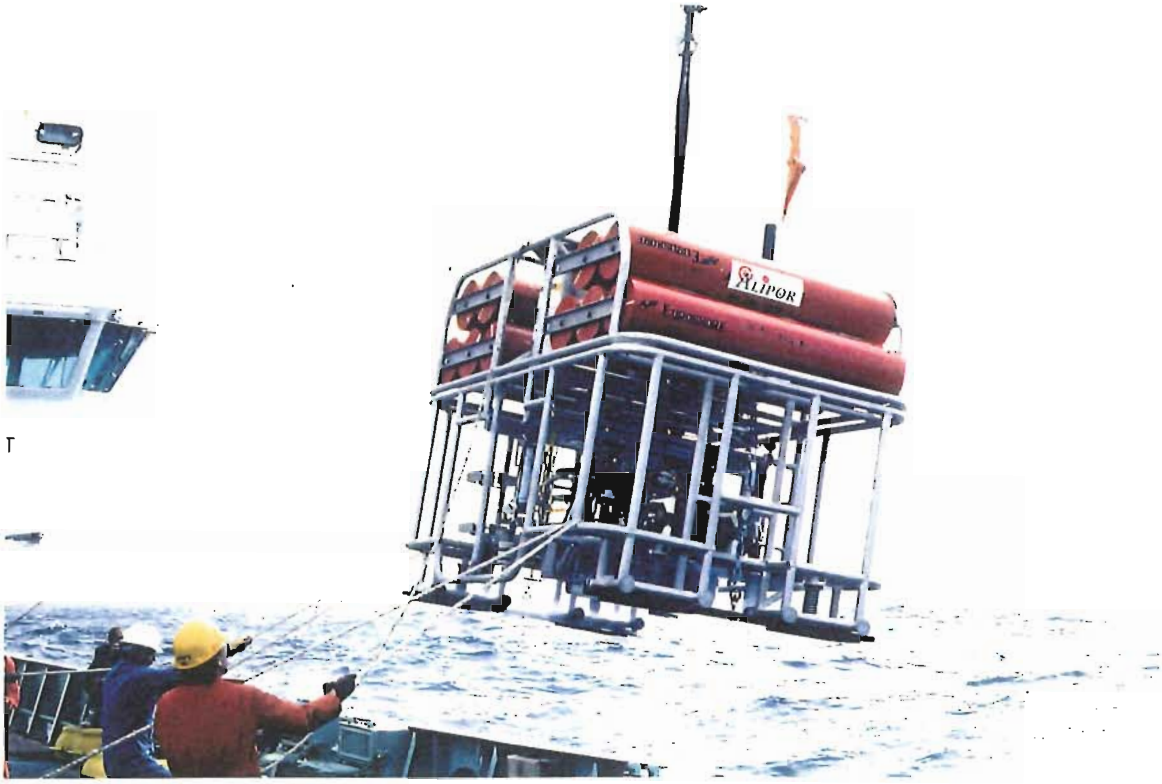
ALIPOR

Autonomous Lander Instrument Packages for Oceanographic Research



RRS Discovery Cruise 222 Leg A

27 July - 26 August 1996

Principal Scientist,

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Cover Photogaph

The IFREMER , RAP2 Lander being deployed over the side of the *RRS Discovery*.
This lander has two benthic chambers for measurement of sediment interface metabolism.

SCIENTIFIC PERSONNEL

Left to Right:

Jean-Claude Caprais, Axel Cremer, Tina Martin, Costas Christodoulou, Michael Poser, Henrick Stahl, Scott Bradley, Emma Jones, Anders Tengberg, Stefan Hulth, Stuart McWilliams, Jorge Valderamma, Phillipe Rodier, Steve Addison, Anthony Grehan, Rees Roberts, Cynthia Yau, Monty Priede, Peter Mason, Martin Collins, Martin Solan, Alexis Khripounoff, Greg Phillips.

Not present:
Howie Anderson, Jean-Pierre Brulport, Collin Day, John Wynar, Annick Vangreishiem

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PHILLIPS, Gregg. R.J.	U. of Aberdeen UK
YAU, Cynthia	U. of Aberdeen UK
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BRULPORT, Jean-Pierre	IFREMER France
CAPRAIS, Jean-Claude	IFREMER France
RODIER, Phillipe	IFREMER France
VANGRIESHEIM, Annick	IFREMER France
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STAHL, J. Heinrich	U of Göteborg Sweden
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CREMER, Axel. B.*	GEOMAR, Kiel Germany
MARTIN, Bettina J.	GEOMAR, Kiel Germany
POSER, Michael	GEOMAR, Kiel Germany
CHRISTODOULOU, Costas	IMBC Iraklion Greece
MASON, Peter J. *	RVS Southampton UK
ANDERSON, Howard C.	RVS Southampton. UK
DAY, Collin	RVS Southampton. UK
ROBERTS, Rhys	RVS Southampton. UK
WYNAR, John B.	RVS Southampton. UK

* Indicates Team Leader

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AVERY, Keith O.	Master
GAULD, Philip D.	Chief Officer
MORSE Terry J.	2nd Officer
MITCHELL, John W.	3rd Officer
DONALDSON, Brian	Radio Officer
MOSS Sam, A.	Chief Engineer
GREENHORD Alec	2nd Engineer
WALKER Barry	3rd Engineer
LUTEY W. Doug.	Electrician
POOK G.A. (Tiny)	CPO (Deck)
BENNET Peter R.	PO (Deck)
COOK Stuart	Seaman
COOPER Gerry	Seaman
WYNESS Martin J.	Seaman
MacLEAN Andy	Seaman
HALLET Richard C.	Seaman
BELL Ray	SCM
PERRY Clive K.	Chef
DUNCAN Andy. S.	Steward
LINK Wally. J.T.	Steward
ORSBORN Jeff. A.	Steward
HANLON Dave J.	PO (Motorman)

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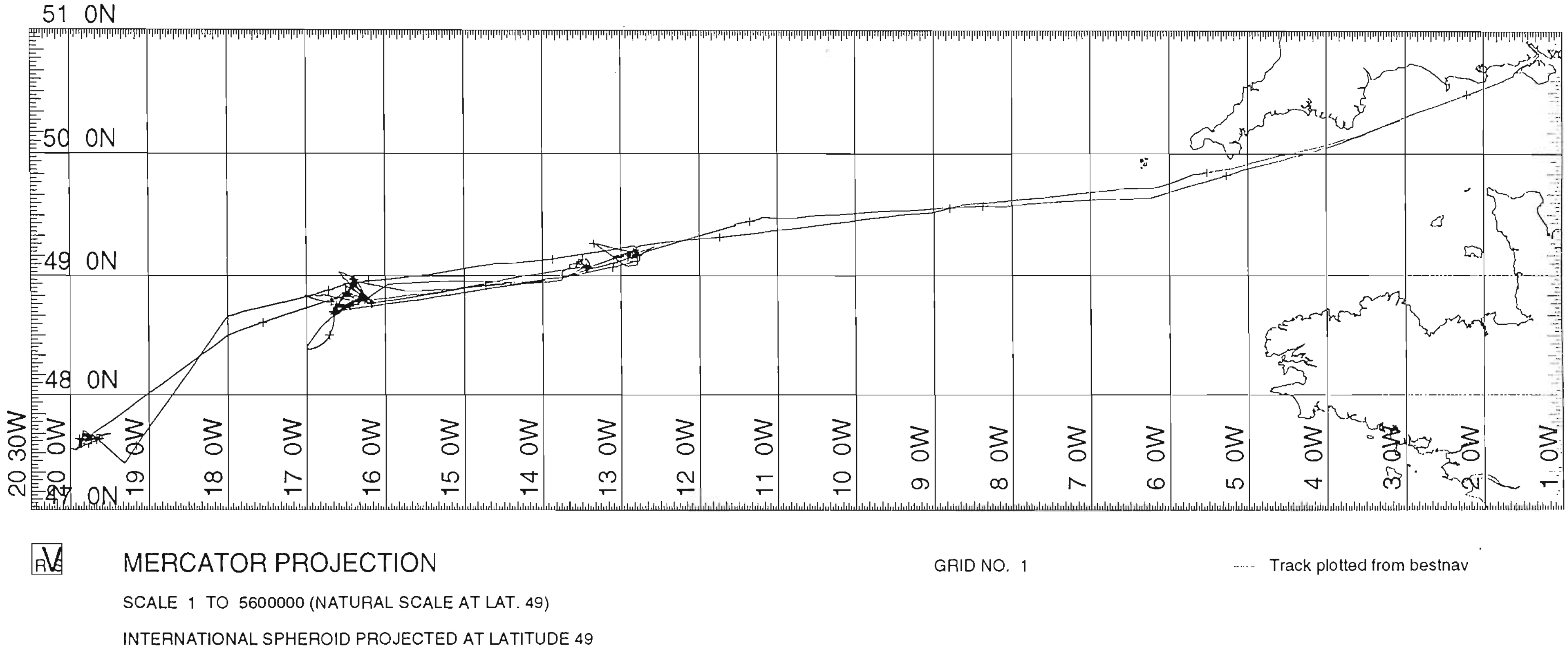

Figure 1. The Track of the *RRS Discovery* Cruise 222A. 1996

ITINERARY.

Depart Southampton Oceanography Centre	-	27 July 1996
Arrive Southampton Oceanography Centre	-	26 August 1996

OBJECTIVES.

This cruise was financed by the European Commission, Marine Science and Technology, MAST-III programme and forms Task 3.1 (Multi-lander Cruise) of Project Number CT950010 Autonomous Lander Instrument Packages for Oceanographic Research.

The following quotation from the preamble to the ALIPOR project description explains the general aims:

"Autonomous landers that can conduct experiments and gather data on the sea floor have the potential to revolutionise oceanographic research. By using a number of landers, the spatial and temporal coverage of a single ship can be increased by orders of magnitude. Landers also enable small ships to carry out deep sea research without the need for wires extending to full ocean depth. Landers have been specified as a necessary component of all the major subsurface oceanographic research programmes, BENGAL,OMEX, JGOFS, HiBETS etc.

European laboratories have already developed a variety of landers. An essential next step is for these to work together in a co-ordinated fashion.

Landers from all the partners will be carried on a multi-lander cruise of the RRS Discovery in the North East Atlantic in 1996. This will comprise the largest fleet of landers ever assembled and will be the prototype for future deep-sea oceanographic expeditions in the next century. This expedition, will confront for the first time the problems of inter-compatibility of systems and management of such a complex exercise. A diversity of landers will be deployed including monitoring of water column above the floor, tracking of abyssal fishes, probing the sediment, in situ chemical analysis, biological and metabolic studies"

ALIPOR is a primarily technical development and proving programme. The objective of the cruise therefore was to simply deploy and recover as many landers as possible.

This technical objective was however integrated within a general scientific aim to investigate physical, chemical and biological processes in the benthic boundary layer. The cruise set out shortly after the expected peak of seasonal deposition of phytodetritus and other particulate organic matter derived from the surface photic zone in the NE Atlantic at this time. Taking advantage of the availability of a number of landers vehicles, the plan was to investigate large scale (100 km) and small scale (1km) spatial variation. In addition intercalibration between similar measurements obtained by different landers would be possible.

Work was aimed along an East-West transect between the following locations:

OMEX (Ocean margin experiment)	49° 11'N	12°49'W	Goban Spur
PAP (BENGAL station)	48° 50'N	16°30'W	Porcupine Abyssal Plain
BIOTRANS	47° 40'N	19°50'W	

The following free-fall landers were loaded on board the ship at Southampton:

1. MAP - (Module Autonome Pluridisciplinaire). IFREMER.
Deployment for long term monitoring of near bottom currents and physical parameters.

2.GEOMAR lander. Benthic chambers, measurement of Sediment community metabolism.

3. IFREMER RAP2 Benthic chambers, measurement of sediment community metabolism.

4.Göteborg Lander Benthic chambers, measurement of sediment community metabolism and geochemical fluxes.

5. AUDOS II. (Aberdeen University Deep Ocean System). Photography of demersal fishes attracted to baits and tracking using ingestible Code Activated Transponders.

6- 9. ATTIS I,II, III, IV (Aberdeen) Acoustic Transponder Tracking and Interrogation System. Tracking of fish using ingestible Code Activated Transponders.
These 4 vehicles were to be deployed to form a linear array.

10. LAFF. (Aberdeen) Large Abyssal Food Fall. A large modular tripod lander with a camera, acoustic tracking system and sediment coring device. Designed to observe the fate of a dead dolphin carcass deployed on the sea floor.

11. Fish Trap. (Aberdeen) A simple 1m cube trap deployed on the sea floor with an acoustic release, designed to capture large fish in the main trap and small Crustacea in auxiliary traps.

In addition the following gears for use from conventional winch wires were loaded:

12. SPI instrument (Sediment Profile Imaging) from the University of Galway.

13. Multicorer. (GEOMAR) for obtaining sediment samples for comparison with SPI images and samples obtained using the benthic chamber landers.

It had also been agreed to recover three sediment trap moorings on behalf of Dr, Avan Antia of the Institut Für Meereskunde, Kiel Germany. These were located in the OMEX area. This work was compatible with the free-vehicle handling objectives of the cruise and data from the sediment traps would be relevant to interpretation of Benthic chamber lander data.

CRUISE NARRATIVE

NB All times are in British Summer Time. (BST = Greenwich +1h)

Monday 23 July, Southampton.

The first members of the scientific party arrived and commenced checking containers and equipment that had been delivered to Southampton Oceanography Centre.

Tuesday 24 July,

RRS Discovery docked at SOC from Cruise 221.

Wednesday 25 July,

Work commenced on unpacking equipment and building the Aberdeen and Göteborg landers on the quay side.

The auto-analyser for the cruise had been delivered to the *RRS Discovery.* Jorge Valderamma of the Swedish Meteorological & Hydrological Institute started the installation of this equipment in the Chemistry Laboratory on board.

Thursday 25 July,

0900h Loading of ship commenced.

1100h One of the party; Simon Creasey, a student at Southampton University had sent on the medical certificate stating he is entirely fit expect for a condition of diabetes mellitus which has been under control for 3 years. The captain discussed this over the telephone with the doctor who stated that if the diabetes control failed for any reason he would need specialist medical care within 24h. Since the ship would be over 3 days from shore the Captain decided he could not permit Simon Creasey to join the cruise.

The Aberdeen party agreed to collect amphipods from traps for Simon Creasey's project. A student from Trinity College Dublin, Stuart McWilliams was invited to join the ship if he could get to Southampton in time.

By the evening half the gear was on board and most of the scientific party had arrived. Frozen dolphins for the LAFF experiment arrived and were stored in the freezer off the main laboratory on board the *RRS Discovery.*.

Friday 26 July.

Loading continued. A problem was encountered with the requirement of gas bottles for the chemistry group. Suitable piping for connecting the bottles was located at Plymouth Marine Laboratory and arrangements were made to send this to Southampton.

1700h The scientific party dined on board.

2030h The last member of the scientific party; Stuart MacWilliams of Trinity College Dublin, arrived at SOC to join the ship.

Saturday 27 July.

0845h The copper gas pipe was delivered to the ship.

0900h *RRS Discovery* cast off from the SOC quay.

1200h Received Fax from the *RV Pelagia* informing of their intentions over the next few days and proposing plans for a rendezvous at OMEX 3 station.

1300h PSO addressed the crew to describe the work of the cruise.

1500h A scientific meeting was held to discuss the work of the cruise.

Sunday 28 July.

0800h *RRS Discovery* steamed westwards towards the first station on the Goban Spur.

1300-1430h Tour of all the landers. Each of the instruments on board was explained to the rest of the ship's company.

1900h A few of the scientific party were feeling a bit sick as the ship steamed forward into the swell. The gas systems to the chemistry laboratory were installed and the first channel of the auto-analyser was working. Work continued on preparing landers for their respective first deployments.

2030h During the day the ship had been steaming against a force 5-6 westerly wind with showers of rain from time to time. The plan was to proceed to PAP to deploy the MAP and LAFF experiments however on the way to test the SPI instrument and to test acoustic releases on the CTD rosette. The aim was to return to the OMEX 3 area for Tuesday morning to rendezvous with the *RV Pelagia.* In view of the head winds the ship was falling behind schedule.

2100h Dolphins seen on the bow of the ship.

Monday 29 July

0525h *RRS Discovery* on station for the SPI deployment. Sea temperature 17.8°C air temperature 15.0°C.

0613h **Station 222/96/01 SPI 1400m 49°15'N 12°46'W**
Gear into the water.

0704h SPI on the bottom.

0840h SPI on board having taken 15 pictures.

0900h PES Sonar fish launched off the port side in preparation for the deep water work.

1230h *RV Pelagia* came into view and called up on the VHF. Monty Priede spoke to Gerard Duineveld. Arrangements for the rendezvous were agreed.

RRS Discovery continued westwards towards the PAP station.

1514h **Station 222/96/02 CTD 4556m 49°06.3'N 14°27.1'W**

CTD with two MORS releases on the frame and Niskin bottles. A new MORS release to be used on the LAFF experiment and an old MORS release on loan from GEOMAR to the University of Aberdeen, fishtrap were tested. Water was collected in the Niskin bottles for filling the sampling syringes on the Gothenberg lander.

1728h CTD in board. *RRS Discovery* continued westwards towards the PAP station.

Tuesday 30 July

0229h **Station 222/96/03 CTD 4800m 49°55.18'N 16°30.45'W**

This CTD cast was to provide base line data at the MAP station.
No Niskin bottles were mounted.

0335h CTD on the bottom.

0615h CTD completed

RRS Discovery remained on station for deployment of the MAP.

0654h **Station 222/96/04 MAP 4800m 48°56.06'N 16°31.93'W**

MAP deployed without incident. Craned over the stern inside the "A" frame.
Descent rate checked on the waterfall display in the main laboratory.
RRS Discovery proceeded eastwards to the LAFF station.

0855h *RRS Discovery* on station for deployment of the LAFF.

LAFF positioned for deployment but the camera failed to fire. Tests and debugging continued

1233h **Station 222/96/05 LAFF 4800m 48°46.09'N 16°10.0'W**

LAFF eventually deployed without incident with half of a dolphin carcass plus three code activated transponders baited with mackerel. It was lowered through the A frame by crane. The dolphin did ride upwards in its slings. Using the waterfall display the descent rate of LAFF was measured as $27 m.min^{-1}$.

1600h *RV Pelagia* informed us over the VHF that they have deployed the NIOZ lander on the OMEX 3 site at 49°05.03'N 13°25.77'W

2315h *RRS Discovery* hove to at the GEOMAR station for OMEX 3.

2338h **Station 222/96/06 GEOMAR Lander 3650m 49°04.99'N 13°27.35'W**

GEOMAR lander deployed over the stern by crane without incident.

Wednesday 31 July 1996

0000h *RRS Discovery* hove to at the IFREMER station for OMEX 3.

0019h **Station 222/96/07 IFREMER Lander 3650m 49°03.98'N 13°25.76'W**
IFREMER lander deployed through the stern by crane. It was a tight fit inside the "A" frame. It seemed deployment over the side would be preferable.
Descent of the lander was observed on the waterfall display and opening of the parachute that slows the descent was confirmed.

0100h *RRS Discovery* hove to at the Göteborg lander position.
There was a considerable delay whilst the lander was prepared for launch.

0350h The lander was positioned and ballasted up on the stern ready for launch.

0428h **Station 222/96/08 Göteborg Lander 3630m 49°03.96'N 13°27.31'W**
The Göteborg lander was deployed without incident through the A frame at the stern using the crane, however the ballast pieces of railway line made this manoeuvre difficult.

The four landers, NIOZ (launched from the *RV Pelagia*) plus the 3 from *RRS Discovery* formed a square with 1 nautical mile spacing between the landers, close to the OMEX-3 sediment trap mooring.

0542h **Station 222/96/09 SPI 3784m 49°08.0'N 13°31.0'W**
The SPI was deployed with the aim of doing three parallel transects.
The first transect was completed after drifting approximately 1.5 Nmiles.

0856h SPI was lifted out of the water having completed the first transect. *RRS Discovery* repositioned for the second transect.

0925h SPI relaunched at 49°07.8'N 13°32.4'W, 3805m depth.
1228h SPI inboard after the second transect.

In the mean time Annick Vangriesheim of IFREMER had asked if she could be transferred to the *RV Pelagia* to travel home having completed her work for the cruise with the deployment of MAP. This was discussed (1020h) with the *RV Pelagia,* Peter De Wilde the principal scientist and the captain were willing to accommodate this request and agreed to send across a boat to the *RRS Discovery* at a later time. In view of this and the need to complete the recovery of a large mooring in daylight SPI work on station 9 was curtailed.

1250h *RRS Discovery* proceeded to the position of the OMEX 3 mooring of Dr. Avan Antia, Institut Für Meereskunde, Kiel, Germany.

1345h *RRS Discovery* on station.
1405h Mooring released 49°05.3'N 13°23.4'W 3650m
1437h First float was grappled
1441h First floats inboard

1445h A shackle failed, the mooring parted and sank.
1541h The rest of the mooring surfaced and was grappled
1602h Sediment trap inboard.
1655h Current meter inboard
1706h Second sediment trap inboard.
1741h Second current meter inboard
1752h Releases inboard
1802h All mooring inboard

1815h 49°06.8'N 13°23.8'W *RV Pelagia* approached close, launched a Rigid inflatable craft with three men on board and collected Dr Annick Vangriesheim.

Work continued on deck securing all the IFM mooring equipment.

2139h *RRS Discovery* on Station 10 for a CTD cast.

2155h **Station 222/96/10 CTD 3652m 49°05.1'N 13°23.4'W**
Full CTD with 12 Niskins Surface,50,75,100,200,300,500,1000,2000,3000, metres from surface plus bottom at the vacated OMEX 3 mooring site. This provided Water chemistry samples for the IFREMER and Göteborg groups.

2316h CTD on the bottom

Thursday 1 August

0049 CTD inboard, removal of water samples continued until 0129 when *RRS Discovery* moved off towards the next station.

0222h **Station 222/96/11 Multicorer 3652m 49°07.07'N 13°31.07'W**
The GEOMAR multicorer was deployed at the SPI (Station 9) OMEX 3 location.
0400h On the bottom
0537h Corer inboard but unsuccessful, no sediment collected.

RRS Discovery hove to to wait for the AUDOS 2 to be prepared for next station.
0956h **Station 222/96/12 AUDOS 3641m49°04.92'N 13°25.78'W**
AUDOS 2 with three code activated transponders and mackerel bait was deployed by crane over the transom inside the "A" frame. A malfunction of the port stern crane caused it to lift AUDOS prematurely. The AUDOS was then switched to the starboard side and was deployed without incident on the location vacated by the NIOZ lander .

The descent rate was observed to be 55.4m/min =0.92m/s.
The pinger did not time out indicating a software fault, it seemed unlikely that any data would be collected.

1100h on the bottom = 0.948 m/s.

RRS Discovery then moved to the centre of the square of landers for acoustic tests.

1115h **Station 222/96/13 Acoustic Tests 3650m 49°04.75'N 13°26.41'W**
Experiments were undertaken on communicating with all four landers from one central location using the various types of equipment in the ship's laboratory. It was possible to telemeter between the ship and the GEOMAR, IFREMER and AUDOS lander simultaneously. The Göteborg lander had a weak signal at this range.

1203h Recovery of GEOMAR Lander (Station 6)
Lander released from the bottom on acoustic command.

1300h Lander surfaced
1321h Lander grappled.
1326h Lander on board one of the 2 chambers had lost its sediment. Otherwise the data seemed OK.
1406h GEOMAR lander secured and stowed. *RRS Discovery* moved off to the OMEX 4 station mooring recovery station.

During this time the ship's engineers were working to repair the constant temperature room. This was necessary for storage of films, analysis of water chemistry samples, and storage of sediment trap samples which were preserved in mercuric chloride and hence could not be allowed into domestic refrigerators. The repairs involved major works on the refrigeration pipe-work.

1523h OMEX 4 Mooring, 48°59.51'N 13°44.06'W recovery. Depth 4485m, 644m long. This was a second mooring to be recovered on behalf of Dr. Avan Antia of the IFM in Kiel.

1645h The first floats surfaced.
1701h Grappled but subsequently lost grip
1748h The mooring was regrappled
1825h All the mooring was inboard. It was found that two of the top floats on the mooring (Large Nautilus glass spheres) had imploded; hence the difficulty in recovering this mooring since there was no line free to grapple.

2110h **Station 222/96/14 Fish Trap 3710m 49°07.02'N 13°31.01'W**
The University of Aberdeen fish trap was deployed with three tubular amphipod traps all baited with mackerel. A Mors release was fitted above the trap linked to 115kg of ballast. The trap was deployed at the stern lowering the ballast, trap and release first and finally trailing the floats. The quick release was attached to the first float rack above the fish trap.

2208h **Station 222/96/09 SPI 3818m 49°08.1'N 13°29.4'W**
The aim was to complete the third transect of this station; work on which had been curtailed previously.
2332h SPI on the bottom

Friday 2 August

0129h SPI back inboard.

0200h Problems were discovered with the SPI instrument; only two images had been recorded. Further work planned for the night using SPI was therefore cancelled. *RRS Discovery* proceeded to the location for recovery of the Gothenberg lander, (Station 8).

0606h The Göteborg lander ballast was released by acoustic command.
0701h Surfaced
0712h Lander line grappled.
0718h The kevlar line hooked onto the lander lifting ring parted. The lander was quickly regrappled
0725h The lander was inboard. Only one chamber had taken an undisturbed sediment sample. There appeared to be problems with penetration of the sediment. Otherwise function of the lander appeared to be excellent with most syringe samplers working well. Whilst the Göteborg group proceeded with analysis of their samples *RRS Discovery* moved into position for recovery of the IFREMER lander.

0830h *RRS Discovery* in position for recovery of the IFREMER lander (Station 7)

0838h Lander ballast released by acoustic command.
1035h Surfaced. There was then a delay whilst the ship's heading was held constant in order to received E-mails over the Inmarsat link.
1110h *RRS Discovery* approached the lander.
1119h The recovery line was grappled.
1120h The parachute was on board and removed.
1129h The lander was inboard.

1320h The lander was secured inside the hanger and *RRS Discovery* proceeded to recovery of the fish trap.

1333h Fish trap released. (Station 14)
A slow ascent was tracked on the waterfall display

1511h Fish trap surfaced.
1527h Fish trap grappled
1540h Fish trap in board with 4 *Coryphaenoides (Nematonurus) armatus* inside. The two amphipod traps inside the trap caught very few amphipods but the one outside was successful.

1700h *RRS Discovery* returned to the AUDOS station (Station 12) The AUDOS was clearly on the sea floor with the pinger working but not responding to commands.

2021h **Station 222/96/15 Fish Trap 3658m 49°04.92'N 13°27.17'W**
The fish trap was redeployed as before but with all three amphipod traps on the outside and one extra float to increase the ascent rate. The ballast was increased to 125kg.

2109h **Station 222/96/16 Multicorer 3700m 49°04.4'N 13°27.0'W**
A successful multicore was carried out at this OMEX 3 location.
2330h Corer inboard.

RRS Discovery continued listening for the AUDOS rising to the surface whilst winch modifications and tests were carried out during the night.

Saturday 3 August
0645h Concern continued that the back-up Mg release on the AUDOS was still holding. It was a Scripps nominal 48h release that in previous work in the NE Atlantic had been found to have an average duration of 32h. Dolphins staged a spectacular show swimming northwards leaping in the red sunrise.

0900h *RRS Discovery* moved to the Fish trap, Station 15 Location.

0902h The fish trap was released.
1013h Fish trap surfaced.
1041h Dan Buoy line grappled.
1100h Fish trap in board with a catch of 4 *Coryphaenoides (Nematonurus) armatus* grenadiers again but with a large amphipod *Eurythenes gryllus* (*ca.*9cm long) in the fish trap.

1120h It was noticed on the waterfall display that the AUDOS had released from the bottom and was rising in the water column. *RRS Discovery* moved onto station to recover the vehicle. Weather was bright and sunny with a light wind.

1225h AUDOS Station 12 surfaced.
1303h The Dan buoy line was grappled.
1318h AUDOS inboard. The folding up of arms was achieved easily by hooking of the line by the bo'sun's hook pole. The Mg link had clearly worked at 49h 20 min after deployment. This new (1992) batch of Mg links appears to match the original Scripps specification.

RRS Discovery set course for the OMEX 2 site to retrieve the last of the sediment trap moorings of Avan Antia of IFM, Kiel.

The constant temperature room had finally ceased working; owing to an electronics problem that could not be solved at sea. Chemical samples were therefore moved into the main freezer and the dolphin carcasses and bait were removed into chest freezers in the hold.

1553h *RRS Discovery* at the OMEX 2 station 49°11.84'N 12°48.63'W.

The acoustic release (Mors) responded to the release command and apparently did work but the mooring showed no signs of moving from the bottom.

1648h Release attempts were abandoned.
It was decided to begin deployment of the three chamber landers at the OMEX 2 site in order to compare metabolism readings at a location of higher respiratory activity. A triangular formation was proposed with the landers 0.5 nautical miles apart. In the mean time a radio and visual look-out was maintained should the sediment trap mooring lift off the bottom.

1932h **Station 222/96/17 IFREMER Lander 1450m 49°10.08'N 12°48.01'W**
The lander was deployed without incident over the stern in fine weather.

There were delays in preparation of the GEOMAR and Göteborg landers so it was decided to postpone their deployment until the next day. *RRS Discovery* therefore moved away slightly to deploy the fish trap.

2021h **Station 222/96/18 Fish Trap 1450m 49°13.49'N 12°48.52'W**
The fish trap baited with mackerel was deployed with the 3 amphipod traps on the outside.

During the evening, further attempts were made to communicate with the OMEX 2 mooring. The back-up (Benthos) was also fired and confirmed it was functioning but still the mooring would not free itself from the bottom.

2200h *RRS Discovery* moved back to deeper water for Station 19 where SPI, which was now functioning again would survey the sediment.

2303h **Station 222/96/19 SPI 2200m 49°09.3'N 13°04.4'W**
SPI deployed on the edge of the Goban Spur.

Sunday 4 August

0038 Commenced hauling SPI from the bottom

0128 SPI secure inboard. The instrument was checked and appeared to have worked well; *RRS Discovery* then moved back eastwards into shallower water.

0418h **Station 222/96/20 SPI 1300m 49°14.0'N 12°35.1'W**
SPI redeployed at a new station.
0612h SPI now in board.

RRS Discovery returned to the OMEX 2 site to deploy the GEOMAR and Göteborg landers. There was no sign of the Sediment trap mooring.

0739h **Station 222/96/21 CTD 1363m 49°09.8'N 12°45.8'W**

CTD at the OMEX 2 site to get water samples for the priming the Göteborg lander water for chemistry. Niskins at 0, 25, 75, 100, 150, 200, 300, 500, 750, 1000 metres from the surface and the bottom.

0835h CTD on the bottom

0924h CTD inboard.

1005h **Station 222/96/22 GEOMAR Lander 1363m 49°10.5'N 12°47.6'W**

GEOMAR Lander deployed 0.5 nautical miles away from the IFREMER lander to form a cluster of landers at the OMEX 2 location.

Preparation of the Göteborg lander continued with priming of all the syringes. As the morning progressed the wind increased to 20knots.

1200h *RRS Discovery* on station for launch of the Göteborg lander.

1217h Göteborg lander deployed at 49°09.8'N 12°45.8'W.
The lander immediately resurfaced after going down a few meters.

1325h The lander was regrappled.

1330h Göteborg lander in board. It seemed the burn wire had broken and released the ballast weights. New ballast weights were loaded up and the lander was made ready for redeployment.

1448h Göteborg lander redeployed. Again it refloated after a few minutes under water.

1525h The retrieval line was grappled.

1536h Göteborg lander inboard again. This time the same fault had occurred but it was clear that the software was triggering the burn wire to release. The lander was stowed for further investigations.

1550h *RRS Discovery* moved into position for recovery of the fish trap.

1634h Acoustic release fired on the Fish Trap Station 18.

1700h Fish trap on the surface.

1716h A squall with heavy rain and winds gusting to 30 knots came through. Recovery was postponed to wait for better visibility.

1729h The mooring was grappled.

1742h The fish trap was on board. 5 eels *Synaphobranchus kaupi* were caught and about 1000 amphipods. The whole mackerel bait in the fish trap was stripped to the bare bones.
The fish trap was then rebaited and set up for redeployment.

2013h **Station 222/96/23 Fish Trap 2234m 49°09.1'N 13°05.08'W**

A rather messy deployment of the fish trap in windy conditions, The Dan Buoy strobe light was damaged and not working. It was replaced with another strobe. After deployment the Dan Buoy lower spar fell off and the Novatech radio inside was lost. It seemed that a vertical impact with the sides of the ship that damaged the strobe must also have shifted the tubes causing the Dan buoy to break up when redeployed. The trap was eventually deployed using a different Dan Buoy and without a radio.

RRS Discovery then steamed westwards for a SPI deployment in deep water.

2157h **Station 222/96/24 SPI 3815m 49°16.0'N 13°20.05'W**
SPI deployed.

Monday 5 August

0100h Started hauling SPI to the surface.
0222h SPI in board. A successful deployment.
0230h *RRS Discovery* headed back towards the OMEX 2 station.

0500h Returned to the OMEX 2 site.

0617h **Station 222/96/25 Multi-corer 3900m 49°10.5'N 12°49.3'W**
Multicorer deployed.
0700h On the bottom.
0742h Multicorer inboard with a good set of samples.

During the multicorer cast, abnormal pings were observed on the SIMRAD echo sounder trace. Further checks suggested these were from acoustic releases of the OMEX 2 mooring that could not be recovered two days previously. Signals were heard on the radio receiver suggesting the mooring was on the surface.

RRS Discovery moved northwards to the OMEX 2 station and it was confirmed that the mooring site had been vacated, no pingers were heard.

A search was initiated to the south and east , the direction of expected drift in the prevailing wind conditions force 4, but the signals were lost. *RRS Discovery* returned to the OMEX 2 area to recover the IFREMER lander while watch was kept for the mooring.

0950h *RRS Discovery* off the lander location.
0956h Lander released.
1036h IFREMER lander (Station 17) on the surface.
1127h Handling line grappled.
1135h Lander in board.

1200h A further systematic search for the OMEX 2 mooring ensued to the west and south.

1616h The search was broken off for recovery of a fish trap.
1715h Fish trap (Station 23) acoustic release fired.
1758h Fish trap on the surface.
1807h Mooring grappled.
1822h Fish trap in board. No fish caught and very few amphipods. One of the amphipod traps attached to the outside of the cage was lost.

Set course to the GEOMAR lander station whilst searching for the OMEX 2 mooring.

2011h GEOMAR lander (Station 22) Acoustic release fired.

2033h GEOMAR lander on the surface.
2055h Handling line grappled.
2103h Lander inboard, both chambers appear to have worked well.

A search for the OMEX 2 mooring continued in the hope of spotting the flashing strobe light as it became dark. The search continued until 2400h without success.

Tuesday 6 August.

RRS Discovery proceeded westwards to the abyssal OMEX 4 station for some SPI work before passage to the PAP station.

0328h arrived at the OMEX 4 station.

0334h **Station 222/96/26 SPI 4500m 49°59.5'N 13°44.0'W**
0540h 4516m of cable out, winch failed.
0600h Winch restarted and work resumed.
0929h SPI in board work satisfactorily completed.

0934h *RRS Discovery* resumed passage to PAP. Weather sunny with light winds.

1845h It was planned to deploy the three metabolism chamber landers in a close cluster in form of an equilateral triangle with sides 1nmi. long.

2016h **Station 222/96/27 IFREMER Lander 4850m 48°57.98'N 16°24.96'W**
IFREMER lander deployed without incident in clear calm sunny weather.

2039h **Station 222/96/28 GEOMAR Lander 4850m 48°59.05'N 16°24.95'W**
GEOMAR lander, with two metabolism chambers running, deployed without incident.

2204h **Station 222/96/29 CTD 4850m 49°51.4'N 16°29.8'W**
A preliminary CTD cast to obtain water to prime the syringes of the Göteborg lander.

Wednesday 7 August.

0214h CTD in board .The ship was then repositioned for the some SPI work.

0319h **Station 222/96/30 SPI 4811m 48°51.49'N 16°30.0'W**
SPI deployed at the centre of the PAP station.
0824h SPI inboard after a partially successful series of photos.

The wind was blowing at 25 knots by this time and the sea was increasing. The Göteborg group meanwhile prepared their lander but found they could get only two chambers to work. A small French tuna fishing vessel on passage back to France passed close to *RRS Discovery.*

1042h **Station 222/96/31 Göteborg Lander 4850m? 49°58.47'N 16°23.51'W**
The Göteborg lander was deployed in roughening conditions.It sank successfully but could not be followed down on the sonar because of poor reception from the MORS unit. This lander completed the triangular cluster.

The fleet of four ATTIS landers were now inside the hanger and being prepared for deployment as a linear array. *RRS Discovery* proceeded across the PAP area to the ATTIS site in the SW corner amidst worsening conditions.

1530h *RRS Discovery* hove to owing to inclement weather with winds of 35 to 40 knots (Force 8-9). No further work was possible.

Thursday 8 August.

0700h The wind had veered to the west and moderated to force 4-5. It was decided that the sea state had moderated sufficiently to resume work so the morning was taken up with preparation of the ATTIS vehicles for deployment.

The *RRS Discovery* manoeuvred into position 4 miles down wind of the proposed location of the last ATTIS lander. She then advanced gradually upwind and the landers were deployed one by one along a line 0.5 nmi apart:

1223h **Station 222/96/32 ATTIS Lander No 4 4850m 48°42.00'N 16°37.70'W**

1242h **Station 222/96/33 ATTIS Lander No 3 4850m 48°41.99'N 16°38.45'W**

1256h **Station 222/96/34 ATTIS Lander No 2 4850m 48°41.97'N 16°39.34'W**

1311h **Station 222/96/35 ATTIS Lander No 1 4850m 48°41.99'N 16°40.06'W**

The sea state was quite high (2m wave height) and release of the landers was coordinated with the pitching of the ship, the release being pulled as the stern went down and the lander plunged into the water.

RRS Discovery then moved to the summit of a sea mount in the centre of the PAP area for deployment of the fish trap.

1546h **Station 222/96/36 Fish Trap 4360m 48°44.77'N 16°27.62'W**
The fish trap (with amphipod traps) was successfully dropped onto the summit of the sea mount. This was checked by telemetry to the release which gave a minimum range of 4354m from the surface.

After major repairs and testing the AUDOS II was ready for deployment.

2008h **Station 222/96/37 AUDOS II 4799m 48°46.05'N 16°21.00'W**
AUDOS II was deployed with the camera firing at 30s intervals autonomously and a back-up MORS release suspended in the centre of the frame. One of the CATS came loose during the deployment in fairly rough conditions.

2155h *RRS Discovery* steamed over the sea mount along a westward track at latitude 48°45.87'N to check the height of the sea mount and locate the peak more precisely.

2200h Acoustic Trials commenced at 48°42'N 16°40'W. A series of tests was carried out on telemetry and ranging the landers of the ATTIS array.

Friday 9 August.

0010h Complete acoustic trials.

0800h The weather had deteriorated with 20-30 knot winds and a large swell building up. *RRS Discovery* hove to until noon waiting for suitable conditions for work. It was decided that in view of the Mg releases that would corrode by the next morning the fish trap and AUDOS should be retrieved.

1218h Station 36 Fish trap, The release command was transmitted and the ascent to the surface began.
1343h Fish trap surfaced in 25 knot winds.
1354h The fish trap was grappled.
1415h The fish trap was in board. 2 *C.(N.) armatus* had been caught together with a number of amphipods.

1500h *RRS Discovery* steamed towards the AUDOS position Station 37.
1504h It was noticed on the acoustics ranging that AUDOS was already off the bottom.
1516h The AUDOS floats were observed on the surface and the top of the Dan Buoy spar had broken off.

1536h *RRS Discovery* came alongside the rig 48°46.64'N 16°19.61'W
1540h The mooring was grappled.
1612h AUDOS was in board following considerable difficulties in retrieving the vehicle in 30 knot winds and large swell. The ropes were caught around the rudder post and had to be cut away.

It was found that the main release controlled by the ACU had opened. On subsequent analysis this was found to have occurred under command of the software that was programmed to release if the on-board processor crashed 20 times. Release had occurred at 2140h; 92 minutes after deployment. AUDOS had not reached the sea floor. It would have reached the surface at about 2300h This meant it was on the surface for 16h before it was sighted. Presumably the Dan

Buoy had been broken up by the heavy seas prevailing in this area during that time; the radio and strobe were lost. The camera had worked well photographing in mid water.

1700h The weather was now too rough for further work so *RRS Discovery* hove to overnight. The LAFF vehicle was checked acoustically and was found to be in place.

Saturday 10 August.

0800h The seas were still rough but the wind was decreasing.

1200h Station 31. The wind had moderated to 15-20 knots. In view of the fact that a back-up timer would trigger the Göteborg lander within 24h it was decided to release this lander whilst conditions appeared workable.

1245h Acoustic release commands were transmitted from the ship. The MORS release did not reply and could not be tracked.

1355h The Göteborg lander (Station 31) surfaced. The VHF radio was OK. It appears the MORS release worked but its transmission system was not working.

1412h The lander was grappled. It was then recovered using the main trawl warp threaded over the A frame block.

1424h The Göteborg (Station31) lander was on board. The two chambers had worked well and had taken two good core samples in soft sediment with polychaete tube worms visible. One pellet glass float had broken.

1436h Station 27. In view of improving sea conditions the IFREMER lander was sent a release command.

Whilst the Göteborg lander was being moved into a stowage position on the deck the port side crane failed. This obstructed the deck working area.

1649h IFREMER lander surfaced. Recovery had to be delayed until the crane could be moved out of the way of the deck working area.

1800h The RVS team managed to move the crane.

1805h The IFREMER lander was grappled
1820h IFREMER lander on board, having worked satisfactorily.

1837h Station 18 The GEOMAR lander was released. Only one release worked.
1955h GEOMAR lander surfaced, The VHF radio did not work.
2018h The retrieval line was grappled.
2025h The lander was in board. One of the MORS release housings had failed catastrophically, it had been flattened, cracked and flooded by pressure of sea

water. The two metabolism chambers had worked well and collected samples of sediment.

RRS Discovery hove to waiting to begin SPI work during the night. The Galway team had extensively refurbished the electronics and were ready to continue work. Seas had considerably calmed since the morning but wind speed had increased again slightly to 20 knots.

2300h **Station 222/96/38 SPI 4850m 48°58.0'N 16°24.1'W**

2303h SPI camera outboard.
2310h A sheave seized so deployment was paused while repairs were carried out.

Sunday 11 August.

0100h Repairs on the sheave completed, deployment of the SPI was resumed.
0415h Hauling of SPI of the bottom began
0603h SPI in board.

0630h *RRS Discovery* headed towards the LAFF site, Station 5. The weather was clear and calm with light winds.

0750h Acoustic interrogation of the ACU commenced.
0751h The ACU replied.
0758h The release sequence was initiated, The corer release was activated.
0808h The main ballast was released.
0812h The LAFF could be seen to be rising towards the surface.
0938h LAFF surfaced.
1005h LAFF was grappled.
1034h LAFF was in board.
The seized eyes on the LAFF mooring line almost failed. The corer had failed to drop; it was found that the polarity of the burn wire system had been reversed. Only bones and a few bits of skin of the half dolphin remained. The photographs which were developed on board were excellent and a full set of fish tracking data had been recorded. The experiment had been a great success.

Work began on recharging batteries for redeployment of the LAFF. In the mean time *RRS Discovery* moved to the centre of the working area for a multi-corer cast.

1246h **Station 222/96/39 Multi-corer 4850m? 48°51.43'N 16°30.05'W**
Multicorer deployed at the centre of the PAP area.
1438h Commenced hauling on the corer.
1620h Multicorer completed. A successful set of cores in soft sediment with much biological activity.

Work continued on the LAFF during the course of the afternoon and evening. A whale was seen circling quite close to the ship. The forecast was now indicating good weather for the next few days.

2059h **Station 222/96/40 LAFF 4803m 48°56.2'N 16°24.1'W**
The LAFF rig was redeployed at a new location in the PAP area using the right half of the dolphin and three CATS baited with mackerel. The rig was acoustically monitored to the sea floor.

2342h LAFF touched down on the sea floor.
1343h *RRS Discovery* set course for the BIOTRANS area.

Monday 12 August

0542h **Station 222/96/41 Sounding run via 48°40'N 18°00'W**
On behalf of P. Hunter at SOC the *RRS Discovery* made a slight detour on this track to obtain soundings of an area that is currently poorly charted.

1330h *RRS Discovery* was approaching the BIOTRANS site and telephone calls were made to Dr Jan Duinke of the Chemistry Group. Institut für Meereskunde, Kiel, Germany to verify the locations of JGOFS sediment trap moorings in the BIOTRANS area. The positions were given as:

1. 47°30.00'N 19°41.60'W
2. 47°44.00'N 19°48.00'W

These had been placed in July 1996 to replace a previous mooring located at 47°43.56'N 19°49.75'W. It was decided to work close to these moorings but to avoid acoustic clashes by keeping landers at least 6 nmi. away and CTD and corers at least 2 nmi away.

1718h **Station 222/96/42 CTD 4525m 47°41.00'N 19°45.05'W**
CTD on arrival at the BIOTRANS site for priming the Göteborg lander syringes. Also samples were analysed for oxygen to check calibrations..

During this time a school of long-finned pilot whales was seen around the ship. The weather was calm.

2155h **Station 222/96/43 IFREMER Lander 4530m 47°37'04N 19°49.98'W**
The first lander of a 1nmi triangle deployed at the BIOTRANS site. Since the weather was calm the lander was deployed using the ship's largest crane over the starboard side. The aft port crane was still out of action with a major fault in the hydraulics.

During preparation for this lander deployment Jean-Pierre Brulport helped with lifting steel ballast weights used on this equipment. After completing the work, he felt a small pain in his back which became progressively worse over subsequent days.

2214h **Station 222/96/44 GEOMAR Lander 4530m 47°37.03'N 19°51.52'W**
The second lander of the BIOTRANS cluster. Deployed over the starboard side but using the small after crane for convenience.

2244h **Station 222/96/45 Göteborg Lander 4527m 47°36.14'N 19°50.74'W**
The third lander of the BIOTRANS cluster; deployed programmed for a shorter period than the others. Also lifted over the starboard side by the large crane.

2320h A school of common Atlantic white sided dolphins spent some time swimming and leaping in the flood lighting provided by the ship.

Tuesday 13 August.

0016h **Station 222/96/46 Fish Trap 4284m 47°37.29'N 19°44.00'W**
The fish trap baited with mackerel and with three amphipod traps attached was deployed on the top of a sea mount in the BIOTRANS area. The trap apparently landed 100m down from the summit.

Further work with SPI was postponed owing to technical problems.

0800h *RRS Discovery* was on station waiting for AUDOS to be prepared.

1017h **Station 222/96/47 AUDOS 4523m 47°32.14'N 19°55.15'W**
AUDOS deployed with three CATS on an abyssal plain location at BIOTRANS. Deployed without incident in calm weather.

RRS Discovery then moved onto station for recovery of the fish trap Station 46.

1400h Fish trap Station 46 released from the sea floor.
1531h Fish trap surfaced.
1545h grappled
1556h Gear all in board. No fish were caught but *ca.* 150 amphipods were found in the traps.

1600h three *Physalia* Portuguese Men O'War were seen floating close to the ship.

1730h Work ceased for a mid-cruise Barbecue and celebration on the after deck.

1800h A strange phenomenon was observed about 10 metres from the ship. A line of small black fins each apparently 10-15cm high flapping about in a group along a line 1-1.5 metre long. This was either a group of fish or a single object with a number of "fins". It remained on the surface for about 2 minutes before disappearing.

2300h After dark *Noctiluca* bioluminescence was spectacular around the ship. In particular gar fishes (*Belone* or *Scomberesox* spp.) produced wavy luminescent wakes in the water.

Wednesday 14 August

0022h **Station 222/96/48 Fish Trap 4533m 47°37.05'N 19°37.29'W**
Fish Trap deployed on an abyssal plain station.

The SPI system was still being rebuilt so without other work to do *RRS Discovery* moved to the location of the Göteborg lander and hove to for the rest of the night.

0610h The release command transducer was lowered over the side.
0620h The Göteborg lander (Station 45) released from the sea floor.
0732h Göteborg lander surfaced.
0800h Grappled.
0809h Göteborg lander secured in board. (Station 45)

During this time Jean-Pierre Brulport woke up to find himself paralysed with severe back pain.

0950h *RRS Discovery* hove to over the AUDOS Station 47. Commenced interrogation of t the ACU
1005h No response from the ACU so switched to telemetry to the MORS backup release.
1006h AUDOS released.
1136h AUDOS surfaced.
1158h Grappled
1220h AUDOS all in board.(Station 47)

RRS Discovery moved into position for recovery of the Fish trap Station 48.
1334h Fish Trap released.
1509h Fish trap surface
1525h grappled.
1540h Fish trap (Station 48) in board having captured 2 large *C.(N.) armatus.*

Jean-Pierre Brulport was examined by the ship's officers. Apart from the pain there appeared to be no serious injury. M. Brulport was advised to rest and he remained in his cabin for most of the rest of the cruise. This was an aggravation of an old injury he was familiar with.

Meanwhile the Göteborg lander was prepared for relaunch for a second short deployment at the BIOTRANS site.

1650h **Station 222/96/49 Göteborg Lander 4529m 47°36.07'N 19°51.53'W**
Göteborg lander deployed over the side of the ship using a crane.

1740h **Station 222/96/50 Multicorer 4530m 47°39.0'N 19°50.0'W**
Multicorer sampling the BIOTRANS site near to the lander stations and sediment traps.

2058h Multicorer in board with a full set of cores. The sediment was apparently well oxygenated to a depth of over 30cm.

2120h *RRS Discovery* steamed towards the fish trap site searching for the top of a sea mount upon which to deploy the trap.

2159h **Station 222/96/51 Fish Trap 4221m 47°37.03'N 19°44.93'W**
Fish trap deployed on a small sea mount. There was some uncertainty about the depth to which it was deployed. The minimum sounding on the Simrad was 4123m Subsequently the fish trap was followed down and depth checked by acoustic ranging on the release transponder.
2323h Fish trap on the bottom , minimum range 4362m presumably having missed to the top of the mount.

Thursday 15 August.
An attempt was made to deploy the AUDOS but various systems failed and finally the deployment was aborted.

0238h **Station 222/96/52 SPI 4557m 47°39.90'N 19°51.17'W**
SPI deployed at the BIOTRANS station.
0709h SPI back inboard. A few pictures were obtained.

A nice warm sunny day with a very light breeze. *RRS Discovery* returned to the fish trap position to check the depth to which it had been deployed.
1125h Minimum range of fish trap was found to be 4361m
1132h The fish trap (Station 51) was released.
1304h Fish trap surfaced.
1310h Grappled
1330h Fish trap in board having captured one *C.(N) armatus.* This appeared to contradict the working hypothesis developed during this cruise that this species is caught only on the abyssal plain.

The weather continued sunny and calm whilst waiting for the chamber landers to complete their missions.

1652h **Station 222/96/53 Fish Trap 4529m 47°34.02'N 19°53.07'W**
The fish trap was deployed on the abyssal plain.

Meanwhile further advice on the camera problems with AUDOS was received by FAX from the manufacturers, The camera was reset accordingly and AUDOS was ready for deployment.

2001h **Station 222/96/54 AUDOS 4525m 47°37.14'N 19°53.96'W**

AUDOS deployed in calm conditions onto the abyssal plain area at BIOTRANS.

Friday 16 August

During this day all the landers were to be recovered as rapidly as possible before proceeding to back to the PAP stations. Work began before first light.

0522h Station 53 Fish trap released.
Wind 5 knots calm with bioluminescence in the water and numerous small fish swimming attracted by the ship's lights.
0650h Dawn feeding frenzy of fish and birds observed near the ship.
0658h Fish trap surfaced
0802h Fish Trap grappled after several failed attempts.
0815h Fish trap (Station 53) inboard, no fish caught,

0816h IFREMER Lander Station 43 released.
1021h IFREMER lander surfaced, Calm sunny day.
1024h GEOMAR lander (Station 44) released, since all the landers were within 1 nmi of the ship it was possible to release the next lander whilst dealing with the previous one. To avoid problems it was decided to only release the next lander when the previous one was on the surface.

1039h IFREMER lander grappled.
1041h Parachute inboard
1052h IFREMER lander all in board (Station 43)
1142h GEOMAR lander surfaced.
1146h AUDOS (Station 54) released.

1205h GEOMAR lander grappled.
1212h GEOMAR lander all in board (Station 44)

1316h AUDOS surfaced.
1320h Göteborg lander (Station 49) released.
1324h AUDOS grappled.
1340h AUDOS all in board (Station 54)

1429h Göteborg lander surfaced
1457h Göteborg lander grappled
1510h Göteborg lander all in board (Station 49)

1540h All secure on deck, *RRS Discovery* headed for the PAP site. 5 landers had been successfully recovered within 10 hours from interrogation of the first to stowing on deck of the last one.

1600h **Station 222/96/55 Sounding run. via 48°30'N 18°00'W**
During the evening wind speed increased to Force 5 from the south.

Saturday 17 August.

0500h Sounding run complete. Having arrived at the PAP site for the second period of work here, *RRS Discovery* hove to ready for a CTD cast to obtain bottom water for the Göteborg lander. 48°49.7'N 19°29.8'W

0534h A cable termination problem was noticed in the CTD cable. The cable was shorting so a section was cut off and the electrical and mechanical terminations were remade.

0900h The CTD was repaired but by now the winds was blowing 30 knots gusting to 40 so no work was possible. *RRS Discovery* therefore moved to the proposed site for chamber lander deployments to await suitable conditions.

1024h 48°50.6'N 16°51.1'W *RRS Discovery* hove to owing to inclement weather conditions.

1300h Hove to.

1530h The windspeed decreased to 20 knots and it was decided to deploy the GEOMAR lander since this was the smallest and most manageable of the landers.

1543h A first attempt to deploy failed since the ballast fell off during lifting. A stray line used for limiting the swing of the vehicle snagged a ballast release cable, triggering the system to shed its load.

1613h **Station 222/96/56 GEOMAR Lander 4802m 48°50.05'N 16°15.55'W**
Successful deployment of the GEOMAR lander using the aft port crane, a very rapid efficient deployment in quite rough conditions.

1706h **Station 222/96/57 Göteborg Lander 4802m 47°50.00'N 16°15.24'W**
The Göteborg lander was deployed using the forward 10T port crane near to the GEOMAR lander.

1744h **Station 222/96/58 IFREMER Lander 4801m 48°50.01'N 16°16.95'W**
The IFREMER lander being much heavier than the other landers was moved out of the hanger last of all. It was also deployed over the port side using the main crane. The 3 chamber landers formed a line near the site of BATHYSNAP located at: 48° 50'N 16°20'W.

1800h *RRS Discovery* proceeded to deployment of the fish trap on the abyssal plain.

1948h **Station 222/96/59 Fish Trap 4799m 48°45.22'N 16°31.95'W**
Fish trap deployed on the abyssal plain at PAP.

2101h **Station 222/96/60 AUDOS 4359m 48°44.90'N 16°27.60'W**
AUDOS deployed on the top of the "Ben Billet" sea mount. Just the camera and the current meter were working autonomously. The sonar array arms were folded up.

Work then adjourned for the Atlantic rowing race in the crew bar, an energetic event won by the Rolls Rhys team!

2338h **Station 222/96/61 SPI 4800m 48°49.70'N 16°18.30'W**
SPI was now repaired and surveyed the sediment in the region between the lander cluster and bathysnap. There were initial delays owing to the wire jamming in the winch pulleys.

0135h Commenced hauling. Work was difficult owing to a heavy swell and intermittent loss of signal from the pinger.

0401h SPI inboard work at Station 61 completed.

RRS Discovery proceeded to the fish trap position station 59.

0936h Having allowed the trap a full 12h on the bottom it was released.
1117h Fish trap surfaced.
1138h Grappled
1155h Fish trap (Station 59)in board. No fish were caught but there were amphipods in the small traps.

1241h AUDOS released (Station 60)

1404h AUDOS surfaced, (5 minutes earlier than expected because the arms were folded up.
1422h AUDOS grappled.
1434h AUDOS in board (Station 60).

A bright sunny Sunday afternoon with 10 knot wind but quite a big swell.

1422h **Station 222/96/62 Fish Trap 4799m 48°46.00'N 16°36.96'W**
The fish trap was deployed on the abyssal plain with the usual mackerel bait and three amphipods traps. In addition remains of a BBQ with raw spare ribs, sausages and part cooked chicken portions were placed inside the trap.

RRS Discovery moved to the position for deployment of AUDOS.

Whilst AUDOS was prepared further problems developed with the camera. The flash stopped working.

2150h **Station 222/96/63 AUDOS 4798m 48°42.73'N 16°38.98'W**
The AUDOS was deployed approximately 1 km to the north of the ATTIS array. Three CATs baited with mackerel were used. The current meter was set to work autonomously and the tracking system reconfigured to work as a self standing system. The camera system was not working reliably.

RRS Discovery hove to waiting for the SPI group to prepare their system . The wind was blowing about 20 knots with a big swell.

Monday 19 August

0600h *RRS Discovery* hove to at the LAFF site, it was decided to wait until first light to decide whether to recover LAFF (Station 40).

0930h Wind 25-30 knots from the NW with a heavy swell. It was decided to not to recover the LAFF. *RRS Discovery* proceeded to the fish trap, Station 62.

1100h *RRS Discovery* hove to at Station 62, fish trap position. Conditions were not suitable for work but there was bright sunshine.

1245h The Fish trap (Station 62) was released as conditions moderated slightly.
1431h Fish trap on the surface.
1451h Fish Trap grappled
1502h Fish Trap (Station 62) in board. No fish were caught despite the large amount of barbecue bait.

1546h Acoustic Tests on AUDOS. Station 63.
1549h Command 281 sent, Response confirmed presence of data on the hard disc.
1550h Release command sent.
1554h Release motor confirmation received.
1554h AUDOS observed rising to the surface.
1731h AUDOS surfaced.
1744h AUDOS grappled.
1756h AUDOS in board all OK. Station 63.

RRS Discovery proceeded to the LAFF station 40 for recovery.

2048h At LAFF location Release command sent.
Delay whilst the corers dropped.
2003h Release motors activated.
2010h Release confirmed using the Aberdeen University system.
2137h LAFF on the surface, just as it was getting dark.
2146h LAFF grappled.
2202h LAFF mooring parted; Instrument fell to the sea floor with one double benthos float pack attached.

The stitch and whip eye splice on the end of the rope had failed.
LAFF lost at 48°56.2'N 16°23.4'W 4803m depth.

One of the surviving eyes was subsequently tested and it parted under a load of 650kg when the rope itself has a breaking strain specification of 5 tonnes..

2256h *RRS Discovery* proceeded to the SPI site.
2400h Hove to on the SPI site.

Tuesday 20 August.
0100h SPI worked abandoned owing to failure of the batteries.

The aim on this day was to lift all the remaining landers from the sea floor and to return to the OMEX area for the last part of the cruise where all three respirometer landers would be deployed for a period 72h on the sea floor at OMEX IV, the foot of the continental rise.

0640h IFREMER Lander Station 58. released. A calm sunny day.
0853h IFREMER lander surfaced.
0915h IFREMER lander grappled.
0924h IFREMER lander all in board,

0945h Göteborg lander released Station 57.
1056h Göteborg lander surfaced
1122h Göteborg lander grappled
1128h Göteborg lander all in board with 4 perfect cores (Station 57)

The GEOMAR lander had been set up for a longer programme than the others. Whilst waiting for that to be completed *RRS Discovery* moved to the LAFF position to acoustically check the location and orientation of the package.

Ranges were measured from 4 positions:

1235h Position 1. 48°54.62'N 16°23.50'W
1306h Position 2. 48°56.17'N 16°25.49'W
1332h Position 3. 48°57.60'N 16°23.40'W
1401h Position 4. 48°54.62'N 16°23.50'W

It was also confirmed by telemetry from the MORS release that the package was sitting upright on the sea floor.

RRS Discovery then returned to the lander site to retrieve the GEOMAR lander.

1534h GEOMAR Lander released (Station 56)
1652h Surfaced.
1712h GEOMAR lander all inboard (Station 56).
This was an extraordinarily rapid recovery of the lander from surface to inboard within 20 minutes! The *RRS Discovery* then moved across the PAP area to the ATTIS array to recover the 4 vehicles placed there in the early part of the cruise. It was a nice calm sunny day ideal for lander work.

1905h ATTIS 3 (Station 33) Interrogation of the unit commenced.
1907h The ACU responded.
1927h It was confirmed acoustically that ATTIS 3 was ascending.

1957h During this time tension test on the LAFF mooring was carried out, The eye broke at a stress of 650kg whilst a bowline knot at the other end held.

2018h ATTIS 3 surfaced.
2034h grappled.
2042h ATTIS 3 all inboard. (Station 33)

2043h ATTIS 4 (Station 32) ACU activated whilst waiting at the ATTIS 3 position
2210h ATTIS 4 surfaced in darkness with a new half moon. The bridge search light was used to aid retrieval of the lander.
2222h ATTIS 4 grappled.
2233h ATTIS 4 all in board (Station 32)

2234h ATTIS 2 (Station 34) activated. The ACU gave all the correct acoustic responses to all the commands but the system failed to release. It was also impossible to communicate with the back up MORS release.

2348h Work on ATTIS 2 was temporarily suspended and release commands were sent to ATTIS 1 ACU.
2351h ATTIS 1 ascending released. (Station 35)

Wednesday 21 August.
0118h ATTIS 1 surfaced.
0131h ATTIS 1 grappled
0138h ATTIS 1 all in board (Station 35)

Around this time a flock of geese was heard and seen to fly overhead in formation in the moonlight. Work now turned to ATTIS 2 using the MORS dunking transducer over the ship's side contact was established with the backup release.

0151h ATTIS 2 released (Station 34)
0316h ATTIS 2 surfaced.
0327h ATTIS 2 grappled
0333h ATTIS 2 all in board. (Station 34)

After a long day's work clearing all the landers off the sea floor at PAP *RRS Discovery* set course eastwards to the OMEX area.

During the day, weather forecasts for the rest of the week were received indicating a deep depression developing west of the British Isles during Thursday, Friday and Saturday. The plan was to deploy the three respirometer landers at OMEX IV and recover them on Saturday morning before steaming to Southampton. This seemed too risky since it seemed likely that late on Friday or Saturday the conditions would be totally unsuitable for retrieving landers. It was therefore decided to turn back to PAP to deploy a modified AUDOS rig with a dead dolphin attached.

1300h 48°57.5'N 13°59.7'W *RRS Discovery* turned back westwards.

Special slings were made up to support the dolphin on a stretcher slung on a swivel beneath the AUDOS vehicle. The dolphin was removed from the freezer to thaw.

2200h *RRS Discovery* returned to PAP but the dolphin had not thawed out. It was therefore placed on deck in front of the warm engine room exhaust and work on SPI proceeded during the night.

2230h **Station 222/96/64 SPI 4835m 48°48.00'N 16°16.10'W**
SPI with a new battery pack and was lowered to the sea floor.

Thursday 22 August

0324h SPI retrieved I/B. Some good pictures were obtained so it was decided to proceed with a second set of drops this station which was near the position vacated by the respirometer landers..

0522h A second SPI deployment of the night

0902h SPI inboard
Work continued on preparation of the AUDOS/LAFF experiment.

1048h **Station 222/96/65 AUDOS/LAFF 4800m 48°47.01'N 16°19.96'W**
AUDOS/LAFF was deployed over the starboard side using the crane after the floats had been trailed over the transom. The wind was freshening to Force 4 but it was sunny.

1241h **Station 222/96/66 CTD 0_2 Probe Test 4798m 48°51.50'N 16°30.00'W**
The GEOMAR and Göteborg oxygen probes were placed onto the CTD to compare calibrations at a series of depths against Winkler samples taken from the Niskin bottles and the sensor on the CTD.

1600h 30 to 40 knot winds developed and it was decided to curtail the experiment and start hauling faster than planned owing to difficulties in holding the ship steady on station.

1805h CTD I/B Station 66 complete.

1900h. Hove to owing to inclement weather.

Friday 23 August

0800h Strong winds had continued throughout the night and the ship had drifted about 30 miles west of the PAP station. The forecast was for continuing gales for the next 24h, it was evident that little work would be possible over coming days so it was decided to bring forward the arrival in Southampton to 1600h BST Monday 26 August, 16 hours earlier than planned.

0912h *RRS Discovery* set course for the PAP site and the AUDOS/LAFF station.

1200h Hove to over the AUDOS/LAFF Station 65. The seas proved too rough and noisy for acoustic communication.
(A month later during *RRS Discovery* Cruise 222B it was the AUDOS/LAFF experiment could not be found. Retrospectively it might be concluded that the rig

had already broken free from the sea floor by 23 August and was floating somewhere in the rough seas).

RRS Discovery set course for the OMEX IV location.

2230h Arrived at OMEX IV, 49°00'N 13°44'W in strong westerly winds and seas, it was obvious no work would be possible so *RRS Discovery* continued eastwards overnight in the hope of improving conditions in the morning.

Saturday 24 August

0710h *RRS Discovery* hove to at the OMEX I site waiting for the SPI instrument to be prepared for deployment. The wind was continuing at 25-30knots, vindicating the decision earlier in the week not to deploy the three big respirometer landers.

1011h **Station 222/96/67 SPI 695m 49°25.40'N 13°33.20'W**
OMEX I site SPI deployed for a series in shallow water.

1203h SPI in board station completed.

1333h **Station 222/96/68 SPI 227m 49°28.60'N 11°12.40'W**
Final shallow water station suggested by Prof. O. Pfannkuche. Bright and sunny weather but wind gusting to 30 knots.

1439h SPI in board.

1454h All secure in board, End of scientific work and *RRS Discovery* set course for Southampton after a successful pair of final stations.

1700h PES in board, dolphins playing around the ship.

Saturday 25 August

RRS Discovery steaming towards Southampton, good weather in the Channel.

Sunday 26 August

1500h Arrived in Southampton. Specialist medical attention was summon for Jean-Pierre Brulport, who by now was reasonably mobile but unable to work.

This was the weekend of the English Bank Holiday Monday so there ws no hurry to unload the ship.

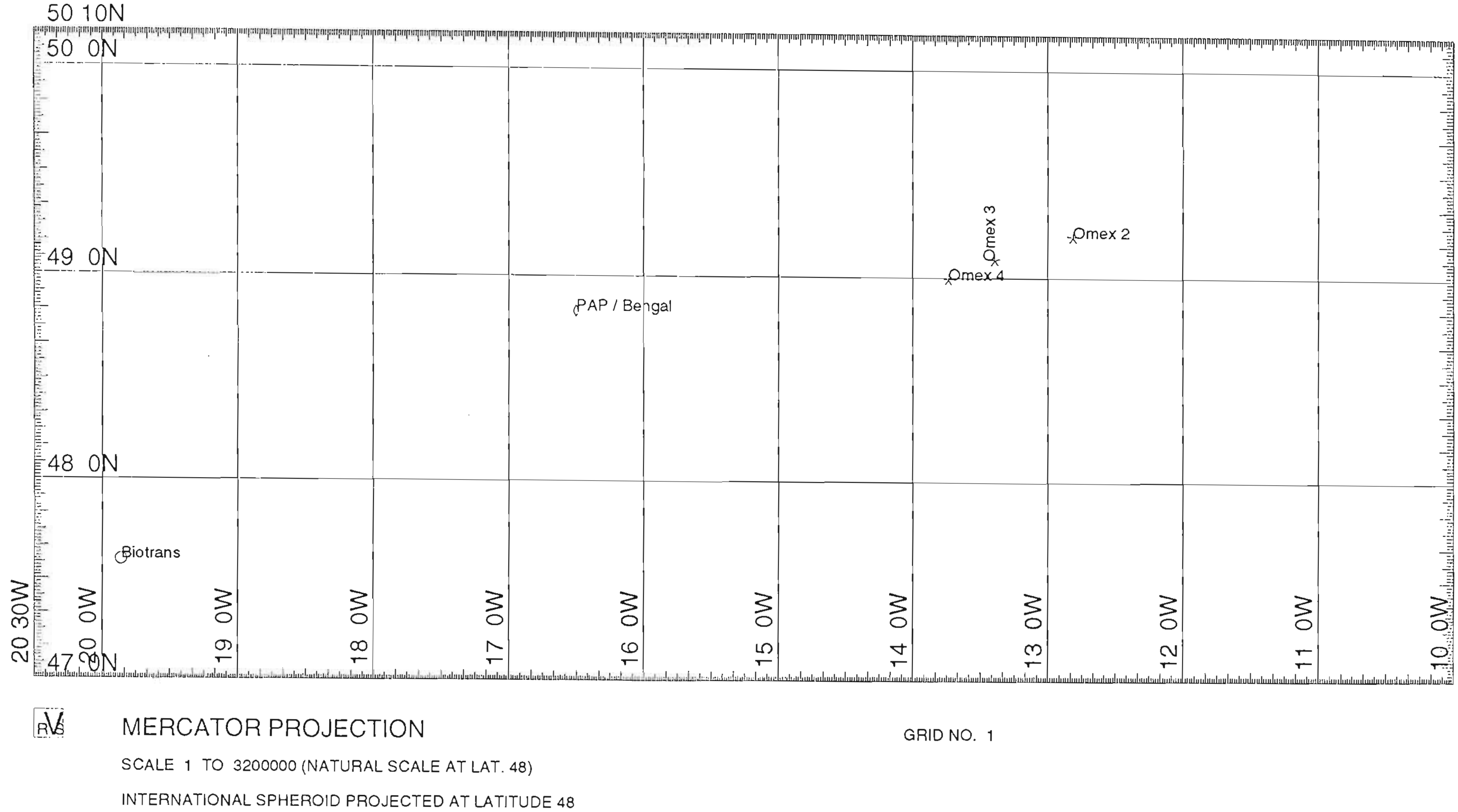

Figure 2 *RRS Discovery* Cruise 222 A (Alipor) Locations of the Main Stations

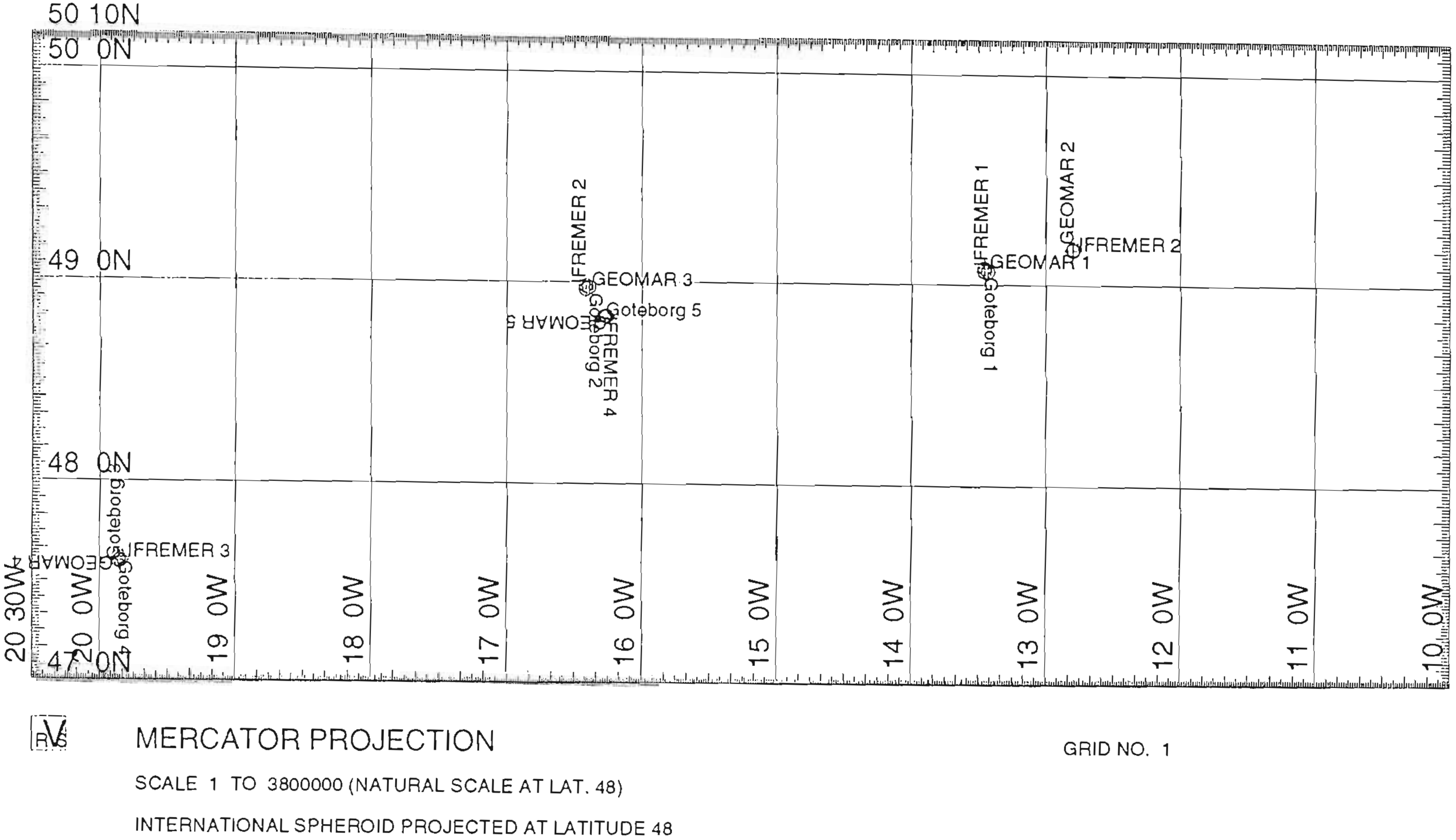

Figure 3 *RRS Discovery* Cruise 222 A (Alipor) Locations of the Chamber Lander deployments

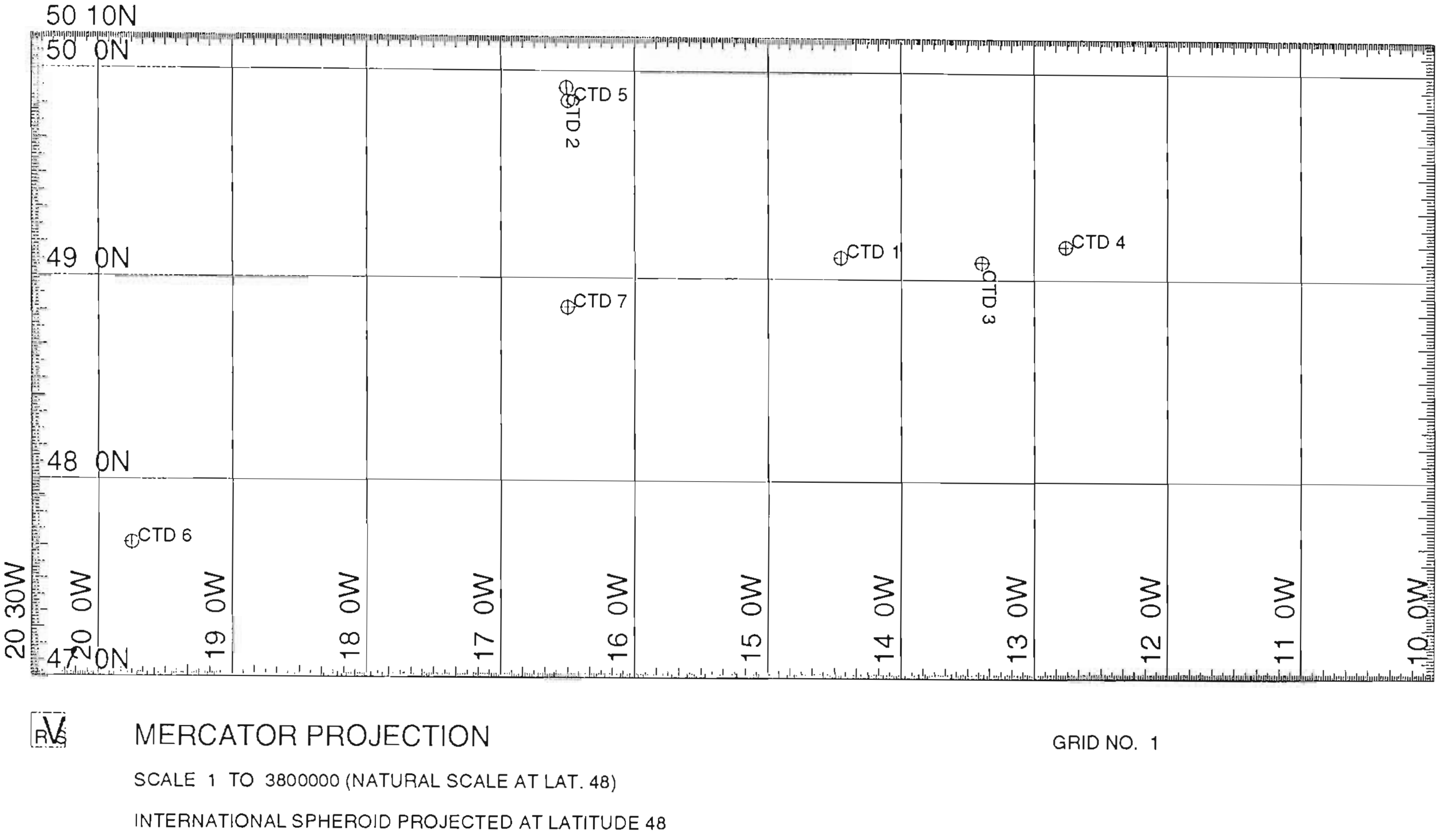

Figure 4. *RRS Discovery* Cruise 222 A (Alipor) Locations of CTD casts

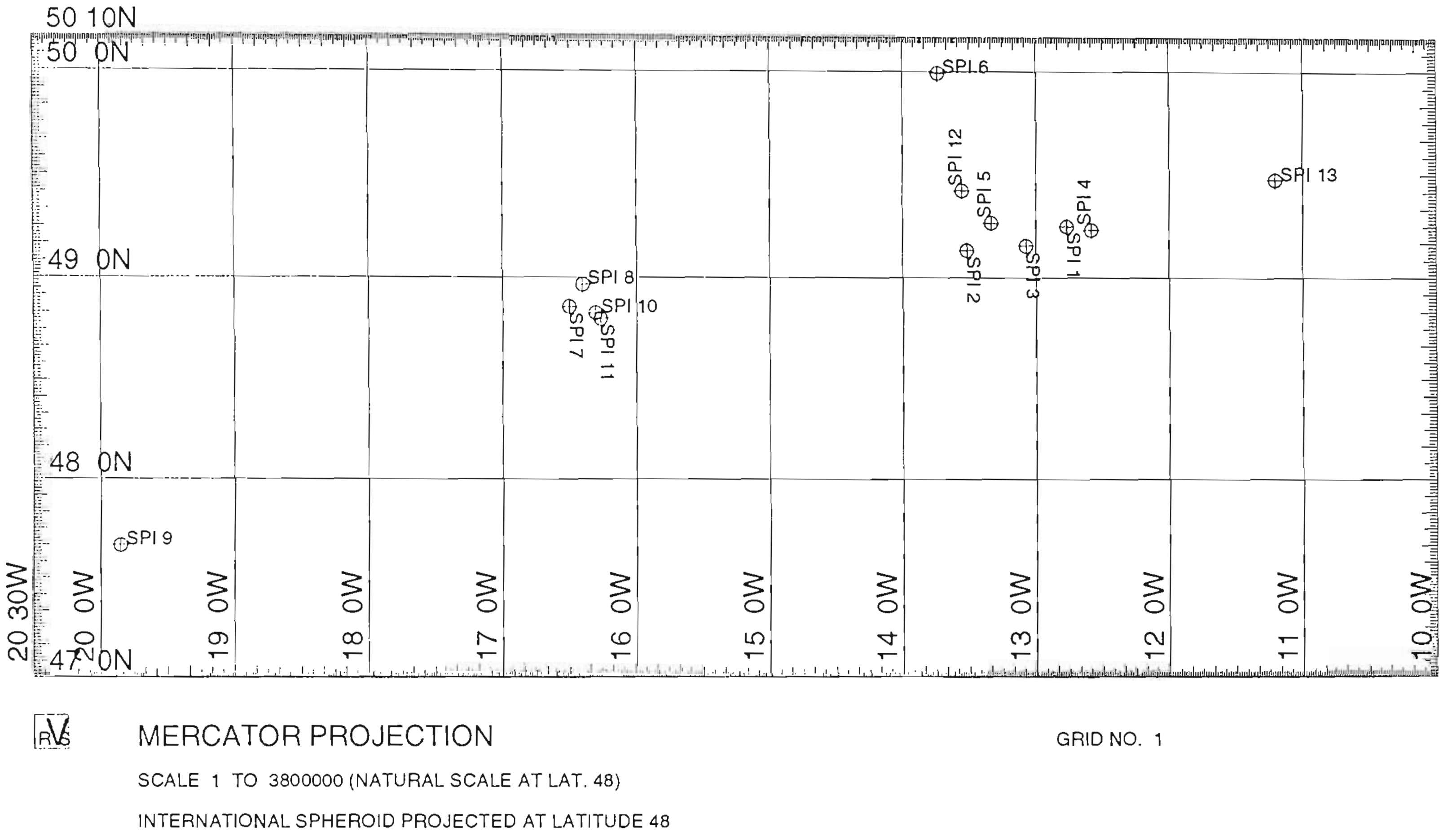

Figure 5. *RRS Discovery* Cruise 222 A (Alipor) Locations of SPI deployments

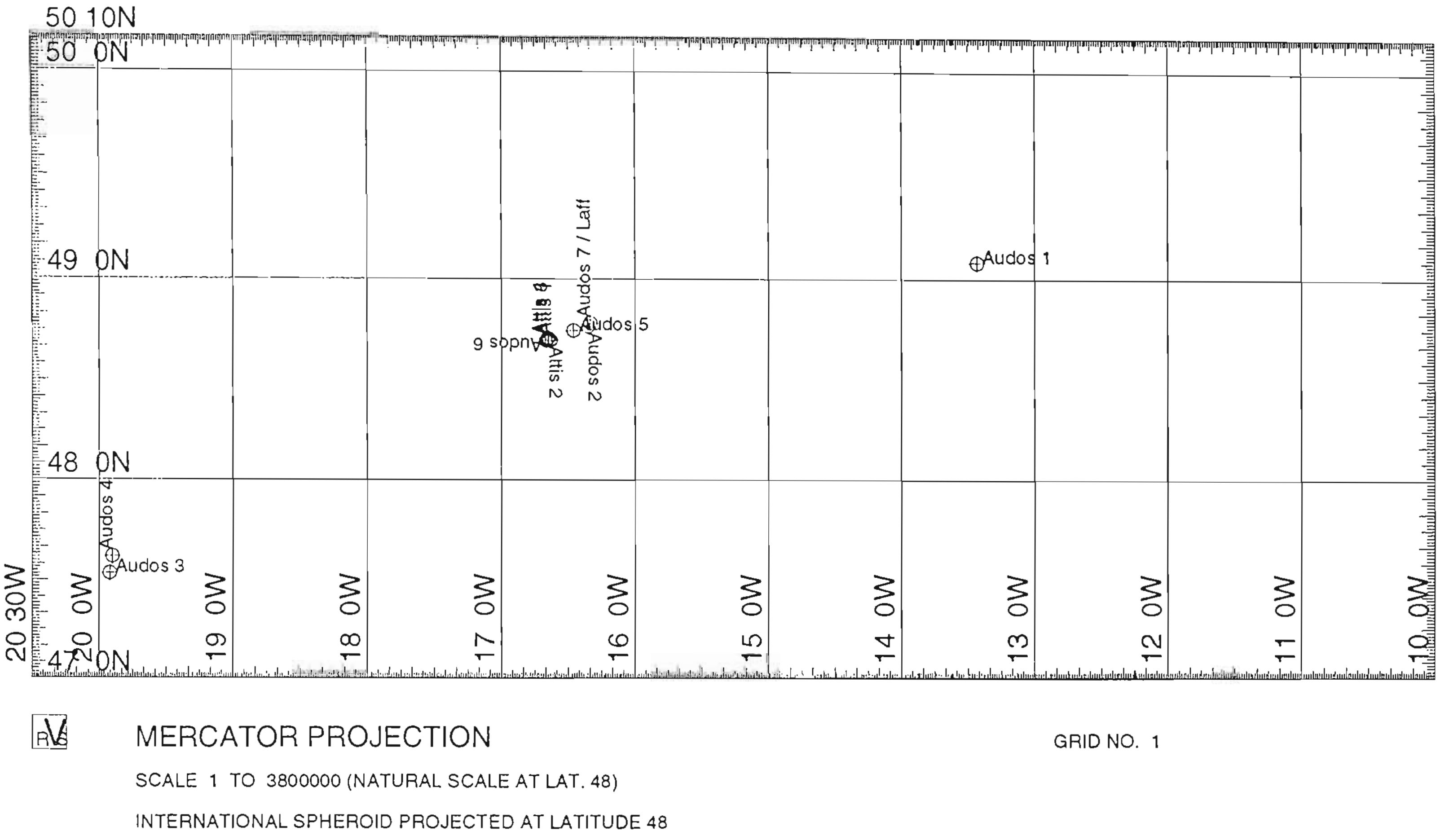

Figure 6. *RRS Discovery* Cruise 222 A (Alipor) Locations of AUDOS and ATTIS deployments.

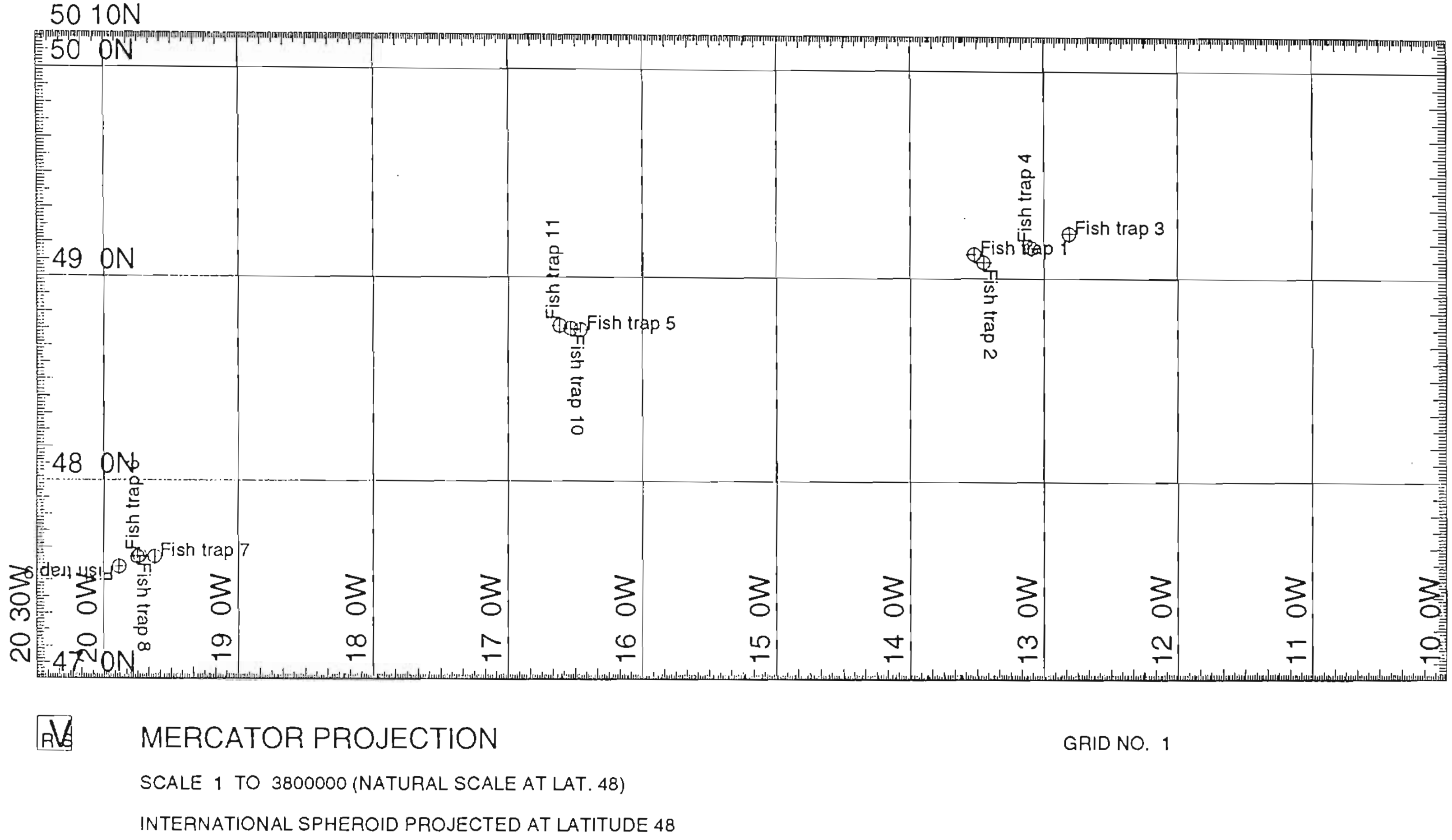

Figure 7. *RRS Discovery* Cruise 222 A (Alipor) Locations of Fish/Amphipod Trap Deployments.

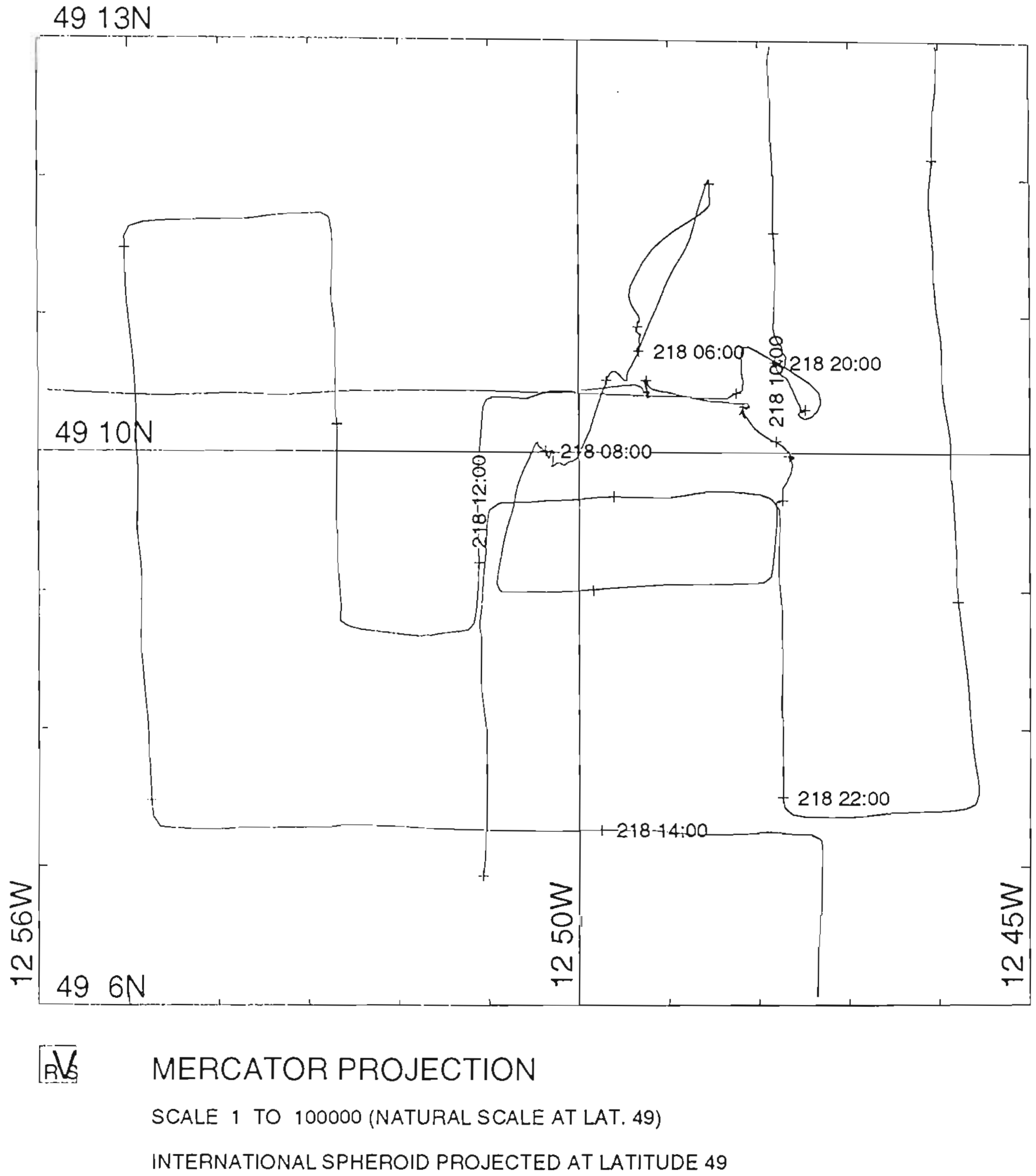

Figure 8. *RRS Discovery* Cruise 222 A (Alipor) Search Tracks for the OMEX II sediment trap mooring.

Scientific Reports

Geomar Free-Fall-Respirometer (FFR 3)

During Discovery 222 the Geomar Free-Fall-Respirometer (FFR 3) was deployed five times. The lander contains up to 4 chambers which close approx. 4 hours after settling of the gear on the deep-sea floor. Water samples are taken out of these chambers at distinct time intervals while sensors constantly measure temperature and oxygen levels inside and outside the chambers. At the end of the deployment the probed sediment and the overlying water is enclosed and brought up with the lander. On board the ship the sampled water is analysed for oxygen content and nutrients.

At each of the lander stations a Multicorer was used for separate sediment sampling. From the corer samples two sediment horizons (0-5 cm and 5-10 cm) were taken and deep-frozen to be analysed at the Institute's laboratory for phospholipids, DNA, proteins and C/N relations.

From the first FFR 3 deployment at OMEX III station no data were obtained from the respirometer because the chambers did not close due to hard sediment. Working time on sea floor had been 32 hours.

At the Omex II station the lander was programmed to work for 29 hours and did so without complications, which meant that sediment and water were sampled successfully and sensors worked during deployment. At PAP, the deepest site, with a deployment time of 77 hours, only some of the syringes failed to sample water. Results have yet to be analysed.

At the BIOTRANS site the lander was programmed for another 77 hours. At this station only one of the two respirometer chambers closed so parallel measurements could not be taken. The second deployment at PAP was set for 68 hours. Sediment and chamber water were sampled successfully. A last deployment at the OMEX IV station had to be cancelled due to bad weather.

Onboard the ship a study was made of the diffusion of oxygen through the syringes. The first series of experiments showed that painting the syringes had no effect on oxygen diffusion through the walls. Larger and therefore thicker syringes were found to be more reliable. The second series showed that the use of shrinking hose prevented oxygen diffusion only partially.

The CTD was deployed with its own oxygen sensor and those of the Göteborg and Geomar landers attached. Thus a comparison of the three different types of sensors could be made. Additionally water samples from different depths were taken and analysed onboard using the Winkler method. Again, results have yet to be analysed.

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MINERALIZATION OF BIOGENIC DEBRIS IN DEEP-SEA SEDIMENTS OF THE NE ATLANTIC OCEAN

ABSTRACT

By using a benthic chamber lander we were able to directly measure sediment-water exchange rates of oxygen, total carbonate (C_T or ΣCO_2), alkalinity (A_T), Σnitrate, ammonium, silicate, phosphate, calcium and dissolved organic carbon (DOC) *in-situ* at five stations along a transect between the Goban Spur (OMEX area) and the Porcupine Abyssal Plain (PAP) in the NE Atlantic Ocean (water depths 3 600 - 4 800 m). In addition, after terminating the sediment-water exchange measurements, pore water distributions were determined for the above solutes and sub-samples were taken for later analysis of organic C and N, ^{210}Pb, ^{14}C, $^{228}Th/^{228}Ra$ (or $^{228}Th/^{232}Th$ ratio) in the solid phase of the sediment. Preliminary data obtained suggest an overall low benthic activity in the area and that directions of nitrate fluxes to and from the sediment were influenced by the presence or absence of macrofauna.

INTRODUCTION

In order to obtain an improved understanding of the biogeochemical cycles of the world oceans it is important to attain further knowledge on the deposition, transformation, transfer and burial of biogenic debris at the sediment-water interface. Today, most marine scientists agree on that further advances in understanding these processes will come about through the use of autonomous data gathering platforms, deployed directly at the sea-floor since accurate data sets are difficult to obtain from sediment cores collected *in-situ* and brought to the surface. This is especially true for deep-sea sediments, mainly due to large pressure, light and sometimes also temperature differences between the bottom and the surface water.

Among the simplest autonomous vehicles for use in marine environments are the benthic chamber incubating "landers" (TENGBERG et al., 1995) which simply descend to the sea-floor by gravity and are ballasted to fall at a speed slow enough to minimise disturbance of the sediment during landing. A lander operates more or less independently once arrived at the sea-floor and when experiments are complete, a timer or acoustic command from the surface releases the ballast weights. The instrument rises to the surface by virtue of positive buoyancy and is retrieved by the ship whereafter collected data, together with sediment and water samples, can be processed. Landers have been developed to carry a suite of sensors and considerable electronic and computer power.

In this study of benthic biogeochemistry in the deep NE Atlantic Ocean, we used a chamber lander that encloses a known sediment area together with ambient, overlying bottom water in four chambers enabling us to measure solute fluxes (oxygen, alkalinity, total carbonate, calcium, nutrients and DOC) across the sediment-water interface directly *in-situ*. After terminating the benthic flux measurements the lander brings the sediment that was used during the incubation, together with the ambient water, up to the surface. This made it possible to determine species, density and distribution of macro- and meiofauna in the sediment, as well as perform chemical analyses of the pore water and sediment solid phase in the same cores as those where the benthic solute fluxes were measured. Since there were three similar types of landers deployed at the same locations (normally separated one mile apart), results from chamber landers used in three different European countries could be inter-calibrated (see PRIEDE et al., this volume).

MATERIALS AND METHODS

Five stations along a transect between the Goban Spur (OMEX area) and the Porcupine Abyssal Plain (PAP) in the deep Atlantic Ocean were studied during the cruise "BENGAL 1A" with the *RRS Discovery* (Table 1). The cruise took place from July 27 to August 27 1996.

The Göteborg lander

The lander used in this study was developed in co-operation with Laboratoire Arago (Banyuls-sur-Mer, France) in 1993-94. It is built as a modular system where one or several of the four experimental modules can be exchanged as desired. The device is capable to perform up to 60 different pre-programmed mechanical actions, as well as register signals from up to eight different sensors (e.g. oxygen, temperature, conductivity, depth). It also controls small DC motors used for stirring the overlying water inside the chambers. In its present version, the lander is equipped with four benthic chamber modules capable of closing off a known area of the sea floor and perform measurements with sensors and/or water sampling in this isolated environment. In each chamber, 8 water samples (+1 start value from the bottom water outside the chambers) are collected with syringes and used to calculate concentration changes with time (benthic fluxes). After terminating the benthic flux measurements the incubated chamber sediment is brought to the sea surface together with the ambient bottom water with virtually no disturbance (Multiple Corer Technique). This gives the possibility to determine the water volume incubated in each chamber (necessary for calculating the flux) as well as possibilities to continue the experiments on-board ship. To recover the instrument, ballast weights are dropped. Once at the surface, spotting is possible by a flash, flag, radar reflector, radio (VHF) and a satellite signal (ARGOS). The Göteborg lander has with success been used during cruises in the Skagerrak (HALL et al., 1996) and the western Mediterranean, but this cruise ALIPOR 1A was the first deep-sea expedition. To facilitate transport, service and storage between and during different expeditions, a specially designed container is used.

Other lander modules under development within the ALIPOR program are such capable of sampling solutes in the sediment at high vertical resolution by the gel peeper technique (DAVISON et al., 1991).

Sediment sampling and pore water extraction

Sediment for pore water studies of total carbonate (C_T or SCO_2), alkalinity (A_T), ammonium, Snitrate, phosphate, silicate, calcium and dissolved organic carbon (DOC), and for the distributions of carbon (organic and inorganic), nitrogen, ^{14}C, ^{210}Pb and $^{228}Th/^{228}Ra$ (or $^{228}Th/^{232}Th$) in the solid phase of the sediment was collected using the Göteborg lander (see above) according to the sampling schedule given in Table 1. One or two sediment cores from each station were collected for pore water studies. After core retrieval a Plexiglas subcore (diameter 10 cm) was manually inserted into one or two of the lander core tubes used for benthic flux measurements. The subcore was removed, the overlying water carefully siphoned off and the surface sediment down to approximately 15 cm sectioned into vertical segments at normally 1 cm resolution. Pore water was extracted from the sediment by centrifugation at 2 100 rpm for 30 minutes. The obtained pore water was subsequently filtered through disposable sterile cellulose acetate filters (0.45 mm) and stored refrigerated (A_T, C_T, DOC, SNO_3, PO_4, $Si(OH)_4$) in 20 ml polyethylene vials until analysis on-board. The vials were thoroughly soaked in acid and rinsed with MQ-water prior to use. Samples for NH_4 and Ca were immediately frozen at -50° C and stored frozen until later analysis in Göteborg and Gif-sur-Yvette (France). At all stations investigated, a complete profile of A_T, C_T, DOC, SNO_3, PO_4, $Si(OH)_4$ and Ca from the sea-surface to the bottom was obtained by taking water from a Rosette-sampler.

Chemical analyses

Concentrations of alkalinity and total carbonate were determined on-board the ship according to HARALDSSON et al. (1996) and JOHNSON et al. (1987), respectively. The precision of the alkalinity titration was better than 0.2 % RSD (n=30) using a sample volume of 1 ml, and the precision of the colourimetric determination of total carbonate was also 0.2 % RSD (n=10), using a sample loop of 4 ml. Phosphate, silicate and Snitrate were determined with a CHEMLAB auto-analyzer on-board ship using standard colourimetric methods. The precision of the determinations were 2.9 % for phosphate, 2.5 % for silicate and 1.7 % for Snitrate (within the concentration interval studied). DOC was measured on-board by high temperature catalytic oxidation (HTCO) using a SHIMADZU TOC-5000 total C analyser after acid treatment to remove dissolved inorganic carbon.

RESULTS AND DISCUSSION

Technical functioning of the lander

The Autonomous lander was deployed at six occasions at five different stations. The technical functioning of the lander at each deployment is given below:

Station 8 (OMEX 3; 3650 m): 35 out of 36 armed syringes worked. Sediment was taken in two (out of 4) of the chambers. Two chambers failed in recovering the sediment due to that one was set wrongly and the other had an defective lid-sealing. The oxygen electrodes registered values but because of bad communication between the electrode microprocessor and the PC, no data from the oxygen electrodes could be obtained. In spite of several attempts to solve the problem, it persisted throughout the cruise. However, there is a chance of retrieving the data once back in Sweden, with the assistance of the manufacturer.

Station 19 (OMEX 2; 1370 m): Two attempts were made to launch the lander at this station but both failed. The lander immediately dropped its ballast weights and resurfaced once at the sediment. Sea water had been leaking into 90 % of the connectors used on the lander (guarantied to 6000 m !!), resulting in either bad/no contact or leak-currents activating different functions (like the weight back-up release) at random occasions. After

80 hours reconstructing work, the connectors for two chambers were made operational for the PAP station.

Station 31 (PAP I; 4800 m): Due to connector problems (see above) sole two chambers operated at this station. 17 out of 18 armed syringes worked. Sediment was taken in two of the chambers with undisturbed overlying water.

Station 45 (BIOTRANS I; 4530 m): Due to connector problems (see above) only two chambers worked. When retrieving the lander it was discovered that the two extra floats used to facilitate the recovery were stuck under the lander, probably preventing the chambers to penetrate into the sediment. The extra floats were most likely caught under the inner tray already when launching the instrument. Out of 22 mechanical functions 20 worked.

Station 49 (BIOTRANS I; 4530 m): Due to connector problems (see above) sole two chambers operated. All 18 armed syringes worked. The activation for taking sediment failed in one of the chambers due to a bad connector. In the other chamber a stone blocked the scoops and only a part of the sediment was retrieved. Not perfectly retrieved sediment made it difficult to have an accurate measure of the overlying water height. Lacking better means to measure the overlying water volume it was estimated by the help of simple mechanical rulers, mounted as a back-up beside the chambers.

Station 59 (PAP II; 4800 m): In an attempt to avoid further entrance of water, the malfunctioning connectors were all provisionally repaired and filled with silicon oil. Out of 36 armed syringes 35 worked. Sediment was taken in all four of the chambers, with clear overlying water.

The average lander descent and ascent speeds were 35 m/min and 70 m/min, respectively, at all stations. Throughout the cruise all surface spotting systems worked without any difficulties. The VHF-radio gave the exact moment of surfacing and a possibility to do short range spotting whereas the ARGOS positioning system gave longer range spotting with about 1 hour time intervals. The acoustic release replied badly but always released when triggered.

Technical Improvements

All faulty and malfunctioning connectors will be exchanged with another type. Most probably a solution similar to the one used on the GEOMAR lander will be adapted, giving the necessity to use only one standard (completely interchangeable) type of connectors and cables. All cables will be placed inside the frame tubing to protect them from physical damage. Most of the syringes will be activated by stepper motors of a similar construction as that of the GEOMAR lander, in order to speed up the arming procedure of the syringes. Funding will be applied for in order to have two acoustic releases, like most of the other landers participating in the cruise and to use syntactic foam instead of glass spheres as the IFREMER lander does. Furthermore, the Göteborg lander will be equipped with a video camera system making it possible to perform overall views of the lander functioning and observe the degree of sediment disturbance during landing.

Benthic fluxes and pore water distributions

Measured concentration changes in the overlying water were, after correction for the input of bottom water replacing the volume removed during sampling, constant with incubation time. Examples of the evolution of solutes during the incubation are shown in Fig. 9. Overall, preliminary data revealed that benthic activity in the investigated area, as governed by benthic flux rates of oxygen (KHRIPOUNOFF et al., this volume), total carbonate, alkalinity, Snitrate, phosphate and silicate, is quite low. Total carbonate, phosphate and silicate were always released from the sediment to the overlying water while alkalinity and Snitrate were sometimes taken up by the sediment, indicating benthic nitrification and denitrification. In most sedimentary deposits underlying oxygenated bottom waters, the activities of benthic animals have significant effects on organic matter degradation, sediment-water exchange and composition of the organic material undergoing burial. It is also quite well known from field, laboratory and theoretical studies that mobile and stationary infauna can have dominant controls on average and local solute distribution patterns in sediment pore water by e.g. sediment mixing, pore water irrigation, particle ingestion and gut transformations which may well vary with time and space. Transport of solutes across the sediment-water interface is thus often heavily influenced by these faunal activities, especially processes that involve oxidation and reduction (e.g. nitrification and denitrification) (ALLER 1980; 1982). The number and size of irrigated burrow structures can determine the magnitude and direction of net fluxes of e.g. SNO_3^-, as well as the relative rates of nitrification and denitrification. Burrow walls are known to have a high potential for nitrification due to the simultaneous presence of oxygen, ammonium and nitrate. In addition, the presence of bioturbation and burrows is generally thought to stimulate denitrification, especially in the presence of high nitrate concentrations in the overlying water, by creating anoxic/suboxic microzones. At station 31 there was an efflux of nitrate in one of the chambers (replicate B1) while nitrate was taken up by the sediment in the other chamber (replicate B2; Fig. 10). In chamber B2, where the nitrate flux was directed towards the sediment, there was a *polychaete* within a tube of approximately 20 cm, while no sign of benthic macrofauna was found in chamber B1. The presence of the *polychaete* in B2 probably stimulated denitrification and made the nitrate flux to be directed into the sediment. However, in general, replicate sediment cores agreed well.

A low benthic activity in the investigated area was in general validated also by the pore water distributions of total carbonate, Snitrate, phosphate and silicate. Examples of the pore water distributions of nitrate and total carbonate are shown for station 31 in core B1 (Fig. 11). The nitrate distribution with depth in core B1 confirmed a transport of nitrate from the sediment to the overlying water as was measured by the benthic lander. In this core, the gradient between the overlying water and the top sediment section indicated nitrification in the uppermost 2-3 cm and denitrification below the nitrate maximum at 3.5 cm. By extrapolating the nitrate pore water profile, nitrate was estimated to penetrate approximately 15-20 cm into this sediment. The pore water distribution of total carbonate reflected a mobilization of C_T to the pore water due to degradation of organic matter in the top 5 cm, while C_T was more or less constant below this depth. A small flux of C_T out of the sediment was confirmed by the benthic flux measurements.

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A. Tengberg, S. Hulth, H. Ståhl and J.Valderrama

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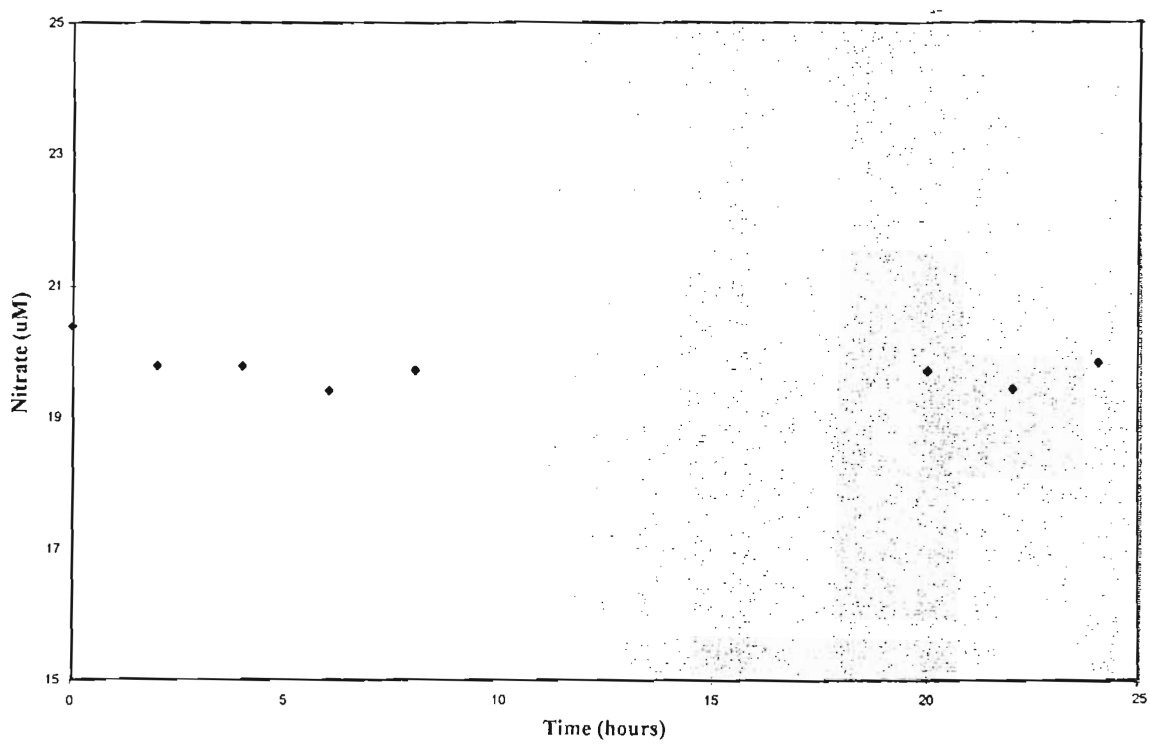
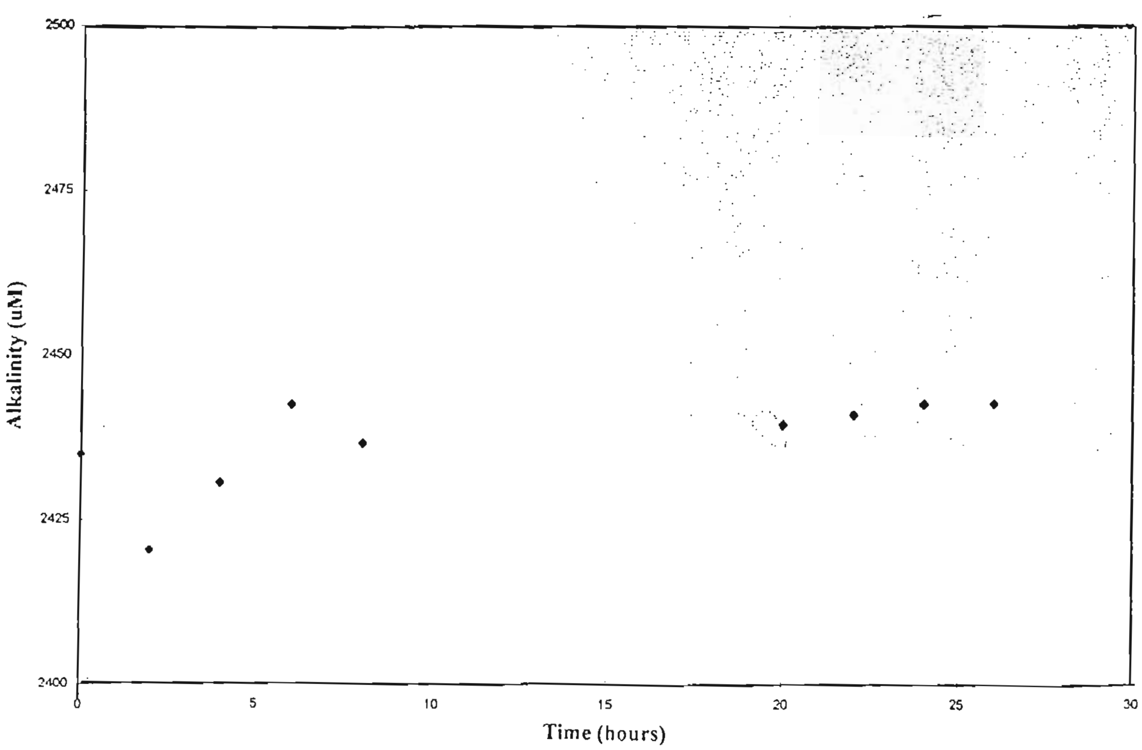
Table 1: Sampling date, station number, station acronym, station position, water depth, sampling gear, bottom water temperature, obtained scientific data and chamber incubation time at the sea floor during the DISCOVERY cruise 222a (July-August 1996).

	Station n:o	Acronym	Position	Water depth (m)	Sampling gear	Bottom wate temperature (°C)	Obtained scientific data from the station	Bottom incubation time (h)
31/07/96	# 8	OMEX 3	49.03´96´´N; 13.27´31´´W	3650	lander		4 chamber flux incubations* with 9 syringes in each; 1 sediment pore-water profile** (2,5 mm resoution)	40
31/07/96	# 10	OMEX 3	49.5´12´´N; 13.23´35´´W	3652	CTD, with Niskin bottles	2.718	CTD profile***	
04/08/96	# 21	OMEX 2	49.09´75´´N; 12.45´76´´W	1368	CTD, with Niskin bottles	6.044	CTD profile***	
04/08/96	#	OMEX 2	49.09´80´´N; 12.45´80´´W	1368	lander		none	0
06/08/96	# 29	PAP	48.51´40´´N; 16.29´77´´W	4801	CTD, with Niskin bottles	2.821	CTD profile***	
07/08/96	# 31	PAP I	48.58´05´´N; 16.23´70´´W	4800	lander		2 chamber flux incubations* with 8 syringes in one and 9 in the other; 2 sediment pore-water profiles** (10 mm resoution); 6 meiofauna profiles; macrofauna	67
12/08/96	# 42	BIOTRANS	47.41´00´´N; 19.49´06´´W	4530	CTD, with Niskin bottles	3.355	CTD profile***	
13/08/96	# 45	BIOTRANS I	47.36´14´´N; 19.50´74´´W	4527	lander		2 chamber flux incubations* with 9 syringes in each?? (the data are uncertain since it is not clear weather the chambers penetrated the sediment)	25
15/08/96	# 49	BIOTRANS I	47.36´07´´N; 19.51´53´´W	4529	lander		2 chamber flux incubations* with 8 syringes in each; macrofauna	39
17/08/96	# 59	PAP II	48.50´05´´N; 16.16´19´´W	4802	lander		4 chamber flux incubations* with 8 syringes in two and 9 in two; 2 sediment pore-water profiles** (10 mm resoution); 12 meiofauna profiles; macrofauna	56

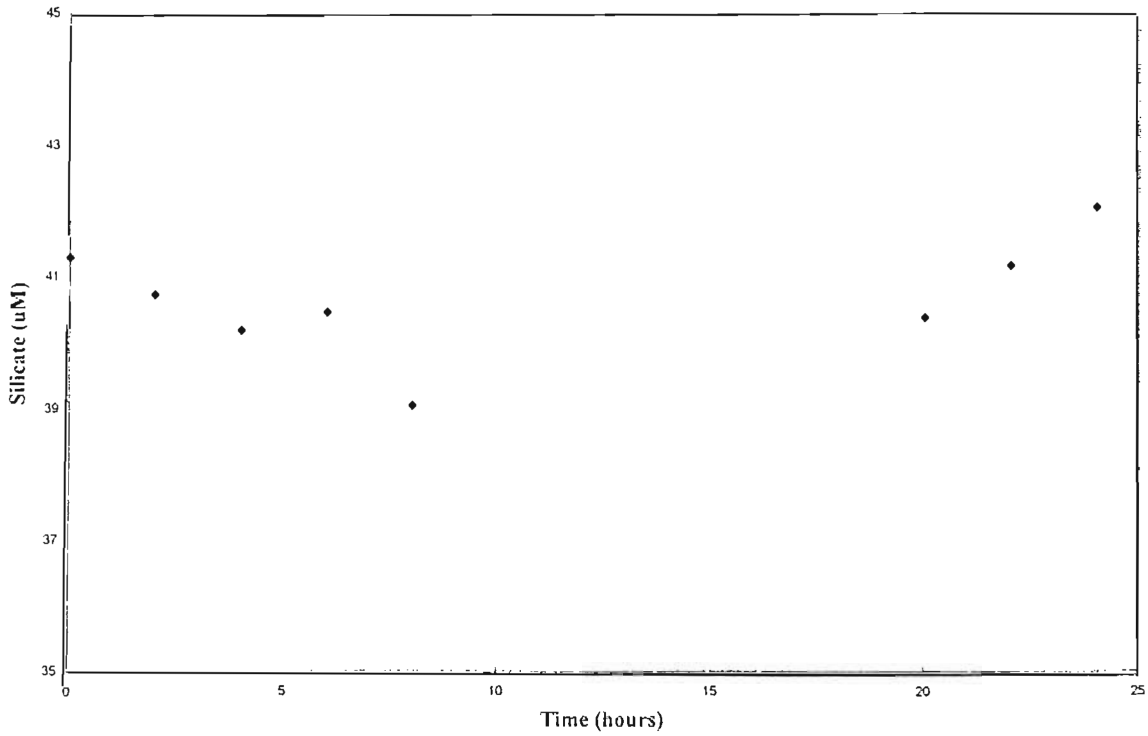
* Benthic fluxes of the following parameters were determined: total carbonate, alkalinity, nitrate, ammonium, silicate, phosphate, calcium, dissolved organic carbon and pH.
** Pore water distributions were made for all the above given parameters (see benthic fluxes) except for calcium.
Furthermore the solid phase of the sediment was collected for later analysis of org. C and N and various radionuclides to obtain sediment accumulation rates.
*** CTD profiles from the bottom to the sea-surface were made for all the above given parameters (see benthic fluxes) and for oxygen, temperature, salinity, fluorescence and transmittance.



25
23
21
19
17
15
Nitrate (uM)
0
5
10
15
20
25
Time (hours)



2500
2475
2450
2425
2400
Alkalinity (uM)
0
5
10
15
20
25
30
Time (hours)



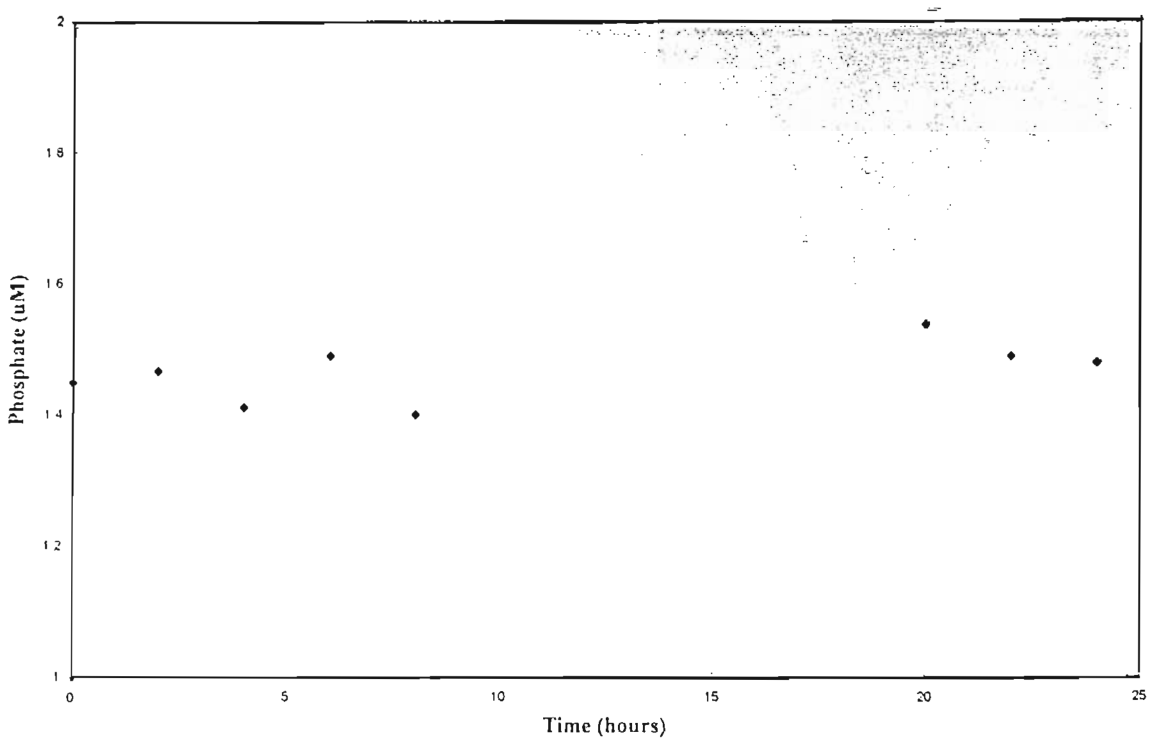


Figure 9. Concentrations of nitrate (A), alkalinity (B), silicate (C) and phosphate (D) in the overlying water during *in-situ* sediment-water incubations at Biotrans station 49 (replicate B2). Corrections have been made for the incoming bottom water replacing the volume removed during sampling.

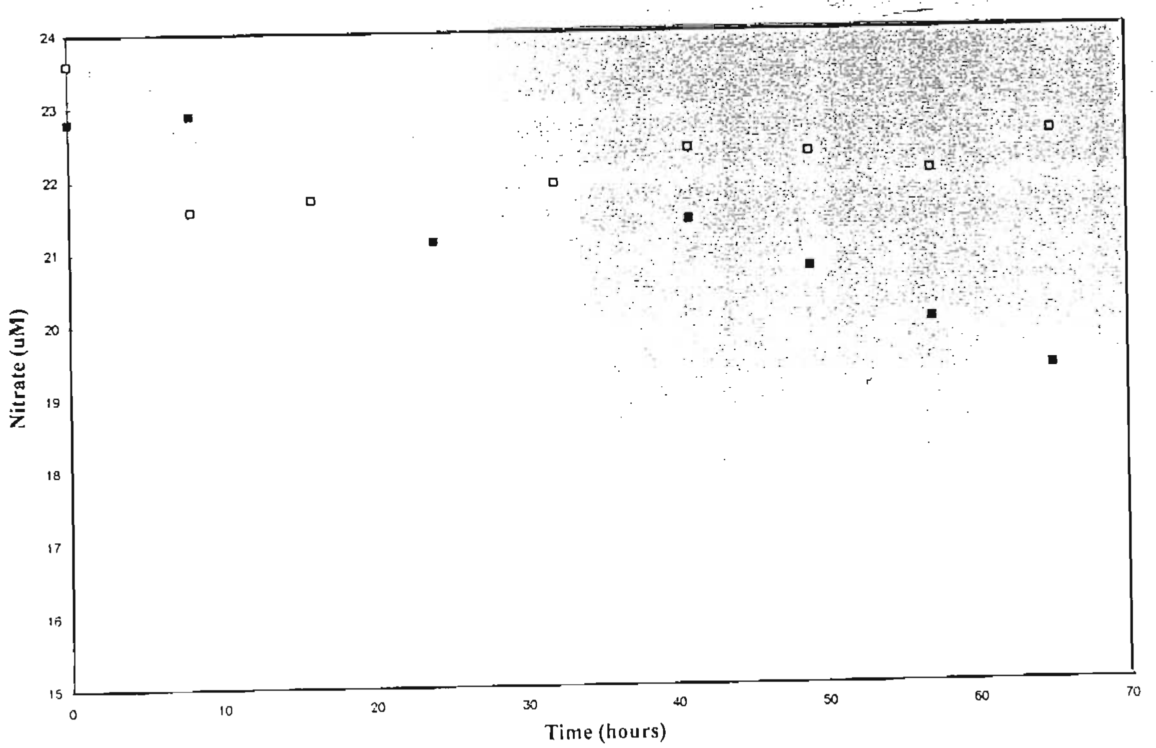
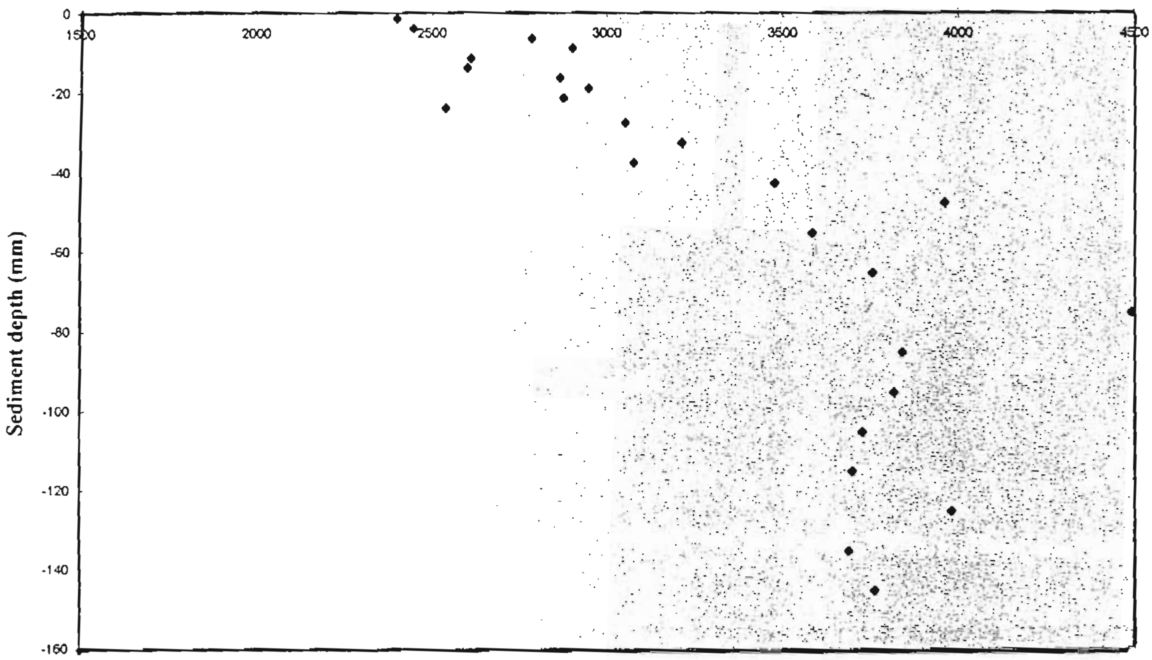
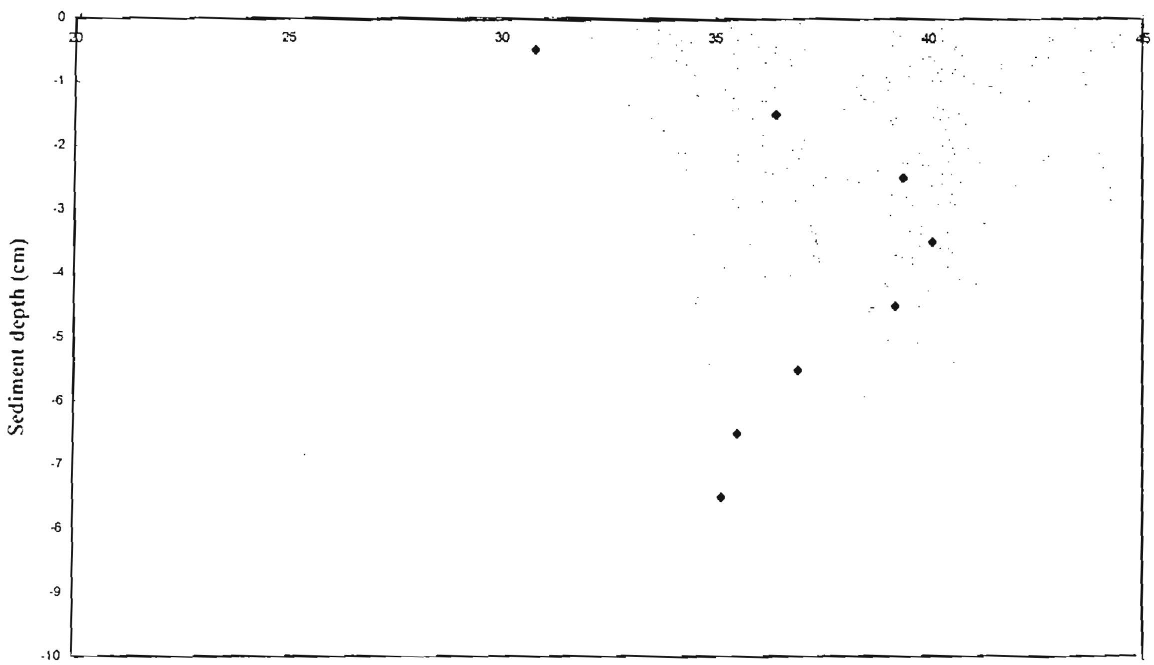


Figure 10. Nitrate in the overlying water during benthic flux measurements *in-situ* at PAP station 31, indicating the influence of macrofauna on benthic fluxes of nitrate. In replicate B2 (filled squares) there was a tube burrowing worm (*polychaete*) probably preferentially stimulating denitrification (decrease of nitrate with time in the overlying water), while in replicate B1 (open squares) no macrofauna was found.

Total carbonate (uM)



Nitrate (uM)



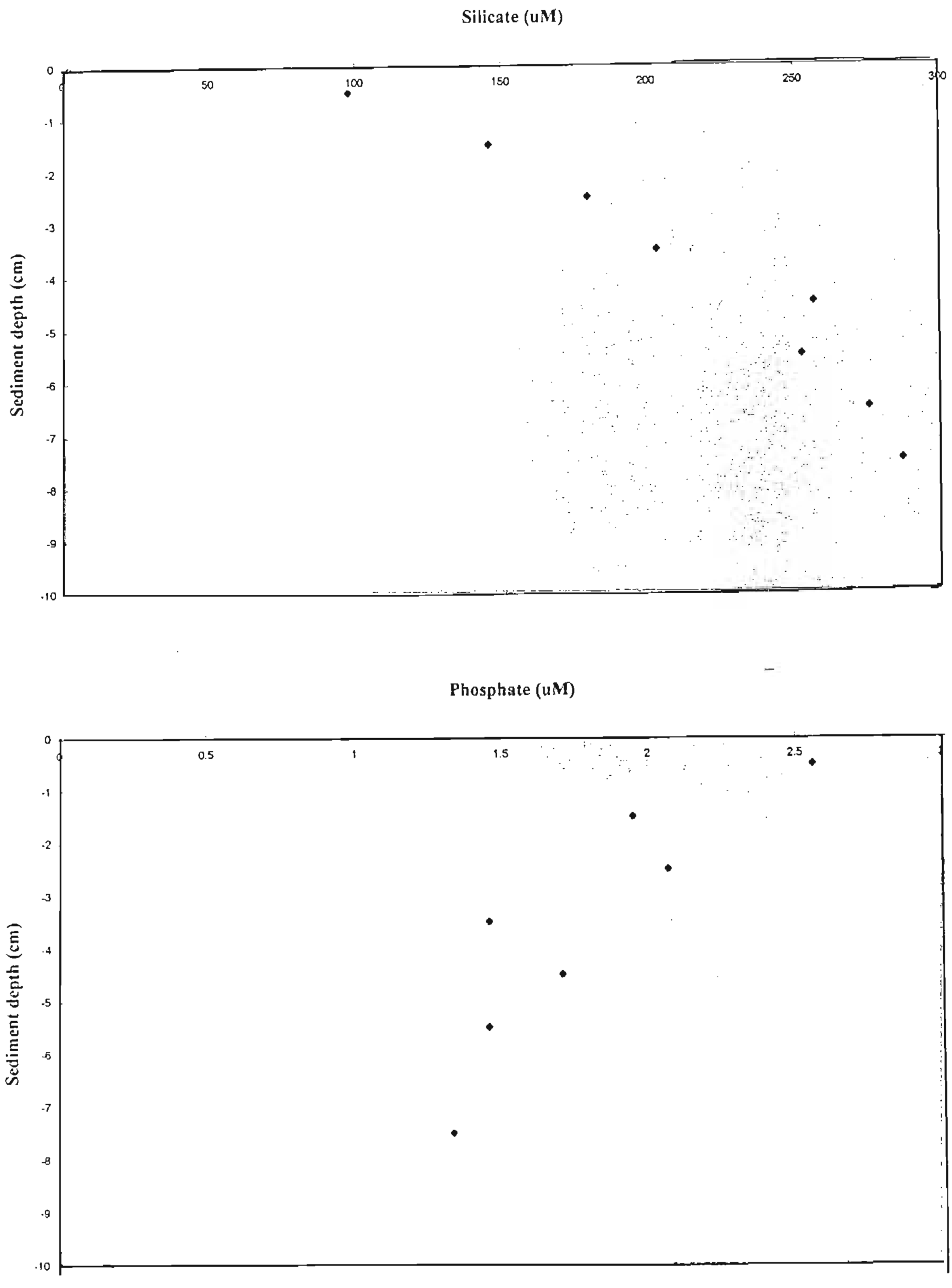


Figure 11. Pore water distributions of total carbonate (C_T or SCO_2) (A), nitrate (B), silicate (C) and phosphate (D) at PAP station 31 (replicate B1). Nitrate was estimated (from the pore water profile) to penetrate approximately 15 cm into the sediment.

Report on the IFREMER experiments

The aim of this cruise for the IFREMER participants was :

(a) To deploy the "Module Autonome Pluridisciplinaire" on the PAP station (4800m depth). This vehicle (MAP) is a deep sea bottom lander basically equipped with a currentmeter, a nephelometer, and camera-flash system. For this experiment, a sediment trap has been integrated to the module. Above it, along the mooring line, are 2 currentmeters at 140 m a.b. and 15 m a.b.. A 10 thermistor chain is installed between 30 and 130 m a.b.. The MAP will stay on the bottom for one year.

(b) To compare results obtained by the new IFREMER respirometer (RAP2) with three other equivalent instruments from GEOMAR (Germany), University of Göteborg (Sweden) and NIOZ (Holland). After various tests in the laboratory and during short cruises in Mediterranean Sea in 1994 and 1995, the Discovery cruise 222 was the first opportunity to observe the RAP2 respirometer during an oceanographic cruise at full ocean depth.

Results

1- The MAP was successfully moored on 30 July 1996 at 4800m depth (Station 222/96/04, *12913#2*, 48°46.06'N and 16°31.93'W).

2- Five deployments of the RAP 2 respirometer were made successfully (table 1).
Technical remarks :

The RAP II did not cause any major problem during the cruise. The only failure was the video camera which ceased functioning during the first deployment.

Because we use a parachute to decrease the speed of the lander during the fall (Fig. 12), we had a discussion about recovering the lander with this open parachute at the sea surface. The technique used by the crew to quickly pull up the parachute before recovering the lander seemed the best solution if the weather is bad. The Argos beacon was used to discover the position of the respirometer by satellite observation. The Argos company gave us a position by fax approximately hourly when the lander was at the sea surface.

Chemical analysis :

The RAP II measures the chemical exchanges between the sediment and the water. 12 water samples are obtained after each deployment : 3 from the surrounding water (t=0) and nine from small bottles inside three chambers.

Oxygen is measured by a Winkler method associated with potential redox probe.

Alkalinity and $\sum CO2$ are determined with potentiometric titration and calculated using the Gran function.

pH is measured by pH meter with a glass probe Orion with an accuracy of 0.004 pH unity. The exact buffer calibration will be made later in the laboratory by colorimetric method.

Calcium is determinated with a EDTA complex and a specific Calcium probe. Unfortunately, the precision of this analytical technique (≈ 0.1mmole/l) is not sufficient to observe any calcium variation in our case.

The Fluoride analysis was made by a specific probe. But this probe failed and this analysis will be repeated in the laboratory.

Nutrients (Nitrate, Nitrite, phosphate and silicate) were analysed with an autoanalyser on board by J. Valderrrama (Sweden); also some determination of $\sum$ CO2 by colorimetric method.

Preliminary scientific results :

At all 5 stations, we observe a decrease of the oxygen concentration under the RAP II chambers (fig. 13). The oxygen consumption by the biological metabolism is maximum at the shallow station OMEX 2, (1400m depth), and minimum at the farthest station from the continent (BIOTRANS station, 4500m depth). The consequence of this O_2 consumption is a production of CO_2 which increases in all our experiments. The second observation is the increase of the pH and the alkalinity. This increase can be explain only by a dissolution of $CaCO_3$. The total CO_2 production is the sum of dissolution of carbonate and respiration production in a ratio of about 1:1.

In conclusion, the cruise 222 was an excellent cruise to demonstrate the reliability of the RAP II lander. The results obtained at the 5 deep stations seem to be of high quality and very regarding the CO_2 flux at the water-sediment interface on the deep sea.

A. Khripounoff

Number	Station	Location	Depth	Time on the bottom (h)	Incubation (h)
RESP1	OMEX 3	49°03.98 N 13°25.76 W	3650	51	48
RESP2	OMEX 2	49°10.08 N 12°48.02 W	1450	38	36
RESP3	PAP 1	48°57.98 N 16°24.96 W	4805	96	75
RESP4	BIOTRANS	47°43.254 N 19°55.106 W	4529	78	75
RESP5	PAP 2	47°50.00 N 16°15.24 W	4801	57	54

Description of the RAP2 Respirometer deployments. All these moorings were a success. The delay between the arrival on the sediment and the beginning of the incubation is necessary to stabilise the respirometer environment.

Table 2. Summary of the IFREMER RAP2 deployments at Stations 7,17, 27, 43 & 58.

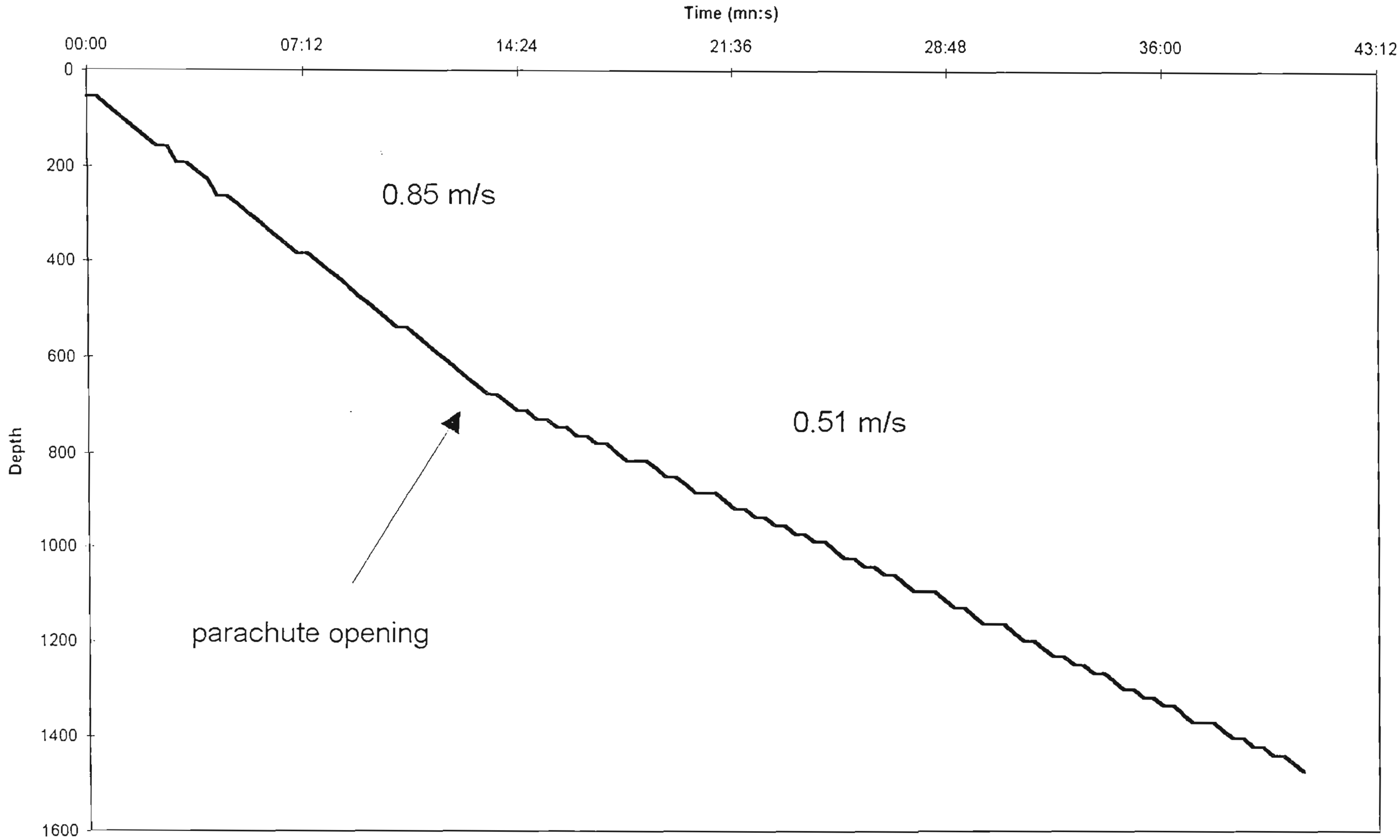


Figure 12. The descent of the IFREMER RAP 2. The vehicle was tracked by monitoring the acoustic pinger on the lander using the "Waterfall" acoustics display system installed on the *RRS Discovery* during this cruise. Note the decrease in descent rate when the parachute opened at 700m depth.

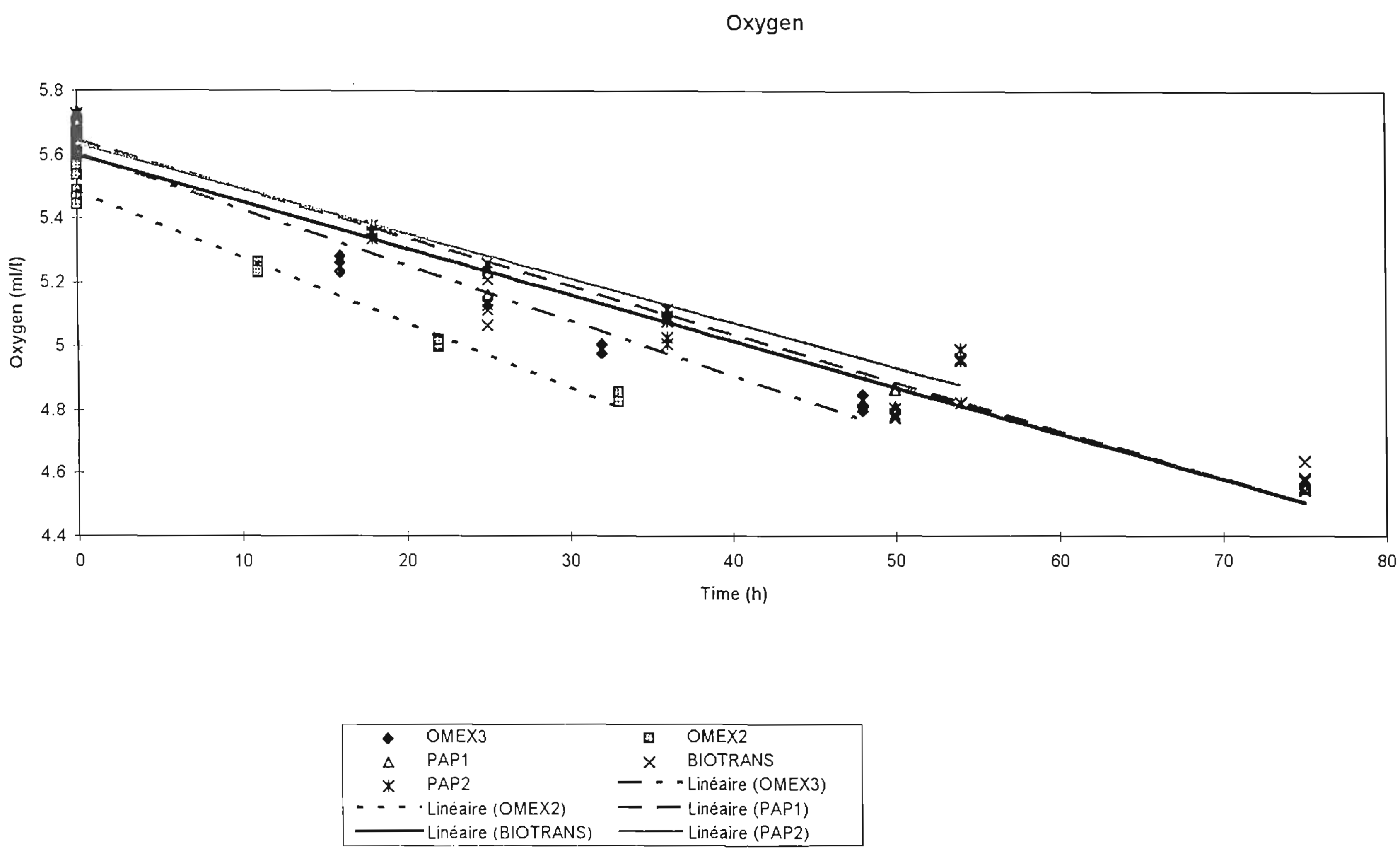


Figure 13. Decrease of oxygen concentration $ml.l^{-1}$ over time within benthic chambers during the five deployments of the IFREMER RAP2

SEDIMENT PROFILE IMAGERY

AIMS:

To test the new SPI II and carry out a transectal study from the shelf to the abyssal plain.

EQUIPMENT: SEDIMENT PROFILE IMAGERY CAMERA -SPI II

The SPI machine functions like an inverted periscope consisting of a wedge-shaped prism with a front face-plate and a back-mirror mounted at a 45° angle to deflect the profile of the sediment water interface up to the camera which is mounted horizontally on top of the prism. Once the machine is in place on the bottom, the inner frame containing the prism is slowly lowered to the seafloor through the action of a passive hydraulic piston - this gentle penetration minimises disturbance.

SAMPLING STATIONS

A total of 9 stations with depths ranging from 220m to 4800m along a transect from the shelf to the abyssal plain were sampled during 16 deployments. Stations were chosen to correspond to sites used by OMEX, BENGAL and BIOTRANS (See Table). Three additional sites were examined, i.e. to the east and north of OMEX II and intermediate between OMEX II and III - ALIPOR G5.

SHIP OPERATION:

The SPI was deployed from midships using trawl wire with a maximum safe operation tension of 5.2 ton. Bottom attainment was ascertained using a tensionmeter and machine mounted pinger (supplied by Greg Phillips). Maximum tensions were experienced at the deep sites. Heavy cross swells on one night caused elevated cable tensions with spikes in the region of 4.5 to 5 ton due to wave surge. Typical deployment time for 25 images (100 minutes bottom time) was in the region of 4 to 4.5 hours at depths > 4500m .

RESULTS

A total of 101 images were taken during the course of the study. The SPI system was successfully deployed to depths greater than 4000 m for the first time. Cursory examination of images suggests there is an along slope gradient in terms of the depth of the faunal reworking zone which reaches a maximum at the PAP site. The latter site also gave the deepest penetration and showed evidence of deep bioturbation (Fig. 1). Inter-site differences are apparent both in microtopography and in the depth of the faunal reworked zone which may have implications for profile chemistry.

SYSTEM APPRAISAL

Mechanical:

Mechanical operation of the machine based on the proven capabilities of the original SPI where shown to be very reliable and capable of successful function in the deep sea with excellent prism penetration accorded at all sites.

Electrical
Problems appeared during the course of the cruise which were caused by electrical faults and poor battery performance.

i) multiple images taken per trigger - this intermittent problem resulted from a high current spike present during flash discharge which had the effect of overriding the principal reset chip on the timer board. This was corrected by adding a capacitor to dampen this return voltage spike.

ii) failed external magnetic trigger - the magnetic switch moulding took water and was replaced by a cable made on board.

iii) declining rechargeable nickel-cadmium battery performance during the cruise. The exact reason for this decline was not pinpointed but could be attributed to one or all of the following:

a) under-conditioning of batteries due to inappropriate exercising by intelligent battery charger;

b) damaged individual cells in battery packs;

c) intermittent shorting placing an abnormal current demand on packs due to faulty connectors.

d) effects of cold, i.e. bottom temperatures below 3 °C resulting in reduced battery capacity by as much as 40 to 50%.

Battery problems were overcome by replacing the rechargeable nicads with non-rechargeable alkalids of the same approximate voltage. In addition, a number of faults were identified associated with a D type 25 pin connector located between the battery packs and the electronic can. This was deemed to be responsible both for a loss of power from battery pack 2 early in the cruise and subsequent intermittent shorting. All wires using this connector were resoldered which appeared to resolve the problem.

SUMMARY

Modifications made during the cruise ironed out all operational bugs resulting in a return to reliable system function during the final week of the cruise. Intermittent performance in mid-cruise while providing images from all stations, resulted in some lost opportunities both in terms of quantities of images per deployment and potential additional meso-scale prospection of the PAP and BIOTRANS sites (although poor weather was also a factor). Taken as a whole, this has been a very valuable and worthwhile exercise both in terms of data gathering and system performance evaluation and fine tuning. The ease of deployment, potential for large areal coverage and data provided about conditions at the sediment water interface makes the SPI an ideal reconnaissance and complementary approach for application during Lander studies.

ACKNOWLEDGEMENTS:

We would like to extend warm thanks to our Principal Scientific Officer Monty Priede, Captain Keith Avery and the crew of the RSS. Discovery. Many thanks also to the Research Vessel Support staff Rhys Roberts , Colin Day, Howie Anderson and John Wynar. We gratefully acknowledge the help of Peter Mason (RVS) for sorting out most of our electronics problems. Finally, our thanks to our fellow researchers for their assistance and stimulating discussions.

A.J.Grehan and M. Solan

DEPLOYMENT	DATE	SITE	LATITUDE	LONGITUDE	DEPTH/m	BOTTOM TIME	IMAGE
SPI 01 (9a)	211 (July 29th)	OMEX II	49 14.21 N	12 48.12 W	1422 - 1557	06:00 - 06:50	12
SPI 02 (9b)	213 (July 31st)	OMEX III	49 07.32 N	13 31.58 W	3759 - 3779	06:08 - 06:42	12
SPI 03 (9c)	213 (July 31st)	OMEX III	49 07.23 N	13 33.36 W	3729 - 3732	09:40 - 10:20	17
SPI 04 (9d)	214 (Aug. 1st)	OMEX III	49 08.13 N	13 29.25 W	3810	22:28 - 23:17	0
SPI 05 (19)	216 (Aug. 3rd)	ALIPOR G5	49 09.19 N	13 03.68 W	2149 - 2164	23:00 - 23:40	6
SPI 06 (20)	217 (Aug. 4th)	E. of OMEX II	49 13.99 N	12 35.06 W	1200	03:42 - 04:46	15
SPI 07 (24)	218 (Aug. 5th)	N. of OMEX III	49 16.14 N	13 20.57 W	3815	22:52 - 00:08	16
SPI 08 (26)	219 (Aug. 6th)	OMEX IV	48 59.01 N	13 44.28 W	4492 - 4501	04:30 - 07:00	3
SPI 09 (27)	220 (Aug. 7th)	P.A.P	48 51.42 N	16 28.60 W	4811	04:10 - 05:40	1
SPI 10 (38)	224 (Aug. 11th)	P.A.P	N/A	N/A	N/A	N/A	0
SPI 11 (52)	228 (Aug. 15th)	BIOTRANS	47 39.73 N	19 50.33 W	4557	03:25 - 04:40	3
SPI 12 (61)	231 (Aug. 18th)	P.A.P	48 49.11 N	16 17.42 W	4834	00:35 - 01:30	1
SPI 13 (64a)	234 (Aug. 21st)	P.A.P	48 48.22 N	16 16.24 W	4835 - 4836	23:05 - 00:50	5
SPI 14 (64b)	235 (Aug. 22nd)	P.A.P	48 48.76 N	16 15.91 W	4834 - 4835	06:00 - 06:40	4
SPI 15 (67)	237 (Aug. 24th)	OMEX 1	49 25.55 N	11 33.10 W	692 - 696	09:45 - 10:35	5
SPI 16 (68)	237 (Aug. 24th)	PFANNKUCHE 1	49 28.81 N	11 12.31 W	227	12:55 - 13:30	1

Table 3. Summary of SPI Deployments

Aberdeen University Deep Ocean Submersible II (AUDOS II)

Aims:
To test the new AUDOS II vehicle and to photograph and track scavenging fishes attracted to baits deployed on the sea floor at the different locations along the ALIPOR transect of the NE Atlantic.

The AUDOS II Lander Vehicle.

The AUDOS II incorporates three main systems; a photographic camera with flash unit (IOS Mk 7), an acoustic fish tracking system (77 kHz) and an acoustic Doppler current meter. These are all linked to an Acoustic Command Unit (ACU) which provides a 10 kHz telemetry link to and from the surface. A microcontroller in the ACU logs data from the current meter and tracking system onto a hard disk and also sends data to the camera for output on an LED digital display associated with each frame. The ACU controls the ballast release mechanism which is driven by two DC electric motors in parallel mounted on an IOS type release mechanism. The camera is trigger either from the CU or using an internal timer.

The integration of control and data logging into the ACU makes a compact vehicle and hydrophones for the 77kHz tracking system are mounted on three arms that unfold when the vehicle is deployed.

The vehicle is held 3m above the sea floor in a tension mooring between ballast suspended beneath the vehicle and Benthos, Glass buoyancy spheres above. Three Code activated transponders in baits are placed on the ballast close to the sea floor. Fish ingesting these transponders can be individually tracked.

Results
During Discovery Cruise 222 AUDOS II was deployed on seven occasions (Table 1).

On the first deployment the software controlling the lander crashed 20 minutes after deployment, when the vehicle was being interrogated using the 10 kHz telemetry. This meant that the release could not be fired and the lander eventually (48 h) free from the sea floor by a soluble magnesium back-up release.

In subsequent deployments a Mors release was loaned from RVS and fitted as a back-up to the main release system.

During the second deployment the AUDOS II returned to the surface early without reaching the sea-floor. The vehicle remained on the surface for 18 h in rough weather, resulting in the loss of the upper section of the Dan buoy, including radio and strobe.

For the third deployment of AUDOS II (on the abyssal plain at BIOTRANS) the camera was operated independently of the main command unit and produced a good set of photographs, but no tracking data were obtained.

The fourth deployment, also at BIOTRANS, produced photos, but the frames were slightly overlapping, and the tracking system did not record any data.

The fifth deployment, on a seamount at PAP was undertaken with the camera only operating.

As a result of the problems with the hardware/software controlling the AUDOS II, the system was changed to allow each integral part to operate independently. A new strategy was adopted for integrating the electronics to the micro controller, which involved using port pins instead of the controller's bus. As a result, the sixth deployment of AUDOS II was the first in which the software operated successfully and the vehicle was released using the AUDOS II release and not the Mors. Unfortunately no photographs were taken during this deployment because of flash problems. The flash problems were subsequently identified as a damaged flash trigger in the camera and a small amount of corrosion in a connector.

The AUDOS II was finally deployed and left on the sea floor with a dead dolphin as a replacement for the large food fall experiment. This was to be recovered during the second leg of Discovery cruise 222, Bengal.

Conclusions.

Photographic data were obtained for the first time for the BIOTRANS station enabling estimation of abundance, size and biomass of scavenging fishes. This, together with University of Aberdeen archive data for PAP, and the Goban Spur provides a complete data set for the ALIPOR transect.

The vehicle mechanical configuration with folding arms was successful in both deployments and recoveries. The concept of integrating all vehicle control and data logging functions in the ACU proved over-ambitious in view of the limited testing opportunities prior to this cruise. By the end of the cruise the problems were largely overcome. Much useful information was obtained for further development of the AUDOS system during the course of the ALIPOR project.

M.A. Collins, S.Addison & S. Bradley

Date	Station	Time	Latitude	Longitude	Depth	Comments
01/08/96	222/96/12	09:56	49°04.92'N	13°25.78'W	3641	Software crash. Surfaced after 48 hrs on magnesium.
08/08/96	222/96/37	20:08	48°46.05'N	16°21.00'W	4799	Surfaced after 20 mins due to
13/08/96	222/96/47	10:17	47°32.13'N	19°55.15'W	4523	Biotrans. Good photographs produced, but no fish tracking. Released after 24 hrs by Mors.
15/08/96	222/96/54	20:01	47°37.16'N	19°53.95'W	4526	Biotrans. Photo frames overlapping and software failure, released by Mors.
17/08/96	222/96/60	21:01	48°44.90'N	16°27.6'W	4359	Deployed on seamount at PAP, without the electronics. Good photos, released by Mors.
18/08/96	222/96/63	21:50	48°42.73'N	16°38.98'W	4798	Flash failure, so no photos, AUDOS software and release worked for first time.
22/08/96	222/96/65	10:49	48°47.01'N	16°19.96'W	4800	Deployed with dead dolphin, to be recovered on Leg 2 of Discovery 222.

Table 4. Summary of AUDOS II deployments during *RRS Discovery* Cruise 222A.

ATTIS (Acoustic Telemetry and Transponder Interrogation System)

Aims.

A major problem with tracking fish in the deep sea is that the depth exceeds the range of any practical high frequency acoustic telemetry system. Tracking stations must therefore be deployed on the sea floor. The ATTIS landers are prototypes for multiple tracking stations that can deployed on the sea floor. Four ATTIS were available for this cruise and the aim was to test these landers deployed in a linear array and to monitor interchange of fish with CATS between the 4 landers.

ATTIS Deployments.

The 4 ATTIS units were deployed, in a linear array at the PAP station, each with 3 baits CATs attached to the frames. The ATTIS's were deployed within 34 minutes with the ship headed slowly into the wind on 8 August stations 222/96/32-35. Acoustic location subsequently demonstrated that they were in a precise line on the sea floor. The ATTIS units were retrieved during the night of 20-21 August. It was possible to telemeter successfully to all the units whenever the *RRS Discovery* passed nearby the array using the on-board 10 kHz link on the ACU.

Conclusion.

The systems on the ATTIS proved reliable except in one case, ATTIS no 2 (Station 34), which despite displaying all the correct responses to acoustic telemetry failed to release. It seems the release motor units jammed having been over-tensioned during the set-up prior to deployment. No data analysis was possible on board ship but the ATTIS units provide a promising basis for a compact lander system.

Monty Priede, Steve Addison & Scott Bradley

Fish Trap Deployments

Aims.

The aim was to capture fishes and invertebrates attracted to baits deployed at the different stations along the ALIPOR transect. This would provide positive identification of species appearing in the AUDOS camera photographs and additional information. Amphipod samples were to be made available to S. Creasey of Southampton University.

Methods

The trap is a 1m cube, 12mm mesh cage that is suspended in a mooring beneath a string of benthos floats. The cage has two funnel entrances and bait is placed within the trap wrapped in wire mesh. The system is deployed as free-fall lander using ballast beneath the case and an acoustic release. For catching small amphipods cylindrical traps 75mm diameter with funnel entrances were also attached to the main cage.

Results.

Eleven deployments of the fish trap were made during the cruise with durations ranging from 13 to 22 hours. Two whole mackerel were tied to the central column of the fish trap as bait and pieces of mackerel were also used as bait for the three attached amphipod traps.

In the first deployment, two of the amphipod traps were positioned inside the fish trap, but the one trap attached to the outside of the fish trap obtained a higher number of amphipods. For further deployments, therefore, all three amphipod traps were attached to the outside of the fish trap.

A total of 13 grenadiers, *Coryphaenoides (Nematonurus) armatus*, 5 eels, *Synaphobranchus kaupi*, and 3964 amphipods was collected. At least four species of amphipods were encountered, the two most common of which were tentatively identified as *Eurythenes gryllus* (including a single 'giant' specimen measuring 100 mm length from station 15) and *Paralicella tenuipes*. Further detailed examinations of the frozen amphipod specimens are required in order to confirm identifications. The station information and preliminary results are summarized in Table 5.

Discussion.

This was the first time this trap had been deployed on the abyssal plain. Catches of fish there were lower than on the continental rise and slope in this and previous studies (Priede *et al.* 1994). The mesh size of the cage had been reduced from 25 mm used previously. This resulted in good catches of the slim bodied eels at the OMEX II station.

Cynthia Yau.

PRIEDE, I.G., BAGLEY P.M., SMITH A., CREASEY S. & MERRETT N.R. (1994) Scavenging deep demersal fishes of the Porcupine Seabight,(NE Atlantic Ocean); observations by baited camera, trap and trawl. *Journal of the Marine Biological Association of the United Kingdom* **74**: 481-498.

Table 5. Fish Trap Deployments: *RRS Discovery* Cruise 222 A (ALIPOR)
Summary of Results. (S = sea mount, P = abyssal plain)

Station	Date Deployed	Duration (h:min)	Depth (m)	Area	No. Fish	Species of Fish	Total no. of Amphipods
14	01/08/96	18:51	3710	Omex III	4	*C. armatus*	33
15	02/08/96	13:52	3650	Omex III	4	*C. armatus*	81
18	03/08/96	20:39	1450	Omex II	5	*S. kaupi*	2575
23	04/08/96	21:32	2234	Transition	0	-	10
36	08/08/96	22:03	4360	PAP (S)	2	*C. armatus*	140
47	13/08/96	13:44	4284	Biotrans (S)	0	-	188
48	14/08/96	13:13	4533	Biotrans (P)	2	*C. armatus*	174
51	14/08/96	15:05	4221	Biotrans (S)	1	*C. armatus*	57
53	15/08/96	14:08	4529	Biotrans (P)	0	*C. armatus*	396
59	17/08/96	16:07	4359	PAP (P)	0	-	224
62	18/08/96	25:09	4799	PAP (P)	0	-	86

The Large Abyssal Food-Fall Experiment (LAFF)

The Large Abyssal Food-Fall experiment used a newly designed and built lander to study the effect of a large carcass on the deep-sea scavenging community.

Two 10 day deployments were planned during the present cruise.

The first deployment was at the Porcupine Abyssal Plain, 48 36.09 N, 16 10.00 W at 4800m depth where the LAFF was successfully recovered 13 days later. The second deployment was at 48 46.18 N, 16 24.14 W at a similar depth, lasting 9 days. Unfortunately the LAFF was lost during recovery owing to parting of an eye on one of the mooring lines .

Deployment

Both deployments of LAFF were relatively problem-free. The new battery on the camera (Ocean Instrumentation) initially caused a problem on the first deployment and was subsequently changed. The release mechanism on the corer also had to be altered in order to be effectively attached. The 2 short term deployments used half a dolphin carcass (cut longitudinally) each, both weighing approximately 50 Kg. This proved to be very messy. The carcass was attached fairly loosely to the stretcher by a wire through the dolphin's vertebrae. The stretcher itself was rigged so that it would not float up too close to the compass, flash lights, etc.

The large amount of excess buoyancy, which was required in order to raise the corer from the sediment, meant that the mooring line was over 100m long. Calm weather was thus necessary for deployment of this rig. The descent rate was very slow at 27 m per minute.

Recovery

The length of mooring line and size and weight of the LAFF could make recovery difficult in a large swell. Additionally, the tubes of the coring device extended below the feet of the lander so that wooden blocks had to be placed underneath the foot pads prior to lowering the lander onto the deck. For these reasons the recovery of the first experiment was delayed until there was good weather. The Aberdeen Acoustic Release was used successfully to release the LAFF and the ascent rate was 53 m per minute. The moorings were recovered without the use of the safety lines attached to the float racks. However, the strain from the weight of the lander on the last 20m line was evident and the whipping surrounding the eyes of the rope had begun to fray. The eyes on this rope were replaced with bowlines.

During the second deployment, the Aberdeen release was used again successfully. There was, however, a delay in LAFF leaving the sea bed, possibly caused by suction of the cores embedded in the sediment. The lander reached the surface at dusk but the strobe was clearly visible. During recovery of the moorings, the 10m line between the last 2 float racks parted at the eye and the lander with one float rack remaining was lost.

Subsequent rope tension tests showed that the whipping around the eye gave way at a breaking strain of just 600 kg, despite being guaranteed to be stronger than the rope itself (approximately 8 tonnes).

Results

The results from the first deployment of LAFF look very promising. The carcass was completely eaten within the 13 day period. Only the skeleton was recovered with a few remaining pieces of skin and sinew. Forty amphipods were picked from between the bones. These have been tentatively identified as *Eurythenes gryllus* and *Paralicella tenuipes.* Parts of the skeleton were frozen and parts were preserved in formalin. The bait in the amphipod traps remained largely uneaten. 22 amphipods were found in the trap containing sliced pieces of the dorsal fin, but in the other 2 traps only exoskeletons were found.

The camera used the entire 30 m roll of Ektachrome film, taking 1440 frames at a frequency of 1 every 10 minutes. Subsequent development of the last 30 frames showed focus and exposure settings etc. to have worked well. Fish were present in many of the photos. The grenadier, *Coryphanoides armatus* and the eel *Synaphobranchus kaupii* were identified along with a possible third species. An as yet unidentified crab was also present in some frames.

An initial analysis of the 4 MB of data downloaded from the Acoustic Command Unit indicated that the tracking of fish was also successful. However, the corer failed to trigger during the first deployment so no sediment samples were obtained.

All systems on the LAFF appeared to have worked well under the given conditions, including a diving compass previously only tested to 600m.

A third and final deployment of a modified large food-fall experiment was made using the AUDOS camera, current meter and acoustic tracking system. this was deployed on the 22nd August again at the PAP site (48 47.02 N, 16 20.00 W) at 4801 m depth. A whole dolphin carcass, weighing approximately 80 kg, was wired onto a stretcher that was suspended directly beneath the AUDOS by wire strops running through a ring and shackle attached to the release. 100 kg of chain was strung along the stretcher bars as ballast. Current ribbons and baited Code Activated Transponders (CATs) were tied to the wire strops within view of the camera. Recovery of the AUDOS is planned in approximately 20 days time although the carcass will not be retrieved. The camera was loaded with approximately 60 m of Kodak 5297 film and was programmed to take photographs every 10 minutes.

E.G. Jones

Acoustic Recovery Systems:

Scientific Framework.
The five sites occupied on this cruise required the co-ordination of 36 deep ocean release units fitted to 13 landers and 6 moorings. All the sites were occupied by existing sampling systems that will provide complementary scientific information for use with the lander scientific results. All were fitted with acoustic recovery units (acoustic releases). It was important to sample as close as possible to these systems without putting their integrity at risk either physically or acoustically. Two of the sites could be cleared (by recovery), three could not. Eleven landers, nine of which were prototypes, were the direct responsibility of this cruise.

Overall Performance.
There were 40 acoustic recovery attempts. Of these 37 were fully successful, one was acoustically successful but the mooring took three days to mechanically break free, one lander was released prematurely but relocated using the acoustics, and one totally failed acoustically and eventually released through a corrodible link.

Acoustic Systems Used.

There were 36 sea units,

22	Oceano Mors
8	Benthos
6	Aberdeen University FM acoustic release units.

These were supported by a range of deck systems:

5	MORS TT301 + dunking transducers
1	OCEANO TT201 + AM201 dunking transducer,
1	BENTHOS + dunking transducer.
1	IOS FM deck unit,
2	J. Fall - Waterfall display
2	Greggs UTS 10/12 kHz receiver units
1	Simrad 10/12 kHz Echosounder
2	IOS PES towed 10 kHz transducer arrays.
1	IOS PES hull tank mounted 10 kHz transducer array.

Acoustic Conflicts.
There were potential command code and general interference conflicts between units of all three types.

The OCEANO/MORS conflict was relatively minor - between transponder code and a "windowed" secondary command code. t is god practice to have all commands of a secure nature such as "release" protected by the "window" facility.

The BENTHOS code conflicts were potentially more serious. One of the units available to the Göteborg lander was the same release code as one of the JGOFS mooring units at BIOTRANS. The BENTHOS system has a restricted number of command codes and no window facility.

The ABERDEEN units had the potential or conflict in that some windowed commands could potentially wake up and therefore open the window of other units. The ABERDEEN system has very few command codes available.

Problems Encountered

Back-up systems.
On the first recovery of the AUDOS 2 system failure of the acoustic meant that the system had to be recovered by waiting for a corrodible Mg link to break. With the changeable weather experienced during the cruise a second independent acoustic release was retrofitted as an alternative.

On the Göteborg lander problems with burn wire back up systems aborted a planned deployment and again a second independent acoustic release was retrofitted as a safer alternative.

ABERDEEN systems. Five Mk 2 units were actively used for 6 successful recoveries of ATTIS (4) and LAFF (2) and functioned well. The Mk3 unit fitted to AUDOS failed on the first deployment, released prematurely the second deployment. It was recovered by virtue of a jury rigged back up MORS unit, the signal from which enabled the AUDOS 2 to be relocated acoustically since the radio beacon, strobe light and flag had been lost in bad weather while the system floated on the surface. The MORS unit suspended 50 metres below the surface transponded early acoustic ranging trials using the TT301 and towed PES transducer. Without this system the AUDOS 2 would have been lost. Problems with the Mk3 system were resolved by the 6th deployment when it functioned perfectly but scientific work had been considerably curtailed by recurring problems with the Mk3 ABERDEEN system.

OCEANO/MORS systems. 15 Units were actively used for attempted recoveries; one was completely unsuccessful (OMEX2) but this was almost certainly NOT due to a MORS failure.

The most serious failure was the implosion of an OCEANO RT361B1S (serial Number 071) currently owned by GEOMAR. This occurred on a lander at 4800m depth and resulted n no other damage. The lander was recovered by a second parallel 361. A second spare 361 was fitted and performed satisfactorily for the rest of the cruise. The other failure was in the transmitting power amplifier of a relatively new AR661B2SHD (serial no. 171) owned by the University of Göteborg. It was however successfully used for all 5 the Göteborg lander recoveries.

BENTHOS systems. Four units were actively used in 8 attempted recoveries; one was completely unsuccessful (OMEX 2) but this was almost certainly NOT due to a BENTHOS failure.

DECK UNIT PERFORMANCE.

IOS FM deck unit.- This performed will in combination with the ships PES towed transducer both commanding the Aberdeen sea units and driving the waterfall displays.

OCEANO/MORS. There were 5 TT301 units on board. It was found that none would work from the mains power supply. This problem was avoided by operating from the internal batteries. There was a large difference in sensitivity to incoming signals between the different TT301 units. One was as good as the TT201/AM201 system, two were useable and two were poor.

The most reliable performance monitoring was achieved using the towed PES single element with 10/12 kHz receiver and the Waterfall VDU display to monitor pinger signals. This in combination with the TT301 manually switched to the towed PES element was successfully used at speeds up to 6 knots. The best range achieved was 9191m at the BIOTRANS site in a depth of 4800m

BENTHOS systems. One system was available and was used with its dunking transducer to monitor the 5 Göteborg lander recoveries and 3 OMEX moorings. Its digitiser performed as well as the best MORS unit. Audio monitoring was possible over greater ranges than the digitiser output. .

Ships Precision Echo Sounder (PES).
The towed transducer was used extensively. The SIMRAD echo sounder itself could operate at 10 or 12 kHz and could be used to monitor the pinger and transponder signals. However it is not designed for this purpose and is difficult to use. It was used for vertical wire work and did detect the OMEX 2 mooring when it had broken free.

Acoustic Exclusion Zones

At the BIOTRANS and the PAP sites acoustic exclusion zones were established around the long term mooring positions to prevent inadvertent operation of their acoustics.

Acoustic Position Fixing.
Whenever acoustic ranges were obtained the GPS fix of the ship's position was noted. This will enabled seabed position to be checked against the nominal position (taken as the ship's position at the launch).

CONCLUSIONS:
The objectives of the cruise were successfully achieved despite a considerable variety of gear that had to be operated together. The main lesson learned was that back-up time releases of various kinds are of limited value in changeable weather conditions in the NE Atlantic. It was concluded by all groups that two acoustic releases in parallel are necessary.

Greg Phillips

RVS Scientific Engineering Group: Cruise Report

The shipboard scientific engineering facilities and equipment were used successfully throughout the cruise.

WINCHES

The ten tonne traction system was used to deploy the CTD package using the CTD conducting cable via the starboard gantry.

The twenty tonne traction system, using the trawl cable, was used for deploying the SPI and the Multi Corer. These activities were carried out over the starboard gantry which proved to be a very stable system for recovery and deployment in rough weather. This cable was also used to recover some of the landers via the aft gantry when the sea state became to great for the crane and double barrel winch.

The double barrel winch was used in conjunction with the starboard crane for the deployment and recovery of most of the landers.

NON TOXIC WATER SYSTEM

This was in continuous operation for the duration of the cruise.

MILLI RO / MILLI Q WATER SYSTEM

This water production system was used throughout the cruise, during which time two pre filters and a Milli RO filter were changed.

ENGINEERING WORKSHOP

Being a partial development / testing cruise, the engineering workshop was made available for general scientific use. The openness of this facility was appreciated and respected by all who used it.

This being a testing cruise for lander operations, the shipboard handling systems, gantries, cranes and winches, proved to be flexible and very effective. The various engineering disciplines offered by the RVS staff were called upon to manufacture, repair and give advice for the onboard development of some of the scientific equipment.

Pete Mason, Colin Day, Rhys Roberts

Analysis of Performance of Lander Operations.

The *RRS Discovery* sailed with 11 landers on board with the aim of demonstrating the feasibility of multiple lander operations from a single ship. In this respect the cruise was overwhelmingly successful.

The vessel was in the working area for 25 days (600h). During this time 40 deployments were carried out at and average rate of one lander every 15 hours. This average includes steaming time between stations and time lost to bad weather. Also 18 vertical wire stations (CTD, multicore) were worked.

The benefit of landers is clearly illustrated by the fact that during 600 hours of ship-time 3519 hours of scientific sub sea time was achieved. This could be described 586% efficient utilisation of ship time.

The large deck area of the *RRS Discovery* allowed placing of several landers ready to be deployed in rapid succession. For example the four ATTIS landers deployed with only 34 minutes between the first and the last. Even the three largest landers, the IFREMER, GEOMAR and Göteborg chamber landers were deployed with 49minutes (12 August, Stations 222/96/43,44,45) each on a predetermined location.

The deck hanger with its new overhead travelling crane allowed servicing of landers in shelter during inclement weather with access to electricity supplies and interfaces to the ship's computers data transfer. The *RRS Discovery* is very well equipped for lander operations.

Prior to the cruise there was considerable discussion regarding methods of recovery of landers. Some institutes prefer to deploy an recovery craft such as a zodiac to attach the lander to a line from the ship. It is general practise within RVS including on board the *RRS Discovery* to manoeuvre the mother ship along side the lander and to throw a grapple line to a float line that is generally attached to the lander. This system proved very successful even in the case of the IFREMER lander which had the additional complication of the parachute to be unhooked before the lander could be brought on board.

Table 6 analyses the times taken to recover the landers. Two types of landers can be distinguished, those with buoyancy distributed in a mooring string, (e.g. AUDOS and LAFF) and those with buoyancy in module on the chassis of the lander, (e.g. IFREMER, GÖTEBORG). Clearly the latter should be most easily recovered but the difference in time required is surprisingly small.

Table 6. Analysis of Lander Recovery Times.

Vehicle	Sta. No.	Recovery Times (Minutes) Grapple	In board	Total	Comments
GEOMAR	6	21	11	32	
GEOMAR	22	22	8	30	
GEOMAR	28	23	7	30	
GEOMAR	44	23	7	30	
GEOMAR	56	10	10	20	
IFREMER	7	44	10	54	E-mail delayed pick-up
IFREMER	17	51	8	59	
IFREMER	27	76	15	91	Crane failed
IFREMER	43	18	13	31	
IFREMER	58	22	9	31	
GOTEBORG	8	11	13	24	
GOTEBORG	31	17	12	29	
GOTEBORG	45	28	9	37	
GOTEBORG	49	28	13	41	
GOTEBORG	57	26	4	30	
ATTIS	32	12	11	23	
ATTIS	33	16	8	24	
ATTIS	34	11	6	17	
ATTIS	35	13	7	20	
AUDOS	12	22	18	40	
AUDOS	37	24	32	56	
AUDOS	47	22	22	44	
AUDOS	54	8	16	24	
AUDOS	60	18	12	30	
AUDOS	63	13	12	25	
Fish Trap	14	16	13	29	
Fish Trap	15	28	19	47	
Fish Trap	23	9	15	24	
Fish Trap	36	11	21	32	
Fish Trap	46	14	11	25	
Fish Trap	48	16	15	31	
Fish Trap	51	6	20	26	
Fish Trap	53	64	13	77	
Fish Trap	59	21	17	38	
Fish Trap	62	20	11	31	
LAFF	5	27	29	56	
LAFF	40	9	20	29	Rope parted
Average Time		22.16	13.43	35.59	ALL
Minimum Time		6	4	17	LANDERS
Maximum Time		76	32	91	
Average Time		24.84	9.53	34.37	FLOATS
Minimum Time		10	4	17	ON BODY
Maximum Time		76	15	91	
Average Time		19.33	17.56	36.89	FLOATS
Minimum Time		6	11	24	ON STRING
Maximum Time		64	32	77	

The upper half of the table shows landers with floats on the body and lower landers with floats on a string.

Using traditional RVS methods, *RRS Discovery* achieved an average of 36 minutes for recovery of a landers from surfacing, to secure-on-deck. The record fastest 17 minutes. These data for deployment and recovery times provide a basis for planning future cruises.

There were extended periods of time when all the landers were on the sea floor and the ship was free for other work. To ensure best use of ship time it is useful to have some instruments deployed conventionally by wire.. The SPI, CTD and multicorer were used to advantage in this way.

A problem peculiar to lander cruises became apparent towards the end of this cruise when bad weather was forecast for the last few working days. It was unsafe to deploy landers which would have to be recovered in gale force conditions. Whilst the landers would be safe left on the sea floor, the ship would have been delayed if recovery of the landers was delayed in order to wait for suitable weather. This uncertainty is difficult to manage. The options are to risk delaying the ship or to have other work that can be done without need for landers. In the present instance *RRS Discovery* departed for Southampton earlier than originally planned.

Whilst this was particularly a lander based cruise it seems advisable in future to combine lander operations with other types of work.

Monty Priede

STATION NUMBERS.

The station numbering system used for this cruise comprises the cruise number (222) followed by the year (96) and then the station number within the cruise 1,2,3 etc. representing deployment of gear regardless of location.

"DISCOVERY" STATION NUMBERS.

The Institute of Oceanographic Sciences (IOS), (formerly National Institute of Oceanography), now based at the Southampton Oceanography Centre, uses the "Discovery" station numbers which simply number stations 1,2,3 etc. from the first sample taken on the first cruise of their first ship the "*Discovery*" in the year 1925.

This series of numbers provides continuity in British biological oceanography and the system has been extended for use by IOS personnel whenever they sail on vessels other than the *Discovery*. A Discovery station number therefore no longer indicates the ship from which the sample has originated.

The Discovery numbers have further now been adopted for all cruises under the EU MAST III sponsored project known as BENGAL: High resolution temporal and spatial study of the benthic biology and geochemistry of the a north-eastern Atlantic abyssal locality.

Since some of the data collected on this cruise are relevant to the BENGAL programme Dr. M. Thurston of IOS has allocated "Discovery" series numbers to the stations on the ALIPOR cruise. The rules are:

(a) Station numbers are consecutive from the first station in 1925.

(b) Consecutive repeat stations at the same locality, even with different equipment, are given sub-series numbers indicated by the sign #. (A locality can be an extended area up to ca. 30 nmiles such as the PAP station)

(c) If the ship leaves a locality, works other stations and returns, a new station number to the further work at the same the locality.

The Discovery station numbers are inserted in the following table in *italic script* beneath the ALIPOR station number.

Station List - *RRS Discovery* Cruise no . 222 Leg 1 ALIPOR

Station No.	Date	Time (BST)	Latitude	Longitude	Gear	Depth (m)	Remarks
222/96/01 *12911#1*	29 July	0613 0840	49°15'N	12°46'W	SPI	1422- 1557	A prelimary test of the new digital SPI 2. 15 images in relatively shallow water.
222/96/02 *12912#1*	29 July	1514 1728	49°06.3'N	14°27.1'W	CTD	4556	2 acoustic releases to be used later were tested on this CTD cast and water was obtained for priming syringes on the Göteborg lander.
222/96/03 *12913#1*	30 July	0229 0615	49°55.18'N	16°30.45'W	CTD	4800	CTD cast designed to provide base-line data at the MAP location on the Porcupine Abyssal Plain Station (PAP).
222/96/04 *12913#2*	30 July	0645	48°56.06'N	16°31.93'W	MAP	4800	IFREMER, Module Autonome Pluridisciplinaire, platform and mooring deployed for recovery in 1998.
222/96/05 *12913#3*	30 July 11 Aug	1233 0938	48°46.09'N	16°10.0'W	LAFF	4800	LAFF deployed with half a dolphin carcase and three code activated transponders baited with mackerel for tracking fish.(PAP station). The Dolphin carcasse was completelt consumed with 10 days.
222/ 96/06 *12914#1*	30 July 1 Aug	2338 1321	49°04.99'N (Surface)	13°27.35'W	GEOMAR Lander	3650	First of three landers to form a square formation with the NIOZ lander deployed from the *RV Pelagia.* (OMEX III location)
222/96/07 *12914#2*	31 July 1 Aug	0019 1035	49°03.98'N (Surface)	13°25.76'W	IFREMER Lander	3650	Third lander of the OMEX III square

222/96/08 *12914#3*	31 July 2 Aug	0428 0701	49°03.96'N (Surface)	13°27.31'W	Göteborg Lander	3650	The square is completed OMEX III Only one (of 4) chambers had collected a good sediment sample.
222/96/09 *12914#4*	31 July 1 Aug	0542 1228 2208	49°08.0'N	13°31.0'W	SPI	3732-3779	Two transects completed at OMEX III. Third transect. Third transect at OMEX III
222/96/10 *12914#5*	31 July 1 Aug	2155 0049	49°05.1'N	13°23.4'W	CTD	3652	12 NISKIN bottles: Surface, 50, 75, 100, 200, 300, 500, 1000, 2000, 3000, bottom
222/96/11 *12914#6*	1 Aug	0222 0537	49°07.07'N	13°31.07'W	Multicorer	3652	GEOMAR multicorer, unsuccessful
222/96/12 *12914#7*	1 Aug	0956 1225	49°04.92'N (Surface)	13°25.78'W	AUDOS II	3641	Deployed with 3 CATs, software apparently failed on the way down. Mg release worked at 51h 20 min.
222/96/13 *12914#8*	1 Aug	1115 1145	49°04.75'N	13°26.41'W	Acoustic Tests	3650	Located at the centre of the lander array, tests were conducted on communicating with all the vehicles.
222/96/14 *12914#9*	1Aug 2 Aug	2120 1511	49°07.02'N (surface)	13°31.01'W	Fish Trap	3710	Baited with mackerel. Three amphipod traps attached.Captured 4 *Coryphaenoides (Nematonurus) armatus*. 33 amphipods
222/96/15 *12914#10*	2 Aug 3 Aug	2021 1013	49°04.92'N (Surface)	13°27.17'W	Fish Trap	3650	Mackerel bait, & amphipod traps outside. 4 *C.(N.) armatus* & 81amphipods including a very large *Eurythenes*
222/96/16 *12914#11*	2 Aug	2109 2330	49°04.4'N	13°27.0'W	Multicorer	3700	A successful deployment of GEOMAR multicorer at the OMEX 3 site.
222/96/17	3 Aug	1932	49°10.1'N	12°48.0'W	IFREMER	1450	OMEX 2 site. First of two landers deployed at this location, 0.5

12915#1	5 Aug	1036			Lander		nautical miles apart.
222/96/18 *12915#2*	3 Aug 4 Aug	2021 1700	49°13.49'N	12°48.52'W	Fish Trap	1450	Mackerel bait. 3 external amphipod traps. 5 eels, *Synaphobranchus kaupi* and over 2575 amphipods were caught.
222/96/19 *12916#1*	3 Aug 4 Aug	2303 0128	49°09.3'N	13°04.4'W	SPI	2149- 2164	SPI deployed on the edge of the Goban spur, good results
222/96/20 *12917#1*	4 Aug	0418 0612	49°14.0'N	12°35.1'W	SPI	1701- 1982	A new station further upthe Goban Spur.
222/96/21 *12918#1*	4 Aug	0739 0924	49°09.8'N	12°45.8'W	CTD	1358	CTD at the OMEX site with Niskins at 0, 25, 75, 100, 150, 200, 300, 500, 750, 1000, bottom.
222/96/22 *12918#2*	4 Aug 5 Aug	1005 2033	49°10.5'N	12°47.6'W	GEOMAR Lander	1363	Deployed 0.5 nautical miles from the IFREMER lander site at the OMEX 2 station. Both chambers full data set.
222/96/23 *12919#1*	4 Aug	2013 1745	49°09.1'N	13°05.1'W	Fish Trap	2234	No fish caught, one amphipod trap lost, Just 10 amphipods caught.
222/96/24 *12920#1*	4 Aug 5 Aug	2157 0222	49°16.0'N	13°20.1'W	SPI	3815	A new station at the foot of the Goban spur.
222/96/25 *12921#1*	4 Aug	0617 0742	49°10.5'N	12°49.3'W	Multicorer	1500	A good set of cores obtained in quite hard sediment.
222/96/26 *12922#1*	6Aug	0334 0929	49°59.5'N	13°44.0'W	SPI	4492 4501	Slight problems with the winch during this SPI deployment at the OMEX IV station
222/96/27	6 Aug	2016	48°58.0'N	16°25.0'W	IFREMER	4850	First lander of a triangular cluster at the PAP station.

12923#1	10 Aug	1649			Lander		Good data from both chambers.
222/96/28 *12923#2*	6Aug 10 Aug	2039 1955	48°59.0'N	16°25.0'W	GEOMAR Lander	4850	Second lander of the cluster at PAP. MORS release imploded. Good data from both chambers.
222/96/29 *12923#3*	6 Aug 7 Aug	2204 0214	49°51.4'N	16°29.8'W	CTD	4850	A CTD cast to obtain deep water for priming the syringes of the Göteborg lander.
222/96/30 *12923#4*	7 Aug	0319 0824	48°51.5'N	16°30.0'W	SPI	4811	A SPI survey of the centre of the PAP station. SPI multiple triggering off some bottom contacts.
222/96/31 *12923#5*	7 Aug 10 Aug	1042 1355	48°58.5'N	16°23.5'W	Göteborg Lander	4850	Deployed with two chambers to complete the cluster of landers at PAP. 2 good chambers one with a tube-dwelling polychaete.
222/96/32 *12923#6*	8 Aug 20Aug	1223 2210	48°42.00'N	16°37.70'W	ATTIS 4	4798	1st lander of the ATTIS array deployed with the *RRS Discovery* steaming westwards against the wind and seas.
222/96/33 *12923#7*	8 Aug 20 Aug	1242 2018	48°41.99'N	16°38.45'W	ATTIS 3	4798	2nd ATTIS of array (no back-up release). ACU and Aberdeen motor drive releases worked perfectly
222/96/34 *12923#8*	8 Aug 21 Aug	1256 0316	48°41.97'N	16°39.34'W	ATTIS 2	4798	3rd ATTIS of array. Release jammed, retrieved on back-up Mors release.
222/96/35 *12923#9*	8 Aug 21 Aug	1311 0118	48°41.99'N	16°40.06'W	ATTIS 1	4798	ATTIS array completed with bait and 3 CATs on each lander.
222/96/36 *12923#10*	8 Aug 9 Aug	1546 1343	48°44.8'N (Surface)	16°27.6'W	Fish Trap	4360	Deployed on the summit of sea mount. 2 *C.(N.) armatus* captured plus 140 amphipods
222/96/37	8 Aug	2008	48°46.1'N	16°21.0'W	AUDOS II	4799	AUDOS II deployed on the abyssal plain.

12923#11	8 Aug	2300					Popped up prematurely before reaching the sea floor.
222/96/38 *12923#12*	10 Aug 11 Aug	2303 0603	48°58.0'N	16°24.1'W	SPI	4800	Unsuccessful, camera failed.
222/96/39 *12923#13*	11Aug	1246 1620	48°51.43'N	16°30.05'W	Multicorer	4850	Multicorer at the centre of the PAP area. A good complete set of cores was obtained.
222/96/40 *12923#14*	11 Aug	2059 2137	48°56.2'N Lost during	16°24.1'W recovery	LAFF	4803	Redeployed with right half of dolphin plus 3 CATS. Mooring parted on recovery owing to defective eye splice.
222/96/41 *12924#1*	12 Aug	0000 1200	48°40'N	18°00'W	Sounding Run	4800-3000	*En route* between PAP and BIOTRANS a sounding run was made through an area of poorly known bathymetry.
222/96/42 *12925#1*	12 Aug	1718 2056	47°41.0'N	19°45.1'W	CTD	4525	A CTD on arrival at BIOTRANS to obtain bottom water for the Göteborg lander.
222/96/43 *12925#2*	12 Aug 16 Aug	2155 1021	47°37.04'N	19°49.98'W	IFREMER Lander	4525	IFREMER lander deployed as the first lander of the cluster at BIOTRANS near the JGOFS sediment trap.
222/96/44 *12925#3*	12Aug 16 Aug	2214 1142	47°37.03'N	19°51.52'W	GEOMAR Lander	4530	The second chamber lander at the BIOTRANS site.
222/96/45 *12925#4*	12Aug 14 Aug	2244 0732	47°36.14'N	19°50.74'W	Göteborg Lander	4527	The third chamber lander at the BIOTRANS station. Retrieved after a short incubation.
222/96/46 *12925#5*	13Aug	0016 1531	47°37.29'N	19°44.00'W	Fish Trap	4284	Fish Trap deployed on the top of a small sea mount in the BIOTRANS area. No fish caught; 188 amphipods.
222/96/47	13Aug	1017	47°32.14'N	19°55.15'W	AUDOS	4523	AUDOS deployed with 3 CATs on the abyssal plain at

12925#6	14 Aug	1136					BIOTRANS. Good photos, but no tracking data.
222/96/48 *12925#7*	14Aug	0022 1334	47°37.05'N	19°37.29'W	Fish Trap	4533	Fish Trap on the Abyssal Plain at BIOTRANS. Captured two large *C.(N.)armatus*. 174 amphipods.
222/96/49 *12925#8*	14Aug 16 Aug	1650 1429	47°36.07'N	19°51.53'W	Göteborg Lander	4529	Göteborg lander deployed for a second short incubation at the BIOTRANS location.
222/96/50 *12925#9*	14Aug	1740 2058	47°39.0'N	19°50.0'W	Multicorer	4530	Multicorer cast at BIOTRANS. A complete set of good deep cores was obtained.
222/96/51 *12925#10*	14Aug 15 Aug	2159 1304	47°37.03'N	19°44.93'W	Fish Trap	4221 (4364)	Fish Trap deployed on a small sea mount in the BIOTRANS area. One *C.(N.) armatus* captured & 61 amphipods.
222/96/52 *12925#11*	15Aug	0238 0709	47°39.9'N	19°51.2'W	SPI	4557	BIOTRANS station survey of sediment by SPI. 3 images obtained
222/96/53 *12925#12*	15Aug 16 Aug	1625 0658	47°34.02'N	19°53.07'W	Fish Trap	4529	Fish trap deployed on the abyssal plain at BIOTRANS. No fish caught 396 amphipods.
222/96/54 *12925#13*	15Aug 16 Aug	2001 1316	47°37.14'N	19°53.96'W	AUDOS	4525	AUDOS deployed on the abyssal plain at BIOTRANS.
222/96/55 *12925#14*	16Aug 17 Aug	1600 0500	48°30'N	18°00'W	Sounding Run	3000- 4850	A sounding run between BIOTRANS and PAP through areas of poorly known bathymetry.
222/96/56 *12926#1*	17Aug	1613 1652	48°50.05'N	16°15.55'W	GEOMAR Lander	4802	The first of a cluster of chamber landers near the BATHYSNAP location at PAP. Both chambers successful.

222/96/57 *12926#2*	17Aug 20 Aug	1706 1056	47°49.99'N	16°16.23'W	Göteborg Lander	4802	The second lander at the PAP/ BATHYSNAP cluster. All 4 chambers worked perfectly
222/96/58 *12926#2*	17Aug 20 Aug	1744 0853	48°50.01'N	16°16.95'W	IFREMER Lander	4801	The final lander at the PAP/BATHYSNAP cluster.
222/96/59 *12926#3*	17Aug 18 Aug	1948 1155	48°45.22'N	16°31.95'W	Fish Trap	4799	Trap deployed on the abyssal plain at PAP. No fish were caught but 234 amphipods.
222/96/60 *12926#4*	17 Aug 18 Aug	2101 1404	48°44.90'N	16°27.60'W	AUDOS	4359	AUDOS on top of the sea mount at PAP, no fish tracking. Good sequence of photos obtained.
222/96/61 *12926#5*	17Aug 18 Aug	2338 0401	48°49.70'N	16°18.30'W	SPI	4834	PAP area near the bathysnap site. Work curtailed owing to swell. 1 image obtained
222/96/62 *12926#6*	18Aug 19 Aug	1422 1431	48°46.00'N	16°36.96'W	Fish Trap	4799	Deployed on the Abyssal Plain at PAP, the usual bait supplemented with BBQ left overs. No fish, 86 amphipods.
222/96/63 *12926#7*	18Aug 19 Aug	2150 1731	48°42.73'N	16°38.98'W	AUDOS	4798	AUDOS deployed near the ATTIS array.
222/96/64 *12926#8*	21Aug 22 Aug	2230 0902	48°48.00'N	16°16.10W	SPI	4834- 4836	SPI at the PAP second chamber lander site. 2 transects were done.
222/96/65 *12926#9*	22Aug	1048 0000	48°47.01'N	16°19.96'W	AUDOS/ LAFF	4800	AUDOS deployed with a dolphin carcass beneath it on slings. To be recovered after 20 days on Discovery cruise 222B
222/96/66 *12926#10*	22Aug	1241 0000	48°51.50'N	16°30.00W	CTD O_2 probes	4798	O_2 logging systems from the GEOMAR and Göteborg lander were attached to the CTD for an intercalibration test.

222/96/67 *12927#1*	24Aug	1011 1203	49°25.40'N	13°33.20W	SPI	692- 696	SPI at the OMEX I site.
222/96/68 *12928#1*	24Aug	1333 1439	49°28.60'N	11°12.40'W	SPI	227	A final shallow water deployement.

Notes: All times are British Summer Time, GMT +1h

Times given are from when the equipment sank beneath the surface to when it resurfaced.

Depths are uncorrected soundings except SPI depths which are corrected.

Station numbers: 222/96/X = *RRS Discovery* Cruise 222. Year 1996, ALIPOR station number.

Numbers in small italic types (e.g. *12928#1*) are Discovery station numbers.