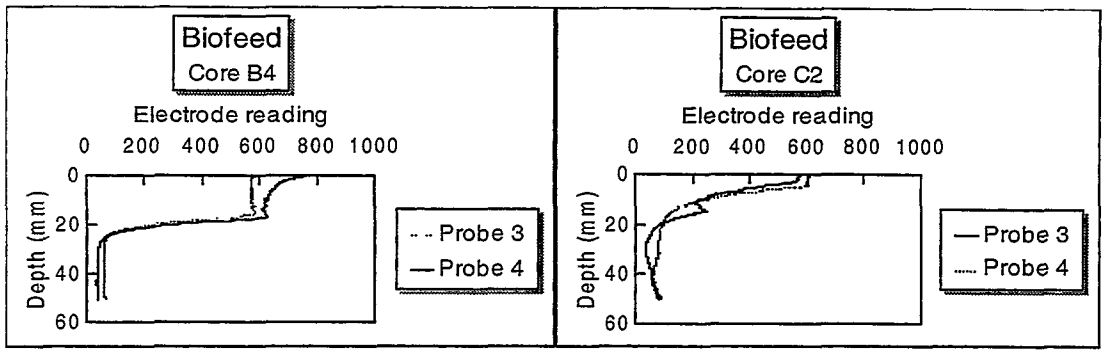


Figure 15 Downcore oxygen electrode profiles of cores incubated under *in situ* conditions. Left. Enriched core. Right. Control.

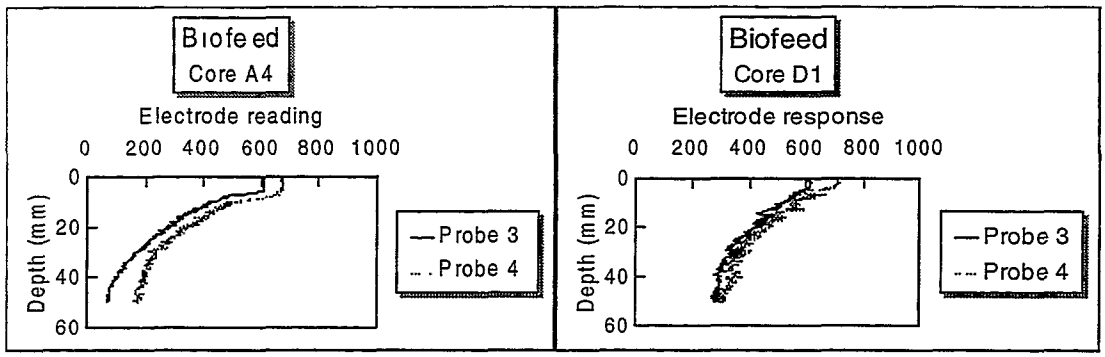


Figure 16. Downcore oxygen electrode profiles of cores incubated under atmospheric conditions. Left. Enriched core. Right. Control

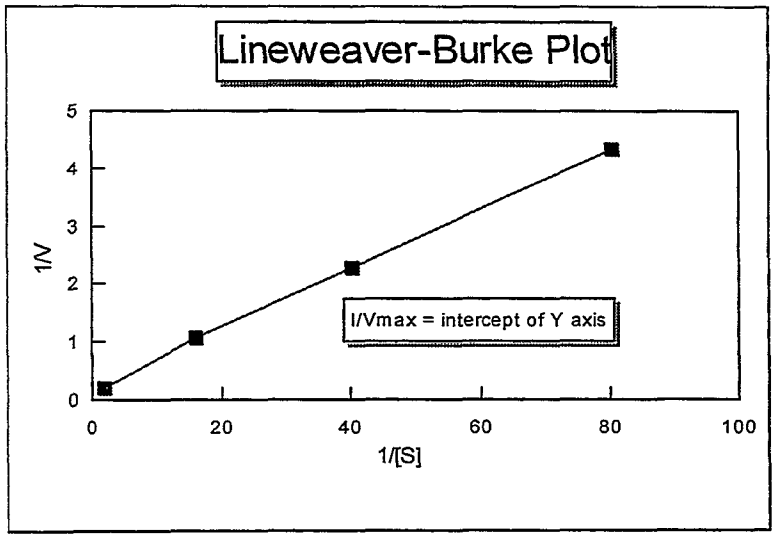


Figure 17. Typical Lineweaver-Burke plot of data obtained from incubation of *O. mirabilis* gut contents with leu-AMC.

GEAR CODES USED IN STATION LIST

BIOFEED	Short-term enrichment experiment based on multiple corer samples
BOX CORER	Spade box corer (0.25m^2), modified USNEL type, fitted with plain box
BSNACK	BATHYSNACK: baited BSNAP
BSNAP	BATHYSNAP: free-fall time-lapse camera system
CP	Chalut a perche: 6m beam trawl
CTD	Conductivity-temperature depth probe
DEMAR	Baited free-fall amphipod trap
DN	Phytoplankton net - Galway pattern, hauled vertically
MAC	Module Autonome de Colonisation: long-term enrichment and recolonisation experiment
MEGACORER	Ten-tube corer using 100mm i. d. core tubes
MLT CORER	Multiple corer, Barnett pattern, using 57mm i. d. core tubes
MS	Multi-sampler: water bottle rosette mounted on CTD frame
MSP	Marine snow profiler: marine snow camera mounted on CTD frame
NIOZL	NIOZ multifunction lander system
OTSB14	Otter trawl
PAR	Photosynthetically Available Radiation meter
SAP	Stand-alone pump
SED TRAP	Sediment trap array. SOC version with three carousel traps at 1000m, 3000m and 100mab: NIOZ version with one carousel trap 10mab
VEGBOXC	Spade box corer (0.25m2), modified USNEL type, fitted with vegematic box
WASP	Wide Angle Survey Photography instrument

STN.	DATE 1996	POSITION LAT.	POSITION LONG.	GEAR	DEPTH (M)	TIMES GMT	COMMENT	MEAN SOUND. (M)
12812 # 2	11/10/95 1/ 9	48 59.98N	16 21.11W	SED TRAP	1000-4745	1911-1851	Deployed D217. 3 good samples	4845
12812 # 3	11/10/95 7/ 9	48 57.25N	16 21.17W	BSNAP	4845-4845	2222-1632	Camera malfunctioned	4845
12929 # 1	31/ 8	49 1.03N 49 0.73N	14 25.50W 14 24.99W	CTD MS	0- 600	1126-1210	Bottles fired at 600m	
12930 # 1	31/ 8	48 49.76N 48 49.64N	16 30.17W 16 30.08W	CTD MS	0-4830	1955-2351	Bottles fired at 7mab, 150m, 5m	4837
12930 # 2	1/ 9	48 49.72N 48 49.80N	16 29.90W 16 29.93W	DN	0- 100	0025-0029	Galway net	
12930 # 3	1/ 9	48 49.95N 48 50.16N	16 29.62W 16 28.90W	SAP	35- 35	0110-0210		
12930 # 4	1/ 9	48 55.97N	16 32.53W	MLT.CORER	4836-4836	0535-	12 good cores for Biofeed	4836
12930 # 5	1/ 9	48 55.63N	16 32.40W	MAC	4838-4838	0910-	ETA bottom estimated	4838
12930 # 6	1/ 9 3/ 9	48 55.44N 48 55.82N	16 34.19W 16 34.62W	NIOZL	4838-4838	1200-0625	ETA bottom 1055	4838
12930 # 7	1/ 9 18/ 9	48 55.27N 48 51.98N	16 36.01W 16 31.22W	BIOFEED	4839-4839	1149-1512	Descent 0.73m/s, ascent 0.82m/s	4839
12930 # 8	1/ 9	48 55.38N 48 55.45N	16 36.09W 16 35.99W	PAR	0- 80	1155-1210		

STN.	DATE 1996	POSITION LAT.	POSITION LONG.	GEAR	DEPTH (M)	TIMES GMT	COMMENT	MEAN SOUND. (M)
12930 # 9	1/ 9 14/ 9	48 54.39N 48 54.47N	16 34.05W 16 33.64W	SED TRAP	4829-4829	1450-1735	NIOZ Array. Trap at 10mab	4839
12930 #10	1/ 9	48 49.86N	16 29.54W	MLT.CORER	4838-4838	1600-	12 good cores	4838
12930 #11	2/ 9	48 49.85N	16 30.24W	BOX CORER	4837-4837	0049-	Failed to trigger. No core	4837
12930 #12	2/ 9	48 50.38N 48 50.44N	16 29.93W 16 28.83W	CTD MS	3-4825	0253-0625	Bottles at 10 depths. Range 4825-3m	4837
12930 #13	2/ 9	48 49.65N 48 48.80N	16 27.07W 16 29.19W	CP	4836-4842	1236-1346	Gear lost. Weak link failed 1100mwo Tow dist. 3.036 km.	
12930 #14	2/ 9	48 50.92N	16 28.89W	BOX CORER	4839-4839	1908-	Good core, full sieving protocol	4839
12930 #15	2/ 9	48 50.55N	16 29.84W	MLT.CORER	4837-4837	2310-	12 good cores	4837
12930 #16	3/ 9	48 51.74N 48 51.73N	16 27.82W 16 27.63W	WASP	4828-4833	0319-0332	Monitor flooded Tow dist. 0.235 km.	4838
12930 #17	3/ 9	48 50.11N	16 29.13W	BOX CORER	4838-4838	1132-	Damaged core, subsampled	4838
12930 #18	3/ 9	48 50.30N	16 29.03W	MLT.CORER	4837-4837	1515-	12 good cores.	4837
12930 #19	3/ 9	48 50.81N 48 50.85N	16 28.01W 16 27.97W	PAR	0- 100	1644-1655		

STN.	DATE 1996	POSITION LAT.	LONG.	GEAR	DEPTH (M)	TIMES GMT	COMMENT	MEAN SOUND. (M)
12930 #20	3/ 9	48 49.93N 48 49.98N	16 29.87W 16 29.72W	CTD MS MSP	0- 100	1740-1755	Test for MSP	
12930 #21	3/ 9	48 50.15N 48 50.54N	16 29.37W 16 28.16W	CTD MS MSP	0-2000	1824-1957	Water at fluorescence max (40m, 1951)	
12930 #22	3/ 9	48 49.94N	16 29.03W	BOX CORER	4839-4839	2216-	Poor core, subsampled	4839
12930 #23	4/ 9 6/ 9	48 57.97N 48 57.99N	16 23.90W 16 24.67W	NIOZL	4839-4839	0300-0705	ETA Bottom 02:45	4839
12930 #24	4/ 9	48 55.33N	16 34.02W	MEGACORER	4839-4839	0402-	Only one good core	4839
12930 #25	4/ 9	48 55.51N 48 55.51N	16 33.70W 16 33.70W	MEGACORER	4839-4839	0750-	No good cores	4839
12930 #26	4/ 9	48 52.93N 48 50.97N	16 42.95W 16 32.99W	OTSB14	4836-4843	1545-1835	Good catch Tow dist. 12.711 km.	
12930 #27	5/ 9	48 49.64N	16 29.82W	MEGACORER	4837-4837	0240-	Only one good core	4837
12930 #28	5/ 9	48 50.28N	16 29.78W	VEGEBOXC	4839-4839	0639-	Good samples, SAMS protocol	4839
12930 #29	5/ 9	48 50.15N	16 29.24W	MLT.CORER	4839-4839	0958-	12 good cores	4839
12930 #30	5/ 9	48 49.90N 48 49.89N	16 28.14W 16 28.06W	PAR	0- 100	1130-1140		

STN.	DATE 1996	POSITION LAT.	POSITION LONG.	GEAR	DEPTH (M)	TIMES GMT	COMMENT	MEAN SOUND. (M)
12930 #31	5/ 9	48 49.89N 48 50.33N	16 26.78W 16 26.46W	WASP	4829-4834	1357-1609	Fished using pinger. Tow dist. 0.901 km.	4838
12930 #32	5/ 9	48 50.62N	16 28.95W	BOX CORER	4839-4839	2034-	Badly damaged core, subsampled	4839
12930 #33	5/ 9 6/ 9	49 0.09N 49 1.32N	16 20.79W 16 19.62W	CTD MS MSP	0-4834	2334-0327	Four bottles at 4834m	4842
12930 #34	6/ 9	49 1.52N 49 1.99N	16 19.33W 16 19.17W	SAP	40- 150	0410-0510		
12930 #35	6/ 9	49 0.47N	16 17.96W	SED TRAP	1000-4741	1412-	IOS rig traps at 1000m,3000m,100mab	4841
12930 #36	6/ 9	48 51.26N	16 29.67W	MLT.CORER	4837-4837	1748-	12 good cores	4837
12930 #37	7/ 9	48 50.42N 48 49.99N	16 41.22W 16 26.64W	OTSB14	4837-4844	0122-0520	Small catch Tow dist. 15.831 km.	
12930 #38	7/ 9 10/ 9	48 50.00N 48 49.84N	16 17.72W 16 17.93W	NIOZL	4840-4840	1400-0713	ETA bottom 1200	4840
12930 #39	7/ 9	48 49.95N	16 29.40W	BOX CORER	4840-4840	1330-	Good core, full sieving protocol	4840
12930 #40	7/ 9	48 58.13N	16 23.83W	MLT.CORER	4842-4842	2027-	12 good cores,including 3 NIOZ tubes	4842
12930 #41	7/ 9 8/ 9	48 49.94N 48 51.15N	16 29.89W 16 28.53W	CTD MS MSP	0-4831	2310-0248	Water at 7mab, 44m	4838

STN.	DATE 1996	POSITION LAT.	POSITION LONG.	GEAR	DEPTH (M)	TIMES GMT	COMMENT	MEAN SOUND. (M)
12930 #42	8/ 9	48 49.82N 48 49.86N	16 29.94W 16 29.92W	CTD MS MSP	0- 100	0348-0407	Water at 70, 43, 16, 4 and 0m	
12930 #43	8/ 9	48 50.19N 48 50.34N	16 29.03W 16 28.12W	WASP	4828-4833	0615-0824	Fished on pinger Tow dist. 1.143 km.	4838
12930 #44	8/ 9	48 49.95N	16 30.20W	BOX CORER	4839-4839	1218-	Good core, full sieving protocol	4839
12930 #45	8/ 9	48 51.64N	16 19.34W	MLT.CORER	4838-4838	1700-	12 good cores	4838
12930 #46	9/ 9	48 47.21N 48 49.49N	16 43.31W 16 32.62W	OTSB14	4837-4841	0045-0425	Good catch. Much mud Tow dist. 13.749 km.	
12930 #47	9/ 9	48 50.71N 48 51.26N	16 26.48W 16 26.40W	WASP	4806-4833	1315-1520	Tow dist. 1.017 km.	4839
12930 #48	9/ 9	48 51.08N	16 31.51W	VEGEBOXC	4838-4838	1929-	Adequate core, SAMS protocol	4838
12930 #49	9/ 9	48 50.77N	16 29.79W	MLT.CORER	4838-4838	2315-	12 good cores	4838
12930 #50	10/ 9	48 50.25N 48 50.39N	16 30.19W 16 30.47W	CTD MSP	0- 100	1204-1226	Camera interval 15 sec	
12930 #51	10/ 9	48 50.43N 48 50.47N	16 30.64W 16 30.74W	PAR	0- 100	1238-1244		
12930 #52	10/ 9	48 50.46N	16 30.57W	BOX CORER	4839-4839	1446-	Damaged core, subsampled	4839

STN.	DATE 1995	POSITION LAT.	POSITION LONG.	GEAR	DEPTH (M)	TIMES GMT	COMMENT	MEAN SOUND. (M)
12930 #53	10/ 9	48 50.97N 48 51.13N	16 30.40W 16 30.36W	CTD MSP	0- 100	1638-1655	Camera interval 15sec	
12930 #54	10/ 9	48 44.44N 48 44.74N	16 34.22W 16 33.33W	WASP	0-4827	1945-2118	Fished on pinger Tow dist. 1.223 km.	4836
12930 #55	11/ 9 14/ 9	48 44.77N 48 45.06N	16 33.30W 16 31.90W	NIOZL	4837-4837	0100-0641	Baited video to start 0025	4837
12930 #56	10/ 9 11/ 9	48 43.99N 48 44.25N	16 31.87W 16 32.90W	CTD MS MSP	0-4825	2328-0329	Bottles at 11mab, 3993 - 0mwo	4836
12930 #57	11/ 9	49 0.35N 49 0.40N	16 20.53W 16 20.58W	DN	0- 100	0655-0700	Galway net	
12930 #58	11/ 9	49 1.14N 49 1.82N	16 20.36W 16 19.21W	SAP	3000-4746	0900-1105	2 pumps at 100mab, 2 at 3000m	4840
12930 #59	11/ 9	48 50.45N	16 30.58W	BOX CORER	4837-4837	1942-	Moderate core, full sieving protocol	4837
12930 #60	12/ 9	48 50.33N 48 48.96N	16 32.99W 16 20.61W	OTSB14	4838-4841	0331-0620	Very small catch, Reason unclear Tow dist. 15.359 km.	
12930 #61	12/ 9	48 50.51N	16 30.69W	BOX CORER	4838-4838	1327-	Damaged core, subsampled	4838
12930 #62	12/ 9	48 50.92N 48 50.98N	16 31.16W 16 31.18W	PAR	0- 80	1507-1512		
12930 #63	12/ 9	48 50.66N	16 30.40W	BOX CORER	4846-4846	1721-	Moderate core, full sieving protocol	4846

STN.	DATE 1996	POSITION LAT.	POSITION LONG.	GEAR	DEPTH (M)	TIMES GMT	COMMENT	MEAN SOUND. (M)
12930 #64	12/ 9 13/ 9	48 47.74N 48 49.68N	16 15.68W 16 28.69W	OTSB14	4836-4839	2340-0317	Small catch. Tow dist. 16.331 km.	
12930 #65	13/ 9	48 50.63N	16 28.44W	VEGEBOXC	4838-4838	1124-1124	Good cores, SAMS protocol	4838
12930 #66	13/ 9	48 50.25N	16 30.67W	MLT.CORER	4840-4840	1459-1459	12 good cores, incl 2 in NIOZ tubes	4840
12930 #67	13/ 9	48 50.98N 48 50.94N	16 30.51W 16 30.59W	PAR	0- 100	1645-1655		
12930 #68	13/ 9	48 49.92N 48 49.92N	16 29.76W 16 29.76W	BOX CORER	4840-4840	1850-1850	Good core, full sieving protocol	4840
12930 #69	13/ 9	48 50.22N 48 50.36N	16 29.25W 16 29.17W	CTD MS MSP	3- 85	2041-2109	Water at 3m. Camera interval 15sec	
12930 #70	13/ 9 14/ 9	48 50.88N 48 51.43N	16 29.07W 16 28.66W	WASP	4829-4833	2305-0105	Tow dist. 1.139 km.	4837
12930 #71	14/ 9 15/ 9	48 46.44N 48 47.04N	16 28.39W 16 28.36W	DEMAR	4836-4836	1135-1640	Descent 0.69m/s, ascent 0.69m/s	4836
12930 #72	14/ 9 20/ 9	48 54.46N 48 54.46N	16 33.63W 16 23.38W	SED TRAP	4737-4737	1900-1800	NIOZ single trap 100mab	4837
12930 #73	14/ 9	48 50.08N	16 29.69W	BOX CORER	4839-4839	2024-	Good core, full sieving protocol	4839
12930 #74	15/ 9	48 47.90N 48 48.36N	16 25.47W 16 24.24W	WASP	4830-4835	0100-0330	Tow dist. 1.733 km.	4839

STN.	DATE 1996	POSITION LAT.	LONG.	GEAR	DEPTH (M)	TIMES GMT	COMMENT	MEAN SOUND. (M)
12930 #75	15/ 9	48 50.23N	16 29.87W	MLT.CORER	4839-4839	0750-	11/12 good cores.	4839
12930 #76	15/ 9 18/ 9	48 48.08N 48 51.01N	16 26.77W 16 30.45W	NIOZL	4836-4836	1400-0500	Released 0700/18. Abandoned 0900/22	4836
12930 #77	15/ 9 16/ 9	48 47.17N 48 48.67N	16 28.65W 16 29.39W	SAP	3600-4737	2202-0002	Main engines off board during haul	4737
12930 #78	16/ 9 17/ 9	48 53.04N 48 50.03N	16 30.49W 16 41.92W	OTSB14	4836-4840	2352-1045	Net fast 0400 Sailed out. Good catch Tow dist. 15.426km.	
12930 #79	17/ 9	48 49.93N 48 50.10N	16 31.01W 16 31.14W	PAR	0- 100	1445-1455		
12930 #80	17/ 9	48 59.56N 48 59.43N	16 34.76W 16 35.52W	CTD MS	0- 100	2238-2318	Bottles at 86-3m	
12930 #81	18/ 9	48 50.54N	16 30.62W	BOX CORER	4837-4837	0343-	Good core, sampled for radioisotopes	4837
12930 #82	18/ 9	48 47.96N	16 28.81W	MLT.CORER	4837-4837	1113-	12/12 cores but cloudy.	4837
12930 #83	18/ 9 19/ 9	48 56.12N 48 56.11N	16 35.53W 16 36.32W	DEMAR	4839-4839	2005-0935	Descent (est) 0.80m/s, ascent 0.70m/s	4839
12930 #84	18/ 9	48 50.80N	16 28.74W	VEGEBOXC	4838-4838	2334-	Good cores, SAMS protocol	4838
12930 #85	19/ 9	48 50.96N 48 51.56N	16 26.36W 16 25.29W	WASP	4828-4838	0315-0530	Tow dist. 1.716 km.	

STN.	DATE 1996	POSITION LAT.	POSITION LONG.	GEAR	DEPTH (M)	TIMES GMT	COMMENT	MEAN SOUND. (M)
12930 #86	20/ 9	48 50.54N	16 28.58W	BOX CORER	4841-4841	0938-		4841
12930 #87	20/ 9	48 49.65N	16 30.30W	MLT.CORER	4838-4838	1312-	12 good cores incl. 2 in NIOZ tubes	4838
12930 #88	20/ 9	48 49.64N 48 49.70N	16 31.69W 16 31.77W	PAR	0- 100	1450-1455		
12930 #89	20/ 9 21/ 9	48 51.97N 48 52.66N	16 26.62W 16 18.97W	BSNACK	4837-4837	1830-1704	Bait bare mackerel. Camera int. 4.5min	4837
12930 #90	20/ 9	48 51.83N	16 27.76W	BOX CORER	4840-4840	2236-	Pretriggered, no core	4840
12930 #91	21/ 9	48 49.90N 48 49.82N	16 30.17W 16 29.97W	CTD MS	0- 100	0045-0110	Bottles at 80-3m	
12930 #92	21/ 9	48 49.62N 48 49.39N	16 29.73W 16 29.25W	CTD MS	0-4831	0145-0540	Bottles at 20mab(8), 3990-1050m (4)	4839
12930 #93	21/ 9	48 50.00N	16 29.91W	BOX CORER	4840-4840	0730-	Moderate core, full sieving protocol	4840
12930 #94	21/ 9	48 50.78N 48 51.18N	16 29.99W 16 30.12W	CTD MS MSP	0- 300	0920-1005	Bottles at 300m(8) and 150m (4)	
12930 #95	21/ 9	48 50.23N	16 30.05W	BOX CORER	4839-4839	1450-	Damaged core, subsampled	4839
12930 #96	21/ 9	48 53.74N	16 17.96W	BSNAP	4838-4838	2042-	Camera interval 10/day	4838
12930 #97	21/ 9	48 56.01N 48 56.43N	16 22.63W 16 22.35W	WASP	4834-4836	2156-2237	Tow dist. 0.852 km.	

Southampton Oceanography Centre
European Way
Southampton SO14 3ZH
United Kingdom
Tel: +44 (0)1703 596666
Fax: +44 (0)1703 596667