Discovery 257

SAMS Northern Seas Programme

21st September > 9th October 2001

Clyde-Clyde

Ship’s Personnel

CHAMBERLAIN R.J.	MASTER
WARNER R.A.	C/O
GRAVES M.	2/O
McALEA K.L	3/0
JETHWA K.	C/E
GREENHORN A.	2/E
COLLARD G.M.	3/E
BURDIS R.M.	3/E
STEWART D.	ETO
BENNETT P.R.	CPO(D)
MACLEAN A.	SG1A
BUFFERY D.G.	SG1A
DAY S.P.	SG1A
DOLLERY P.	SG1A
HEBSON H.R.	SG1A
TUPPENNE N.P.	SG1A
SMYTH J.G.	MMIA
STAITE E.	SCM
CONNELLY D.	CHEF
ISBY W.C.	M/STWD
LINK S.E.M.	STWD
LINK W.J.	STWD

Scientific Personnel

GRIFFITHS C.R.	PSO	legs 1 & 2
HARVEY S.M.	SCI	legs 1 & 2
EZZI I.	SCI	legs 1 & 2
BREUER E.	SCI	legs 1 & 2
THOMSON W.	SCI	legs 1 & 2
FEHLING J.	SCI	legs 1 & 2
BRIDGER M.	IT	legs 1 & 2
JONES J.L.	ENG	legs 1 & 2
McLACHLAN R.F.	ENG	legs 1 & 2
ROBERTS R.	ENG	legs 1 & 2
TEARE D.	SIG	legs 1 & 2
WYNAR J.B.	SIG	legs 1 & 2
WADDINGTON I.	SIG	legs 1 & 2
INALL M.	SCI	leg 1
JONES K.	SCI	leg 1
FOUILLAN E.	SCI	leg 1
COTTIER F.R.	SCI	leg 1
BRAND T.	SCI	leg 1
SHIMMIELD T.	SCI	leg 2
NICKELL L.	SCI	leg 2
PROVOST P.	SCI	leg 2
LAMONT P.	SCI	leg 2
HUGHES D.	SCI	leg 2
WATSON J.	SCI	leg 2
PEPPE O.	SCI	leg 2
ROBERTS M.	SCI	leg 2
LIKELY D.	SCI	leg 2

Acknowledgements

Despite the loss of time due to bad weather during the D257 many of the objectives were achieved. We are grateful for the assistance given by Captain Roger Chamberlain and all the officers and crew. Special thanks as ever to the catering department for the excellent food regardless of the weather. Thanks also to the UKORS support both aboard and ashore for all their help, patience and understanding.

Cruise Narrative (Rough Log) – Colin Griffiths

19/09/2001

Scientific party aboard.
Safety briefing at 14:00Z in the Officers Bar.
Problems with MilliQ system, continually flushing.

20/09/2001

08:00Z Move off from quay to lower Starboard lifeboat

09:00Z Due to sail but problems with 10T system, engineer is aboard. Winch sorted but problems encountered with one of the davits on the Starboard lifeboat. A ram has been removed and sent off for repair.

Sailing delayed for 24 hours, ram was returned around 18:00Z Engineers worked until 20:00Z, had to halt with one pin left to fit, too dark.

21/09/2001

Engineers finished off remaining pin, pilot set for 09:30Z Underway by 09:50Z, a calm, still day, bit cloudy though. Proceeded down the Clyde, the Balmoral overtook us. I spoke to Andy Louch re delay, there is no slack in the program. Andy will keep me informed if there are any developments. Problems again with the milliQ, a solenoid is blowing the fuses. Fortunately there was one spare left. Another unit will be posted up overnight. Dropped the pilot off and proceeded to the first station FC1 (Discovery Stn #14172). The CTD was deployed twice before commencing with the multicoring. Problems were encountered with the multicorer, winch system unable to pay out any slack in such shallow depths. Only one success out of six attempts.

We broke off from the coring to deploy the lander. Ideal conditions, flat calm, dry but still cloudy. Resumed coring with some extra lead attached to the trawl wire, this solved the problem, two successful drops. (Coring wire is only used when coring in water depths greater than 3000m).

22/09/2001

Waiting for first light to recover lander from FC1, all inboard soon after 7 o'clock. Another calm morning. Straight off to C1 (Discovery Stn #14173), arrived 09:30Z. CTD deployed, then the plankton net. The lander was deploymed at 11:34Z. Two more CTD's during the afternoon, switched over to multicoring, broke off to recover the lander. Slight problems with the Corer but we got there in the end. No time for a final CTD, getting dark for the optic boys plus it's been a long day. Off we go to S2. Another cracking day, one basking shark spotted, like a mill pond.

23/09/2001

Arrived on station S2 (Discovery Stn #14174) 23:45Z, lander deployed immediately. CTD was deployed at 07:26Z followed By the plankton net. Recovered the lander then commenced multicoring. Having problems keeping wire vertical. Abandoned coring soon after midday, no joy whatsoever. Another fine sunny day, wind had picked up a bit from the North-East. Exchanged troops and away, came outside Campbeltown loch for the safety briefing. The spare part for the milli-Q had not arrived.

Heading up to the Wyville Thomson Ridge via the Minch.

24/09/2001

Heading through the Minch, making very good time, just passing Northern tip of Skye soon after breakfast. Another fine day, a slight breeze from the North East. Continuing towards WT3, way ahead of schedule, eta 23:30A.

25/9/2001

CTD's at WT3 (Discovery Stn #14175) through the early hours, collected water for CCAP.

The top half of the lander was lowered on the trawl wire to test the buoyancy and acoustics. Then a CTD cast was performed to test the three Acoustic Releases for the W/T moorings and one release for the lander.

The mooring was deployed successfully during the morning. Conditions still good, little wind, slight swell, bit nippy plus rather cloudy. Off to WT2 (Discovery Stn #14176), same again, CTD then the morning, all went fine. Finished before 20:00A. Off to WTN, added one way point so as to stay along the axis of the trough with 3.5kHz sub bottom profiler system on.

Slowed down with 2 miles to run, passed over WTN at 23:00Z. Very smooth topography. There appears to be some interference on the PES trace, depth of station 1065m.

26/9/2001

On station 00:18Z at WTN N60º 15.899' W06º 55.888' 1187m (Discovery Stn #14177), CTD deployed twice.

The multicorer was then deployed four times.

Conditions still good, a very gentle swell. The lander was deployed at 08:34Z. The final multicore was in board by 10:25Z. The bedhop camera was deployed at 11:28Z, problems were encountered with the winch system. The package is too light for the 20T system even with an extra weight added to the wire. Plankton net was deployed at 14:01Z. The inaugural deployment of the mega corer began at 14:34Z, sadly no cores, the mechanism had fired but core tubes were full of water. Some modifications were then made to the mega corer. The NIOZ box corer was deployed at 17:14Z, successful core, top layer sandy. The next deployment of the NIOZ box corer was not so successful. A stone had prevented the spade from sealing the box. Another bed hop deployment was tried with the trawl wire. This was abandoned, the winch system was unable to pay out enough slack.

27/9/2001

Successfully cored two more times with the NIOZ before trying the bed hop camera on the CTD wire, all worked well. The lander was recovered at 07:54Z. The mega corer was then deployed with four core tubes, no success. Two tubes were removed and the corer deployed again. A core was obtained from one of the core tubes. The mega corer was then deployed again with just two core tubes. No further success with the mega corer. Switched over to multi coring. Deployed the bed hop camera twice during the evening.

28/9/2001

Back to the multi coring, wind increasing all the time, first drop was successful, second one not so. At 03:00Z conditions had deteriorated, multi coring stopped. Agissez trawling has been cancelled. Just after breakfast, we left WTN and headed towards the mooring position at WT1. XBT's were deployed along the way. Conditions continued to deteriorate and it was decide to break off and run for shelter in the Minch. The forecast for the coming days is not very good.

29/9/2001

Into the Minch in the early hours. It was decided to continue down the Minch and start with the inner Ellett line stations.
En route to 1G we altered course slightly to survey the Muck Deep with the 3.5kHz sub-bottom profile system. Problem with the CTD winch at the start of the dip. The wire jumped off the rollers when the CTD was just below the surface. No serious damage to the wire, the wire and roller were reunited. When the whole system had been safely recovered, the CTD was examined. One strand had been damaged, some wire was cut and the tail was re-terminated. This delay cost nearly 4 hours. A very nice day, even warm in the sun, bit breezy.
Started along the Ellett line 1G (Discovery Stn #14178),2G (Discovery Stn #14179),4G (Discovery Stn #14180).

30/9/2001

Continued along the line, 6G (Discovery Stn #14181), just arrived at 7G as the wind was picking up ~02:30Z. Unable to hold station, in view of the forecast headed off to shelter East of

Muck. Conditions moderated by midday, headed back out to rejoin the line at 7G (Discovery Stn #14182).
Gales forecast, continued along the line, 9G (Discovery Stn #14183) managed 10G (Discovery Stn #14184) before seeking shelter again just before midnight.

1/10/2001

Hove to all night to the East of South Uist, winds blowing Force 7-9 through the day. Just after 12:00Z we started to head South towards the Barra Deep. Very slow progress, a 3.5kHz survey was performed on the way to examine potential coral sites. Conditions did not improve during the afternoon. No station work or trawling was possible and we returned to shelter through the night.

2/10/2001

A wild night, gusts exceeding 55 knots, and showing no sign of decreasing. Nothing to be done but wait for a break in the weather. Spent the day sheltering to the East of South Uist.
By early evening the wind had decreased slightly. We decided to head back down to Barra Heard to assess the conditions, wind has dropped, still a bit of a swell but worth a bash. Off we go, had to slow down a touch, rolling a bit as we went past Barra Head.

3/10/2001

Wind decreasing slowly, punchy our way through a heavy swell at 6 knots. Proceeded straight to station M. Fired some XBT’s on the way but conditions were not ideal. Arrived at M just after midday (Discovery Stn #14185), CTD first then we deployed the mooring. Conditions slowly improving. We then headed to station F, XBT’s again on the way. Arrived just before midnight (Discovery Stn #14186). Started with a CTD.

4/10/2001

Mooring deployment started at 03:00Z, perfect conditions, full moon, light breeze with a gentle swell. Mooring away by 04:27Z, tracked it acoustically to the bottom, all ok. We then steamed to WTS. No XBT's on the way. A nice day, wind began to pick up during the evening.

5/10/2001

Arrived at WTS just after midnight (Discovery Stn #14187). Deployed lander, all ok, wind picking up a bit. We deployed the CTD, slight problems with the secondary sensors, unit was recovered, problem solved and re-deployed. This dip is for Jane's radionuclide studies. CTD brought on board at 03:00Z, conditions have deteriorated. Some concern over snatch on CTD wire on recovery. Operations suspended for a while. Resumed in the morning, first two core drops produced no cores but things picked up through the day. A predominantly coring day.

6/10/2001

CTD inboard just after midnight, followed by the bed hop camera. Once again the elements intervened, strong winds, heavy swell, confused seas. Hove to until just after breakfast. Lander recovered. Conditions still marginal for station work so decided to head for WT1, XBT's deployed along the way. Arrived on station at 12:03Z (Discovery Stn #14188), CTD and plankton net deployed.

Mooring deployed by 15:11Z. Returned to WTS, XBT's on the way, still a large swell running. Arrived on station WTS at 18:00Z. Wind in excess of 35 knots and heavy swell. Hove too awaiting improvement in conditions.

19:00Z As I write this cruise report, news has just come in that Dave Ellett died last night. A very sad day indeed.

7/10/2001

Hove too through the night, no improvement in sea conditions, forecast not very good. WTS station abandoned, head for the Minch.

8/10/2001

Arrived on Mingulay coral site at 05:04Z (Discovery Stn #14189), deployed Agissez trawl. Trawl bent on recovery, weak link had broken. Trawl a success, some live coral. Deployed

bedhop at 08:47Z, having problems. Proceeded across the Minch in worsening conditions. Unable to do any work in the Muck Deep. We’ve also run out of time to test our NIOZ corer at the top of the Sound of Mull.
Met up with Calanus close to the lab. Transferred samples, some gear and some of the scientific party onto the Calanus.
Head to Govan.

9/10/2001

At least conditions had improved and it was a calm sail around into the Clyde. Docked in King George V dock at 08:00Z.

Scientific Summaries:-

1) OAERRE

Eric Fouilland, Ken Jones, Tim Brand, Ivan Ezzi

The aim of this study was to quantify the main biological and chemical parameters at three stations in the Clyde Sea in September 2001. These parameters will be generated for OAERRE ecosystem models. The response of primary productivity to the fluctuating light and nitrate enrichment has been studied as a specific objective at one station in the Clyde Sea (C1 Inchmarnock Waters).

Water samples were collected from selected depths within the upper water column at three stations (see Table 1,2,3).
Water samples were processed on ship as follows:

1- Samples for **dissolved oxygen concentrations**
2- Samples (two depths) incubated for **dissolved oxygen uptake rates**
3- Samples for **nutrients concentrations**
4- Samples preserved with glutaraldehyde for analysis of **pico- and nanoplankton abundance and biomass**
5- Samples preserved with Lugol's iodine for analysis of **microplankton abundance and biomass**
6- Samples filtered for **POC, PON concentrations**
7- Samples filtered for **chlorophyll concentrations** (GF/F Whatman filter, 0.2 ? m, 2 ? m and 20 ? m polycarbonate filters)

Waters from Inchmarnock waters (C1) was collected at the max of chlorophyll (15m) and incubated during 6 hours under 4 different treatments:

1/ simulated in situ light (3 % light attenuation)

2/ darkness

3/ alternated light (70%) / dark period every 1 hour

3/ alternated light (70%) / dark period every 1 hour and with an initial nitrate enrichment of 5 ? M

The parameters measured during this 6-hours experiment were (Table 4):

- Photosynthetic parameters (P-E curves)
- C14 uptake rates
- Dissolved oxygen concentrations
- Chlorophyll a concentrations

In order to differentiate the prokaryote and the eukaryote components to the plankton activity, we added specific prokaryote (Streptomycin) and eukaryote (Cycloheximide) inhibitors.

2) Lander Operations
Oli Peppe, Eric Breuer, Willie Thomson

Introduction

The objectives of the cruise required the lander to be deployed in both its moored mode (on leg 1) and in autonomous free fall mode (on leg 2). The work on leg one was primarily in support of the OAERRE project with the lander deployed at each of the three stations in the Clyde. Two deployments were made on leg 2 north and south of the Wyville Thomson ridge in support of theme B of the SAMS Northern Seas programme. In addition the cruise was to be used to train new personnel in the operation of the lander.

For all deployments the lander was used in its “Profilur” configuration, using micro-electrodes to obtain high resolution (~ 50µm) profiles of Oxygen, Sulphide and pH across the sediment-water interface.

A summary of the lander configuration and the deployment and recovery times and positions for each deployment is given in Table 1.

Pre-cruise preparation

The lander had recently been mobilised for a cruise in the North Sea for Shell, although in the end it was not deployed. This meant that little preparation was required for the instrumentation. However as the system had not been used autonomously since the Benbo cruises in 1998, much work was required to prepare and check out the buoyancy, ballast and release systems. A summary of the work and changes carried out is given below:

?? A second acoustic release (MORS RT661B2S type) was fitted to the buoyancy frame, with alterations made to the release wire system so that either release could be used for dropping ballast. Once tested this should remove the requirement for a burn-wire backup.

?? A new Argos beacon (SiS SMM6000) was fitted to the buoyancy frame.

?? Larger zinc anodes were bolted to the buoyancy frame and both instrumentation frames.

?? New certified lifting hardware and safety equipment was purchased.

?? New amplifier boards for the electrodes (from Unisense) were fitted to one computer, but found to be too noisy and so not used.

?? All buoyancy and recovery aids were serviced.

Leg 1 – Clyde

Deployment Plan

The aim was to deploy the lander three times during this leg in its non-autonomous mode. The deployments were to be made at three sampling stations (Inner Firth FC1, Arran Deep C1 and Sill S1). Data obtained from the lander could then be tied in with the core incubation work carried out by Martyn Harvey. The *Profilur* system would be fitted with Oxygen, pH and Sulphide.

Details of Deployments

Deployment 036_PRF – Leg 1, Station FC1, 21/09/01 – 22/09/01

The system was fitted with 3 oxygen electrodes (1354, 24, 1348), 2 sulphide (1040,1041) and 1 pH electrode (17). The electrodes were set up assuming that the sediment reached the bottom of the plates. The profilur moved down after a 1 half-hour wait period 110mm. After this initial step the profilur moved down at 0.25mm steps for 10 mm placing the electrodes hypothetically 1cm above the seabed. The profilur then moved down 0.05 mm steps for 30mm, and then 0.1mm for 25mm. The profiling protocol was designed to maximise the chances of not missing the sediment interface whilst ensuring sufficient logger memory, given the unknown of how far the lander would penetrate the sediment.

The lander was set-up for a 12 hour deployment in a mooring configuration. The leg height was set to the lowest possible position with 10 holes showing at the top. Deployed during calm conditions of the back deck using the double-barrelled winch in 58 meters of water. Set up a mooring line of 80 meters with three buoys and a flag. Weather conditions were calm and the deployment went smoothly. Recovery was also smooth with no problems.

One problem on recovery was that the water bottles did not fire. This was due to a break in the burn wire within the coil that went unnoticed.

Initial analysis of the data indicates that in fact the lander sank significantly above the leg plates. This is not surprising but the level it sank was. The first step (110mm) sunk the electrodes past the sediment water interface and the oxygen zone. No usable profiles obtained for flux calculations. Some worm burrow evidence plus oxygen consumption rates may be salvageable. No electrodes were broken, no change was seen in the pH signal throughout the profile.

Deployment 037_PRF – Leg 1, Station C1, 022/10/01 – 22/10/01

The electrode configuration and profiling protocol were the same as used in 036_PRF.

Again the lander sunk in to far and the first step of electrode missed the sediment water interface. Additionally miscalculated times meant recovery was done too soon with the result that the profilur was not finished with the program when recovered. On recovery the electrodes were sticking out the bottom. Fortunately not far enough as to cause breakage when set on deck. No electrode breakage occurred. Sulphide profiles obtained but without knowledge of sediment water interface they will be of minimal use.

Deployment and recovery went smoothly in nice weather conditions.

Deployment 038_PRF – Leg 1, Station s1, 023/10/01 – 24/10/01

The electrode configuration was the same as used in 036_PRF. The profilur control program was changed to: first step of an 80mm move down, then 10mm by .25mm steps, then 20mm by 0.05mm steps then 30mm by 0.1 mm steps and finally 40mm by 0.2 mm steps.

Deployment and recovery went smoothly in nice weather conditions.

Deployment was a success with oxygen profiles. No sulphide and the pH still does not work.

Leg 2 – Wyville Thomson Ridge

Deployment Plan

The aim was to deploy the lander twice during this leg in its autonomous mode. The deployments were to be made at the two main sampling stations, one north and one south of the Wyville Thomson ridge. The data obtained from the lander could then be tied in with the geochemical coring work. The *Profilur* system would be fitted with just Oxygen and pH electrodes, but no Sulphide.

Details of Deployments

Deployment 039_PRF – Leg 2, Station WTN, 26/09/01 – 27/09/01

The system was fitted with 5 oxygen electrodes and 1 pH electrode. Problems experienced in leg one with the pH electrode continued, with no good calibration signal, despite changing electrode and reference.

The leg height was set to the lowest possible in autonomous mode (to ensure the ballast buckets don't hang below the leg plates) with 9 holes showing at the top. The electrodes were set to start a coarse profile in 250µm steps at 45mm above the sediment. At 15mm above the sediment step size was changed to 50µm, then at 5mm below the sediment was increased to 100µm. A final change in step size was made 55mm below the sediment to 250µm steps, which were used to the maximum depth of 105mm below the sediment. (All heights relative to sediment assume sediment surface level with bottom of leg plates) The profiling protocol was designed to maximise the chances of not missing the sediment interface whilst ensuring sufficient logger memory, given the unknown of how far the lander would penetrate the sediment.

Initial analysis of the data indicates that in fact the lander sank significantly above the leg plates (by ~ 15mm). This is perhaps surprising given the sediment type which had a sandy surface layer which corers were finding difficult to penetrate. However three good oxygen profiles with close correlation were obtained, with the sediment interface neatly corresponding to the finest resolution profile steps. Unfortunately by the end of profiling all electrodes were broken, but thankfully after oxygen levels had reduced to a minimum. No change was seen in the pH signal throughout the profile.

Deployment and recovery were both smooth in good sea conditions. The only slight problem was a short pellet line – this should be around 10m in future. The new MORS release system was successfully tested and has the added benefit of providing a pinger for tracking the lander up and down (note at 12kHz not 10kHz), and also providing a tilt indicator to ensure the lander is upright on the bed. However problems were experienced with the original InterOcean release system during tests prior to deployment so this was disabled, and the burnwire was relied on for backup.

Deployment 040_PRF – Leg 2, Station WTS, 04/10/01 – 06/10/01

The electrode configuration and profiling protocol were the same as used in 039_PRF with minor alterations made to allow for softer sediment and different electrode lengths.

Five good oxygen profiles were obtained (a full set!) but unfortunately were almost entirely on the coarse 250µm steps at the beginning of the profiling. This indicates that the lander sank in around 40mm above the leg plates, slightly surprising given the consolidated clay nature seen in cores. However the lander was slightly heavier in the water and had a significantly faster descent rate than in 039_PRF. This problem just emphasises the need for some means of detecting the sediment interface in real time to determine where to start profiling.

The recovery was in very difficult conditions, but went remarkably smoothly. Weather conditions the previous day had in fact been better but recovery was put off as it was reckoned to get better. This just shows that if conditions are suitable then recovery should be at the earliest opportunity! The InterOcean release system was used to drop the ballast and worked OK (although there are still problems with responses from the transponder on the lander), so in future deployments a burn-wire backup shouldn't be necessary. The longer pellet float was an improvement, but needs to be easily removable from the pellet line on recovery so that the pellet line can be used as a third stray line.

Calibration Procedures

Oxygen

Oxygen calibrations were done pre/post leg 1 sites and pre/post WTN and WTS sites. The procedure placing electrodes in oxygenated seawater at the appropriate temperature for each site and recording the signal. Then sodium-dithionite was added to remove all oxygen and the signal was again recorded.

Sulphide

Using a sulphide buffer solution (pH 7) small increments of NaS were added and the resulting signal measured.
This procedure was carried out at the same temperature as the bottom water of the sites.

pH

Used pH buffer solutions for one calibration then used a calibrated pH meter to measure pH of bottom water measure signal then add acid to change the pH and measure again.

Table 1: Deployment summary

Deployment #	**036_PRF**	**037_PRF**	**038_PRF**	**039_PRF**	**040_PRF**
Site	FC1 (Holy Loch)	C1 (Arran Deep)	S2 (Sill)	WTN	WTS
D257 Event No. / Discovery Station #	10 / 14172#10	16 / 14173#3	24 / 14174#1	45 / 14178#6	111 / 14187#1
Configuration	Profilur, moored	Profilur, moored	Profilur, moored	Profilur, autonomous	Profilur, autonomous
Deployment date	21/09/01	22/09/01	23/09/01	26/09/01	04/10/01
Deployment time	1904Z	1135Z	0000Z	0826Z	2320Z
Deployment position	55º 58.94'N 04º 53.12'W	55º 48.774'N 05º 15.885'W	55º 14.929'N 05º 15.765'W	60º 15.829'N 06º 53.786'W	59º 43.13'N 07º 09.123'W
Deployment Water depth (m)	58	161	48	1187	1094
Recovery date	22/09/01	22/09/01	23/09/01	27/09/01	06/10/01
Recovery time	0630Z	1800Z	1000Z	0750Z	0800Z
Recovery position	as deployment	as deployment	as deployment	60º 15.684'N 06º 52.875'W	59º 43.07'N 07º 09.251'W
Time on bottom (hrs)	11	6	9	22.0	31.3
Weight on descent (kg)	n/a	n/a	n/a	49	
Weight on ascent (kg)	n/a	n/a	n/a	-87	-87
Descent speed (m/min)	n/a	n/a	n/a	59	65
Ascent speed (m/min)	n/a	n/a	n/a	59	61
Estimated max. penetration of electrodes, gels or chamber into sediment (mm)	55+ (missed sediment interface)	55+ (missed sediment interface)	55	120	140

Note: *Dep. time:* time system reset prior to deployment
Dep. pos.: position of ship when lander released, or mooring released
Rec. time: time lander completely in-board
Rec. pos.: position of ship when lander grappled or mooring picked up

3) Geochemistry
Tracy Shimmield

The main aim of the cruise with regards to geochemistry was to obtain sediment samples for a variety of analyses. These included radionuclide, lipid, chlorophyll, solid and pore water phase metal analysis, at a site north of the Wyville Thomson Ridge which is dominated by Norwegian waters for comparison to one from the southern side of the ridge, which is dominated by Atlantic water.

The radionuclide activites from sectioned down core sediment samples will provide sediment accumulation and mixing rates. The samples collected will be analysed for both ^{210}Pb and ^{234}Th isotopes. Triplicate samples were to be taken of the solid and pore water phases, one from each of three separate deployments of the corer, to assess the degree of sediment *patchiness* and assess the effect of such variation on any biogeochemical flux rates calculated. The results will then be combined with the lander *profilur* data to allow the investigation of biogeochemical fluxes at the contrasting sites. Ultimately this will be linked with the benthic data to calculate biodiffusion coefficients.

The sediment type found at the north station, WTN, was sandy with gravel lenses at a depth of approximately 10 cm. This made coring virtually impossible as the corers, both multi and mega could not penetrate the gravel layer. However it was obvious from several drops of the multi-corer that there was a large variation in sediment type. As a result a mega-core was finally recovered at this site and the required number of multi cores was obtained. Due to bad weather conditions there was no opportunity for triplicate sampling at this site.

Samples obtained: 1 mega-core and 4 multi-cores. The cores were sliced at intervals of 0.5cm until a depth of 5cm, 1 cm until 20 cm and 2 cm until the bottom of the core. The last sample in contact with the extruder was discarded.
Generally the sediment was sandy mud until approximately 2 cm at which depth it changed to coarse sand, this continued to a depth of 10 cm where the sediment was comprised of finer sand and mud. Finally at a depth of 15cm coarse sand and gravel were detected until the bottom of the core at 24 cm.

Numerous worm tubes were found with in the 0-0.5cm section but were absent until a depth of 2 cm where a large worm hole was identified.

Location: Latitude: 60° 15.4831   Longitude: 06° 15.4833

Station	**WTN water depth : 1187m temperature of bottom water : -0.7°C**			
Core type	Lipid/Chlorophyll	Radionuclides	Pore water metals/nutrients	Solid phase metals
mega			0 – 22 cm	0 – 24 cm
multi	0 – 17 cm	0 – 17 cm		
multi	0 – 22 cm (WTN MC1)	0 – 20 cm (WTN MC2)		

Due to worsening weather conditions the ship ran for shelter in the Minch. At this point the cruise continued along the Ellett line awaiting suitable weather conditions to allow the station south of the ridge to be sampled.

Samples obtained: 0 mega-core and 2 multi-cores. The cores were sliced as above.
The sediment at this site comprised of very compact fine sand with some silt/mud. Due to bad weather conditions the mega-corer was deployed twice and was unsuccessful in obtaining sediment. The multi-corer equipped with 4 tubes obtained sediment cores within 3 drops, however operations ceased due to worsening weather conditions. It was hoped that coring would resume next morning but conditions prevented any further coring at this site. As a result no pore water samples were obtained for nutrient or metal phase analysis. Two short multi-cores were obtained and will be used for metal, radionuclide and organic solid phase analysis.

Location: Latitude: 59° 42.56   Longitude: 07° 11.42

Station	**WTS water depth : 1075m temperature of bottom water : 7.5°C**			
Core type	Lipid/Chlorophyll	Radionuclides	Pore water metals/nutrients	Solid phase metals
mega				
multi	0 – 15 cm	0 – 15 cm		

4) Deep Sea Benthos

David Hughes, Lois Nickell, Peter Lamont & Murray Roberts

Benthic faunal samples and seabed photographs were taken at the two study sites north and south of the Wyville-Thomson Ridge. Our objectives were to quantify the abundance and biomass of benthic fauna at each site and to compare the biomass size spectra of the two communities. Boxcore excavation was carried out to compare the degree of bioturbation in the bottom sediments. At both sites sampling intensity was limited by bad weather, and the poor performance of the megacorer also prevented the intended use of this device as the main sampler for macrofauna.

Wyville-Thomson North

A single core from each of three multicore drops was sliced at 1 cm intervals to 5 cm depth and fixed in 4% formaldehyde for meiofaunal analysis. It was originally intended that the megacorer would provide samples for macrofauna but intact cores were not recovered. Instead, six multicores (two cores from each of three corer drops) used for oxygen and nutrient incubations were subsequently sliced at 0-5 cm and 5-10 cm and and fixed to provide samples for macrofaunal analysis. An additional three multicores from the same corer drop used for geochemistry work were subsequently sliced and combined to provide additional macrofaunal data. Macrofaunal density data from a hydraulically-damped corer will therefore be available, although the total sample is smaller than would have been obtained from the megacorer.

The NIOZ box core was deployed four times and provided three good cores with undisturbed sediment-water interface. The fourth was partially washed-out as a result of a large stone catching in the spade. Overlying water was drained from the intact cores and the sediment surface was photographed. Surface fauna were picked off and fixed. The front panel of each box was then removed to expose the vertical face of the core, and the sediment carefully cut back with a trowel to look for evidence of sub-surface biogenic structures. A vertical section was cut from each intact core and cold-stored for later X-ray analysis of relict burrows.

The boxcore surfaces showed no large burrow openings but were covered with small-scale biogenic material including sponge debris and polychaete tubes. Small brittlestars, pycnogonids and amphipods were abundant. A stalked sponge was present on one core. The sediment consisted of muddy sand with fine gravel down to approximately 20-30 cm, overlying a much finer mud containing dry, hard packed mud clods. Around the 15-20 cm horizon, a layer of larger pebbles was found amongst the sand. There was virtually no visible evidence of burrows or other biogenic structures below the surface, suggesting a low intensity of bioturbation at this site. The coarse-grained sediment made it impractical to sieve the contents of a boxcore on fine mesh (250 or 500 µm), instead the uppermost 10 cm of sediment from each core was retained and sieved though 2 mm mesh Retained animals were picked off the sieve and preserved to quantify the larger macrofauna. Preliminary examination of X-radiographs showed no evidence of sub-surface biogenic structures.

Sea bed photographs were taken using the POL bed-hop camera. Three drops were completed using monochrome print film and one using colour transparency film (25 exposures per film). Films have now been developed and all deployments confirmed as successful. Detailed analysis has still to be undertaken, but preliminary examination indicates a high density of stalked sponges and brittlestars.

Wyville-Thomson South

Three multicores, each from a separate drop, were processed for meiofaunal analysis. An additional two cores from each of these drops were used for oxygen and nutrient incubations and these were subsequently sliced at 0-5 cm and 5-10 cm and fixed for macrofauna.

The NIOZ box core was deployed three times. The first deployment failed due to the winch wire tangling around the corer, preventing spade closure. Two further deployments provided good cores, although both showed some surface disturbance. The cores were photographed, picked and excavated as described for the northern site. Small brittlestars were the most common animals visible at the sediment surface. Both cores also had one or two small xenophyophores (2-3 cm diameter) on their surface. These fragile giant protists are seldom collected and care was taken to preserve them intact. There were no large burrow openings in either core.

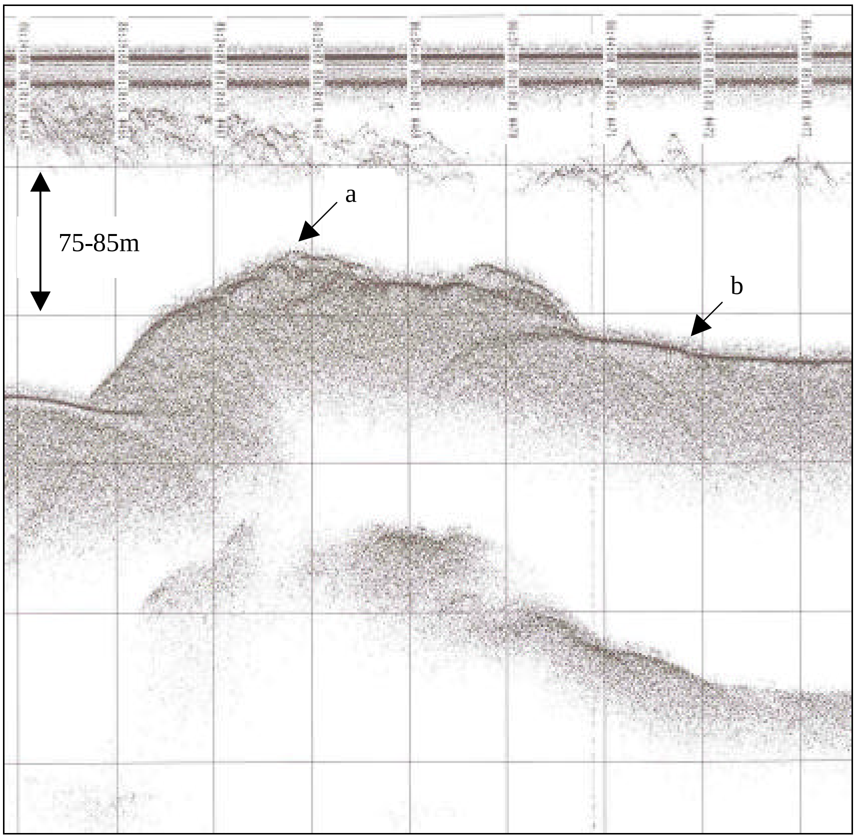
The sediment at Wyville-Thomson South was much finer than at the northern site, consisting of a stiff, greyish clay largely devoid of stones. Small burrows and long polychaete tubes were present in the upper 10 cm layer. One large worm (approx. 7 cm long), provisionally identified as a sipunculan, was found in a horizontal burrow just below the surface of one boxcore. The same core also contained a pennatulid. Vertical sections for X-ray analysis cut from each core show some possible biogenic structures. The uppermost 5 cm of each boxcore was fixed and later seived through 250 and 500 ?m meshes. The deeper sediment was passsed through a 2 mm sieve to recover any larger macrofauna.

Only one drop of the bed-hop camera was completed because of weather constraints. The deployment, using monochrome film, was successful. Preliminary examination of the negatives shows a more irregular seabed than seen at the northern site, including possible biogenic mounds. Probable cerianthid anemones are the most conspicuous fauna. One image clearly shows a linear trawl scar.

Agassiz trawling

Planned Agassiz trawls at the Wyville-Thomson Ridge sites, which would have provided ground- truth data for interpretation of bed-hop camera images, had to be abandoned because of time and weather constraints. However, on the return leg of the cruise the opportunity was taken to tow the trawl at a site to the east of Mingulay, Outer Hebrides, where the cold-water coral *Lophelia pertusa* had been observed on submersible dives in the 1970s. An echo-sounder survey of the site made while sheltering from bad weather earlier in the cruise gave indications of ridges and other topographic features that were considered potential coral habitat. After towing for approximately one hour the trawl was recovered showing severe damage from collision with a seabed obstacle. The net contained large amounts of dead *L. pertusa* rubble and one fragment of living coral, along with sponges, crinoids and other fauna. The living coral was returned to the DML aquarium and the remainder of the catch preserved for later analysis. The 3.5 kHz record shows an irregular acoustic return from the surface of the seabed high east of Mingulay compatible with the coral rubble that was sampled (Figure 1). This and the live *L. pertusa* recovered implies that viable cold-water coral reefs may be present off Mingulay.

Figure 1
3.5kHz echosounder output across ridge feature east of Mingulay. The highest point on this feature rises between 50 and 75 above the surrounding seabed. The water depth immediately before the ridge was 225m and immediately after was 180m.
a. Acoustically chaotic surface suggesting an irregular seabed with some acoustic penetration.
b. Acoustically hard, strongly reflective surface suggesting a regular seabed.



Achievements

Although less sampling was carried out than originally intended, information on all three major size fractions of the benthos (meio-, macro- and megafauna) was obtained, which will allow comparison of the two sites. Densities of megafauna will be quantified from the seabed photos. Data on density, biomass and taxonomic composition of meio- and macrofauna will be available from the core samples. A comparison of the northern and southern sites will be possible in terms of broad-scale size composition (ie. meio-, macro-, megafauna), but the relatively small sample sizes may not justify calculation of a more detailed size spectrum. Information on bioturbation intensity will be used to help interpret the geochemical data from each site. Confirmation of the continued presence of living *Lophelia pertusa* near Mingulay was a useful added bonus of the cruise and could be followed up by a more detailed survey using the RV *Calanus* operating from DML.

5) Phytoplankton
Johanna Fehling

Participation in the cruise Has allowed investigation of the abundance and distribution of protistplankton, in coastal Scottish waters, the Scottish shelf and the open ocean along the ElletT Line. Within the protistplankton community particular focus was placed on the diatom genus *Pseudo-nitzschia*.

Some *Pseudo-nitzschia* species (e.g. *P. australis, P. multiseries* and *P. seriata*) are known to produce the neurotoxin domoic acid which causes Amnesic Shellfish Poisoning (ASP). Although these diatoms are known to form blooms in Scottish coastal waters during the summer and early autumn leading to closure of scallop fishing grounds, the distribution pattern of *Pseudo-nitzschia* is not yet known. We therefore sought to determine the distribution of *Pseudo-nitzschia* spp. on the continental shelf and in the open ocean as well as coastal waters at this time of the year (late September/ early October). Furthermore the vertical distribution of *Pseudo-nitzschia* and the co-occurrence with other phytoplankton was to be investigated.

Water samples for cell counts were collected from at least 6 depths (in the mixed layer, deep water and bottom water) using water bottles from the CTD. Surface water samples (0-10m) were taken for identification, isolation and culturing of phytoplankton using 20 µm hand plankton net. Complementary information in the form of nutrient analyses, CTD profiles of temperature, salinity, oxygen and fluorescence was collected to give information of the water column properties at each sampling site.

The coastal Ellet Line stations 1G, 2G, 4G, 6G, 7G, G9, 10G and the open ocean stations M and F were sampled. Further samples were taken at the Wyville-Thomson-Ridge (stations WTS and WT1).

Diatoms of the genus *Pseudo-nitzschia* were found at each station and were isolated and cultured. Preliminary results from net samples showed that plankton from coastal sites (Ellet Line 1G to 10G) differed from plankton at the open ocean sites (M, F, WTS and WT1). The plankton community and its composition was similar within the four open ocean stations and within the coastal stations. *Pseudo-nitzschia* spp. from the open ocean did not represent toxic species, whereas first attempts of identification (by light microscope) indicated that *Pseudo-nitzschia* spp. from the coastal stations included toxic species. Further identification using genetic methods and electron microscopy will be conducted in the laboratory.

Phytoplankton from all stations and depth will be identified and counted to determine horizontal and vertical distribution and abundance patterns at coastal and open ocean sites. Together with CTD and nutrient data those results will provide more information about the ecology of *Pseudo-nitzschia*.

6) Multicorer

Martyn Harvey

OAERRE (Clyde)

The DML multicorer was used at 3 stations to obtain sediment cores.
FC1 – difficulty obtaining cores due to the shallow depth and soft sediment. After several failed deployments a 100kg lead weight was attached to the wire 10-12 metres above the corer and three successful deployments were then obtained. The weight was attached during all subsequent deployments in the Clyde.
Two cores from each deployment (ie six in total) were used to measure sediment oxygen and nutrient fluxes.
C1 – 3 successful deployments of the multicorer were carried out. Cores were used as above.

S2 – Despite several attempts no cores were obtained. Due to the rapid drift of the ship when the corer reached the seabed the wire could not be paid out rapidly enough to prevent its being dragged sideways.

Theme B (Wyville-Thomson Ridge)
Cores were obtained from two stations, WTN and WTS. At each station 6 cores were used as above, 3 (one from each deployment) were sliced for geochemical analyses and 3 for meiofaunal analysis.
Additional cores were obtained at WTN for geochemical analyses.

The deployments of the multicorer are summarized below:

Number	Station	Date	Time (Z)	Lat. (N)	Long. (W)	Depth	No. cores
MC1	FC1	21/9/01	1610	55 58.765	04 55.103	62	0
MC2	FC1	21/9/01	1630	55 58.720	04 53.110	60	0
MC3	FC1	21/9/01	1705	55 58.720	04 53.110	60	4
MC4	FC1	21/9/01	1740	55 58.720	04 53.061	60	0
MC5	FC1	21/9/01	1758	55 58.647	04 53.080	60	0
MC6	FC1	21/9/01	1828	55 58.754	04 53.074	59	0
MC7	FC1	21/9/01	1946	55 58.710	04 53.110	47	4
MC8	FC1	21/9/01	2026	55 58.474	04 53.084	57	4
MC9	C1	22/9/01	1647	55 48.445	05 15.616	161	4
MC10	C1	22/9/01	1832	55 48.258	05 15.492	161	0
MC11	C1	22/9/01	1856	55 48.154	05 15.364	162	4
MC12	C1	22/9/01	1929	55 48.110	05 15.426	161	4
MC13	S2	23/9/01	1004	55 15.361	05 14.745	48	0
MC14	S2	23/9/01	1055	55 15.940	05 14.098	48	0
MC15	S2	23/9/01	1150	55 14.910	05 15.99	48	0
MC16	WTN	26/9/01	0513	60 16.031	06 56.049	1187	4 short
MC17	WTN	26/9/01	0621	60 15.555	06 56.195	1188	4
MC18	WTN	26/9/01	0738	60 15.46	06 55.350	1156	4
MC19	WTN	26/9/01	1000	6 015.884	06 56.480	1188	4
MC20	WTN	27/9/01	1444	60 15.826	06 54.836	1186	2 disturbed
MC21	WTN	27/9/01	1555	60 15.831	06 54.833	1187	3 + 2 small
MC22	WTN	28/9/01	0000	60 15.966	06 55.298	1187	5
MC23	WTN	28/9/01	0151	60 15.950	06 54.650	NR	0
MC24	WTS	5/10/01	1929	59 42.56	07 11.42	1075	4
MC25	WTS	5/10/01	2053	59 42.55	07 12.07	1078	4
MC26	WTS	5/10/01	2156	59 43.14	07 12.09	1080	4

Bedhop camera

WTN 4 successful deployments (3 black and white, 1 colour)
WTS 1 successful deployment (black and white)
Ridge East of Mingulay (trawling site) 1 deployment (colour) – aborted early due to confusing pinger returns.

The Bedhop camera deployments are summarized below:

Number	Station	Date	Start Time (Z)	Lat. (N)	Long. (W)	Depth	Film	
BH1	WTN	26/9/01	1128	60 15.987	06 55.951	1187	b/w	ok
BH2	WTN	26/9/01	2217	60 16.743	06 54.687	1180	b/w	ok
BH3	WTN	27/9/01	0401	60 15.531	06 55.594	1187	b/w	ok
BH4	WTN	27/9/01	1700	60 15.491	06 55.055	1187		-
BH5	WTN	27/9/01	1937	60 15.597	06 55.314	1187	col	ok
BH6	WTS	6/10/01	0113	59 43.061	07 10.092	1090	b/w	ok
BH7	WTS	6/10/01	0320	59 43.210	07 09.511	1088		-
BH8	Mingulay	8/10/01	0847	56 46.624	07 25.621	218	col	?

Both the bedhop camera and multicorer had operational problems due to incompatibility with the ship’s winch system. The lightness of the equipment and/or the shallow depths encountered meant that the weight of the equipment plus wire paid out was on a number of occasions insufficient for the winch to operate correctly. The attachment of the lead weight to the wire helped to a certain extent but problems were still encountered, particularly with the bedhop camera.

7) Nutrients

Ivan Ezzi

The following table summarises sampling for oxygen, chlorophyll and inorganic nutrients from the CTD water bottles. Oxygen was taken for either a full profile in its own right or as calibration samples for the CTD oxygen electrode. Samples were fixed at once for later measurement on board.
Similarly samples taken for chlorophyll would be used as profile data or as calibration for the CTD fluorimeter. Samples were filtered and frozen for later analysis at the Laboratory. Chlorophyll samples were also taken at regular intervals from the ships non-toxic water supply for calibration of the non-toxic fluorimeter.
Nutrient samples were taken in triplicate from all depths and analysed immediately on board. Nutrient analysis was also carried out on core incubation and core pore water samples

DATE	STATION	DIP	OXYGEN	NUTRIENTS	CHLOROPHYLL
21/9/01	FC1	001	+	+	+
22/9/01	C1	003	+	+	+
22/9/01	C1	004	+	+	+
23/9/01	S2	006	+	+	+
25/9/01	WT3	008			+

25/9/01	WT2	009			+
26/9/01	WTN	013	+	+	+
29/9/01	1G	014		+	+
29/9/01	2G	015		+	
29/9/01	4G	016		+	+
29/9/01	6G	017		+	
29/9/01	7G	018		+	+
30/9/01	9G	019	+	+	+
30/9/01	10G	020		+	
3/10/01	M	021	+	+	+
4/10/01	F	022		+	+
5/10/01	WTS	025	+	+	+
6/10/01	WT1	026		+	+

8) Water Radiogeochemistry
Jane Foster

Objectives

To sample vertical profiles of particulate (> 0.45? m) and dissolved (< 0.45? m) matter at Wyville Thomson Ridge stations WTN and WTS and to carry out radiogeochemical measurements of the particle-reactive natural radionuclides ^{210}Po and ^{210}Pb on these fractions. Their activity will be measured in the laboratory to quantify particle residence times in the water column. POC analysis will be performed on particulate samples taken from the same depths so that a particulate flux of organic carbon to the sediment is determined at each station. From this we can assess whether the flux of carbon at the two stations varies. These results will be related to the ^{210}Pb profiles and organic carbon content of sediment cores at each of the 2 sites.

Methodology

^{210}Po and ^{210}Pb analysis

Approximately twenty litre samples of seawater were collected from 10l Niskin bottles attached to the CTD rosette by firing two bottles at each of eleven depths (Table 1) at both the north and south Wyville Thomson ridge stations, WTN and WTS. These seawater samples were filtered through a 0.45? m Asypor filter to remove particulate material. After acidification with HCl, addition of a ^{208}Po spike and allowing around 24 hours for equilibration, the dissolved material (<0.45? m) was precipitated via APDC and cobalt (II) nitrate and collected on a 3? m Asypor filter.

In the laboratory these filters will be digested in a mixture of hydrofluoric and nitric acids and the ^{210}Po and yield tracer, ^{208}Po, plated onto silver discs and counted on an Ortec™ alpha spectrometer. The samples will be left for a period of 8 months to allow in-growth of ^{210}Pb.

POC analysis

Approximately 250ml samples were collected from the same depths as the for the radionuclide analysis and filtered through 13mm GF/F filters and the filters frozen. The POC will be measured be using the CHN analyser.

Table 1
Stations and water depths sampled for ^{210}Po, ^{210}Pb and POC analysis

WTN	**WTS**
Depth (m)	
5	5
100	100
200	200
300	300
400	400
500	500
600	600
700	700
850	850
1000	1000
1100	1090

9) Vessel-mounted Acoustic Doppler Current Profiler
Finlo Cottier, Mark Inall & Damian Likely

Two hull-mounted ADCP units were available on D257. An older 300kHz unit controlled by DAS software and a newer 150kHz unit controlled by VM-DAS. For the three days in the Clyde Sea, the units were operated intermittently whilst operational and data logging routines were developed and tested. On departure for leg 2, the two units were run near continuously and raw data were downloaded at regular intervals from the onboard level C system.

The 300kHz unit was set to run in water track mode as the majority of leg2 would be beyond bottom track range (~350m). The instrument setup had 54 bins each of 8m depth with data measured along 2-minute ensembles. Heading data for the ADCP was through a hardwired Gyro compass input and time stamps for the data came via the ship's GPS system. In addition to the ADCP data, navigation data was logged continuously from the gyro compass, Ashtech DGPS and a suite of navigational sensors from which a parameter, BESTNAV, was derived.

Processing of the ADCP data requires removing the ship's velocity from the measured water velocity and converting the resultant into an earth reference frame. Given that ship velocity and current velocity differ typically by an order of magnitude, this is not a trivial matter. To date, a suite of Matlab routines have been developed by SAMS Marine Physics to accomplish processing of the 300kHz data. The details of this have been published in SAMS Marine Tech/Marine Physics Internal Report #161. In general, the broad magnitude and direction of the currents can be determined but these are subject to significant contamination by the ship's velocity.

10) Equipment report D257
Dave Teare

Simrad EA500

The echo sounder was run continuously throughout the cruise on both the hull and fish transducers. The were no reported faults. On retrieval it was found that a whole section of the fairing had been lost. There were also a small number of cracked fairing clips.

I.O.S. 3.5Khz sub-bottom profiler.

The profiler was run for most of the cruise without any obvious faults. The lack of operating instructions for the 'new' recorder interface made initial setting guess work. Output was to a continuous paper trace.

Surfmet

The standard suite of instruments were logged for the whole cruise without problem. A number of salinity samples were taken to provide quality check and salinity offset correction. These will be processed back at SOC.

Seabird CTD

A twin SBE 9/11+ (Ser No 0528, Pylon 0345) was used throughout the cruise. The system carried an altimeter (874), Fluorometer (88241, 88242 from cast 10), PAR DWIRR (8), PAR UWIRR (12), LBSS (346) & Trans (161047). A total of 26 cast were performed during the cruise. The system had or developed the following faults. Bottle 7 was inoperative for the whole cruise, this was a known problem before the cruise. The fluorometer became 'noisey' on cast 9 and the spare unit fitted for cast 10 onwards. There were a couple of casts, later in the cruise, where short periods of noise were present. Towards the end of the cruise the transmissometer became noisey on the down casts. This noise was not present on the upcast. No action was taken.
The difference between the primary and secondary salinity (0.005) requires investigation. A number of salinity were taken these will be processed back at SOC. Post processing was performed using the standard suite of SBE software Version 4.244.

Autosal

The 8400A unit was not used, this was because the zero offset was a little high and the unit appeared to be only just within its specification. Due to the rather high difference between the two salinity signals, it was decided to process the CTD salinity back at SOC where a spec. 8400B unit is available.

Expendable Bathythermographs (XBT’s)

XBT’s were supplied by the Hydrographic Office, Taunton. The data from launched XBT’s were collected on the SEAS Mark 12 XBT deck unit. The data were stored in the SEAS format and periodically copied from the system via a 3.5” floppy disk drive. Since returning from the cruise, copies of the data have been sent to The Hydrographic Office, Taunton.

Data logging systems

All systems worked well thoughout the cruise, ASCII dumps of all channels were provided at the end of the cruise on CD. A copy has been sent to Lesley Rickards at BODC (along with a ROSCOP form). A data base is being built at SAMS of all the cruise data by Steve Gontarek.

11) Moorings
Ian Waddington and John Wynar

WT2 and WT3 Deployment

Moorings WT2 and WT3 are constructed very similarly and as such are deployed in the same manner. Deployment is buoy first anchor free fall last.

All the mooring hardware and instrumentation is pre-assembled ready for deployment. Mooring line is wound onto the Double Barrel Capstan winch under tension and with all sections having links were applicable.
The upper 40inch steel buoy is filly rigged on the aft deck with recovery line and buoy, chain ,swivel and S4 current meter all being connected to the mooring line.
As the ship commences deployment run the 40 inch assembly with S4 is lifted outboard using mooring line and crane block. The 40 inch is lowered into water and deployed some 20 to 30m from the ship.

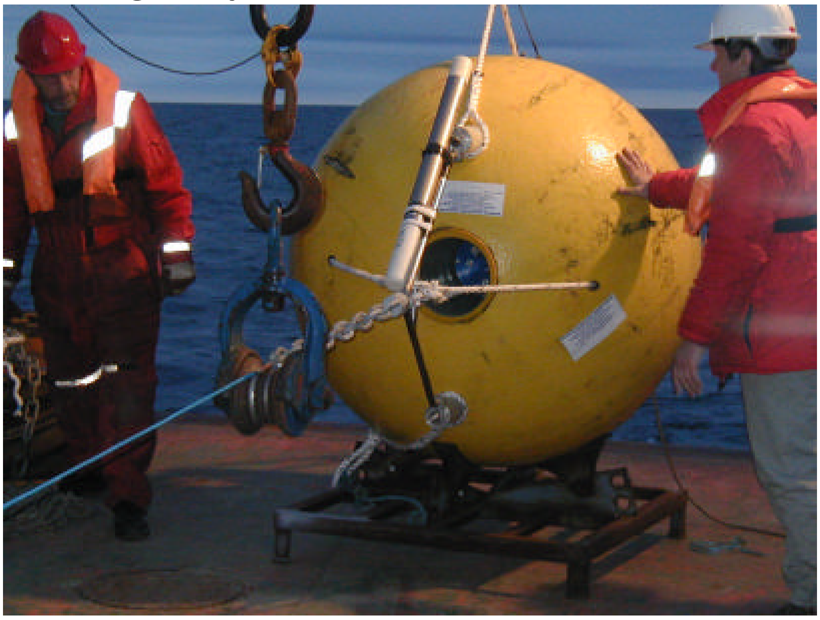
Clip on fairing in 1metre sections is then attached and slid down towards the 40 inch sphere. As the fairing progresses filling the line the line is slowly paid out and fairing stoppers attached around ea.20 to 30m. Minilogs are attached with cable ties and pvc tape ea. 100m. Note the long wire lengths were pre-marked for the minilogs when mooring wound onto dbc.

As the line is deployed along the unfaired section the Syntactic ADCP buoy is positioned near to the stern on its pallet.

At the point of insertion the inboard or lower attachment of the buoy is stopped and as the upper attachment is reached the top of the buoy can then be shackled into the link. Paying out the line transfers the load through the buoy to the stopper . The mooring line can then be disconnected and reattached into the swivel chain assembly beneath the buoy .By heaving on the line the mooring tension is transferred through the mooring line allowing the stopper to be removed.

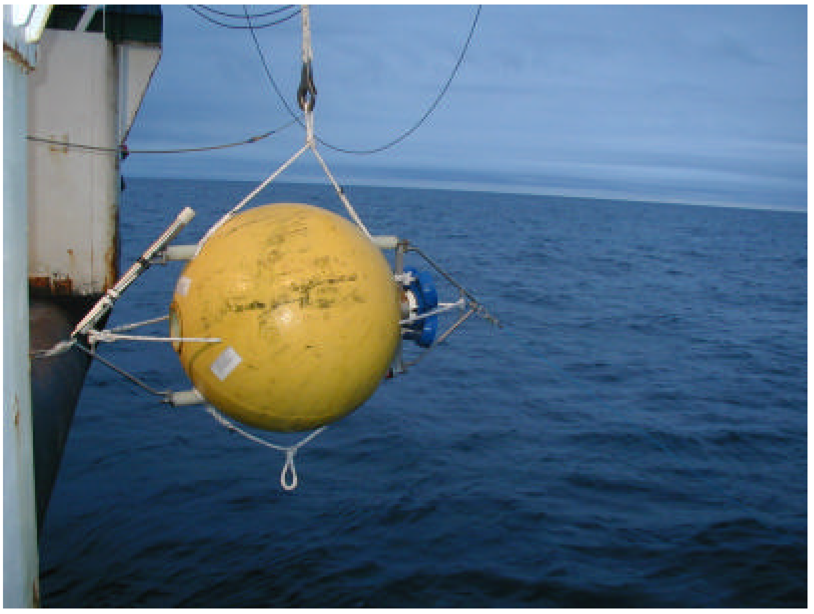
Preparing to insert the ADCP LongRanger Buoy , note the buoy is already stopped off to the deck chain and the outgoing mooring line is being positioned for attachment of the buoy to the mooring line.

TOW release hook is already attached to buoy lifting strop , line tension transferred through buoy frame to winch.



The crane can then be hooked onto the buoy lifting strop using a TOW release hook.

By controlling both cranes and winch the buoy is then lifted overside and lowered to sea surface where the TOW hook is released.



Lowering away on the TOW hook using starboard crane. Note outboard mooring line tension streaming the mooring wire clear of the buoy.

The mooring line is then paid out to the Recording current meter which is inserted into the line using conventional stopping off procedures

Stopping off to insert Aanderaa Current meter using deck stopper chain. Note the widethroat sheave attached to the crane in the foreground. This in the lowered position for stopping off.

At the attachment of the Acoustic release the release link is pre-connected to the anchor riser chain such that the mooring is stopped off conventionally and then the load transferred by an additional polypropylene release line . This must not be long enough to foul the release mechanism.

Mooring line stopped off to deck chain , inserting acoustic release, note the anchor riser chain connected to the release link.

As the load is taken by the polypropylene line the Acoustic Release is disconnected from the stopper and the polypropylene line paid away such that the release is overside.
With the release overside the polypropylene line is cut away allowing Acoustic release to take line load.

Acoustic release overside , anchor held to ship by restraining line , cut off / lift line on deck ready for connection to crane.

The railway wheels then see the tension from the mooring and as the ship approaches the drop site the wheels are lifted overside on a cut off rope. When on position the cut off line is severed and the anchor freefalls to the seabed

The ship is then hove to and the Acoustic Release is checked by transmitting ON,OFF and Diagnostic commands to check mooring is on seabed and upright.

Moorings F & M

Design and Construction

Moorings F & M are redeployments of a previous mooring series.
In discussion with Colin Griffiths ,DML , a mooring scheme was agreed for a 2 year deployment period and a check made on the previous design outlines. This check was made by inputting the previous designs to the BUOY 2.42 mooring program and running a current profile provided by Colin Griffiths. This rerun showed inadequate top buoyancy which caused the mooring to have significant knockdown. A simple improvement was implemented by increasing the top buoyancy , this from 40 inch dia. to 48 inch dia.
Mooring outlines were drawn up and agreed by DML , procurement and allocation then being commenced.
The moorings now follow conventional OED design with back up / support buoyancy being included in the form of glass sphere packages.Design is

based around the long term GDD/JRD/RVS deployments obtained through the 1990s period.
All mooring components are as standard long term moorings and proven in the field by the former GDD Survey Team at SOC , now incorporated into OED UKORS.
To satisfy the H&S requirements all items are certified either in house at SOC or on supply from manufacturers , all copies of these documents being available onboard Discovery. A Risk Assessment is placed with the documentation based on the generic risk assessment from OED .

Buoyancy

The top buoyancy is steel spherical as standard 48 inch diameter OED UKORS, each buoy having welded on ARGOS mountings.

Back up / support buoyancy comprises Benthos Glass spheres shackled to chains in packages of 6 spheres.

48 inch steel sphere fitted with OED ARGOS beacon

Mooring wire

The mooring wire is 6mm dia. 7x19 Galv.Blue.Poly.to an outside diameter of 8mm. A standard OED mooring product . Each end being terminated in a closed swage steel socket with sealant and bend restricting boot.

All wires supplied on reels or coils fully finished from the wire manufacturer.

Each wire length having full certification and specification. Accuracy

of length at better than 0.25%.
Mooring wire wound on to Storage winch

Mooring Hardware

The mooring hardware comprises commercially supplied shackles,links and chain with specialist OED products such as swivels.
All the items are specified by SOC and supplied with test certification . Specialised handling and lift lines being constructed and tested by OED.

Anchoring

The anchors are constructed as deadweight anchors and are formed using railway wheels chained together. There are several through wheel chains each binding the wheels together to ensure survival of the assembly for the 2 year period.

Deployment

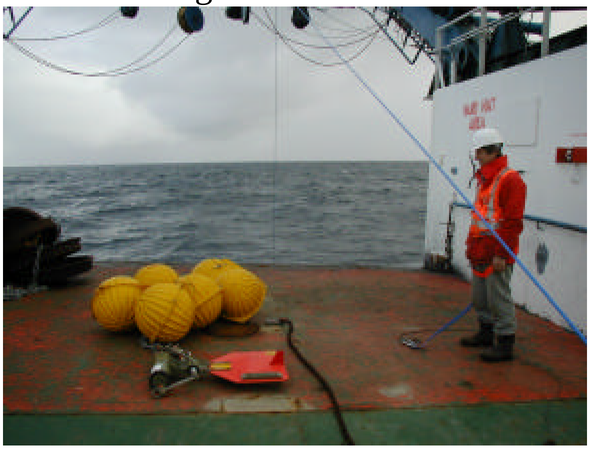
The moorings are deployed buoy first from the aft deck of Discovery. As these moorings use relatively long lengths of coated mooring wire the OED DBC winch system is used to pay out the mooring wire. The wire being first wound onto a large storage drum through the DBC winch, this then tensions the mooring line onto the storage drum .
On deployment the two ships aft cranes are utilised to provide a movable sheave,port crane, for payout and as a lifting crane,starbd crane, for heavy deployments such as steel sphere and anchor.This method adopted onboard Discovery provides a very user friendly system when combined with the OED DBC.

Machinery in readiness to deploy 48 inch steel sphere . Note use of both starboard and port cranes

Double Barrel Capstan Winch

Mooring commences with deployment over the stern of the 48 inch steel sphere and current meter using ships starboard crane and TOW release hook. As the ship makes way at 1.5kts the mooring line can then be payed out to the next RCM.

At each instrument connection the mooring line is stopped off into a reevable link using a deck mounted chain and BOSS hook. This permits disconnection of the mooring line and insertion of the instrument.

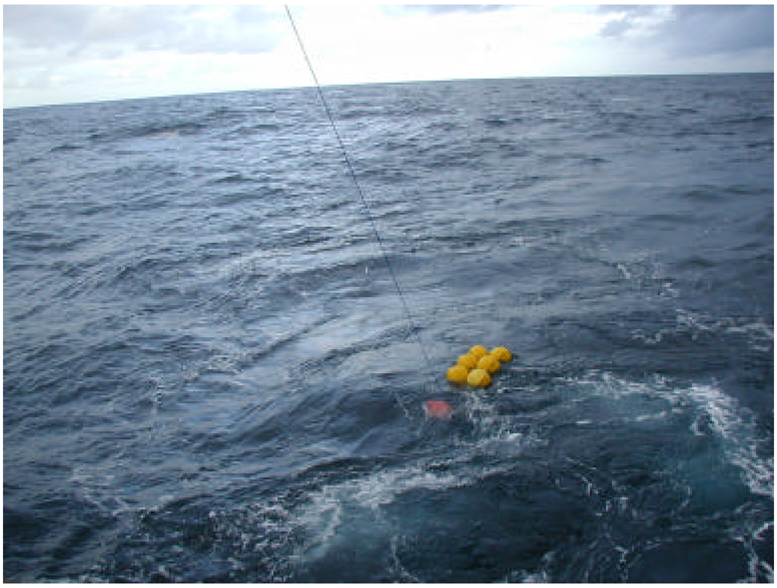


Glass spheres and current meter prepared on deck , note deck stopper chain

To lift the instrument overside the sheave can be maneuvered using the port crane and by a combination of control of the DBC and Crane the instrument can be lifted safely outboard and paid away into the water.
This procedure is repeated at each instrument/buoyancy package.

Deploying sphere package and recording current meter using sheave on crane and DBC

Deployment of short lengths of wire is achieved by pulling these onto the winch as required , thus reducing shackles and links on the storage winch.



Paying away spheres and current meter the tension in the mooring wire can be seen as the
mooring streams away from the ship underway at 1.5 kts

To deploy the anchor and release , in this instance a rope tail on the winch is paid out such that the release can be lifted overside and the winch rope then cut away such that the release is deployed. The anchor chain then taking the towed mooring load.

The anchor is then lifted overside on a 3 tonne polyprop cut off strop using the starboard crane .
With the mooring on position this cut off strop is cut away and the anchor freefalls to the seabed.

The ship then immediately heaves to.

The mooring is monitored during descent using the TT300 deck unit interrogating the descending MORS release. As the slant range stabilises at the expected value interrogation of the mooring's verticality is made using the Diagnostic command. Finally the MORS unit is turned off using the OFF command.

Moorings WT1 , WT2 , WT3

Design and Construction

The mooring outline was agreed between DML and UKORS and a system produced to enable on site instrument depth adjustment and recovery by the Scotia . Duration was defined as up to 3 weeks , however for practical purposes and contingency the moorings have a design life minimum of 6 months.
The moorings evolved as two stage buoyancy designs with the upper subsurface buoyancy supporting a single InterOcean Current Meter and Mini Logs. This upper mooring section requires low drag materials to minimise mooring drag and as such the wire chosen was 4mm dia. steel wire coated to 6mm dia with polypropylene. The upper section drag was further reduced with the addition of 200m of Endeco clip on fairing sections.
The second or lower section of the mooring comprises a 49 inch diameter CRP Syntactic buoy , this buoy remachined to accommodate ADCPs and fitted with a newly designed in line mooring framework. The wire beneath this buoy was 6mm dia. steel wire coated to 8mm dia. with polypropylene . This wire having more drag than the upper section was a necessary requirement to meet the line tensions.
This section supporting an in-buoy ADCP , ARGOS beacon , RCM current meter and Acoustic release.
Anchoring by railway wheels chained together to form a suitable anchor weight.

All the mooring layouts were run on Buoy 2.42 mooring program to establish performance of the mooring , knockdown , in line tensions and anchoring requirements. Static conditions were also checked to eastablish correct hold up and anchor hold down using the spreadsheet Design1.1.

Moorings WT2 & WT3

From the first design this mooring was then modified to move the ADCP from 500m depth to 800m depth. As all three moorings were to be modified it was possible to exchange wires lengths between the moorings and from spare wires brought for adjustment.

As this depth move increased wire weight above the buoy it could be seen that on recovery the ARGOS beacon would have to be mounted on the underside of the buoy on deployment. As the buoy surfaces the buoy inverts and the ARGOS beacon is then exposed above the sea surface. On deployment this could be seen that as the tension in the mooring lines decreased , the buoys natural tendency was to invert.

Syntactic Buoy fitted with Through Load framework. Instrument mounted is a Long Ranger ADCP.

To manouver these buoys around the ship a custom made steel pallet is used which can be moved using a conventional fork truck. Care must be exercised when moving these heavy items as if the ship is rolling the truck and sphere need careful control.

Buoyancy.

The top subsurface floatation consists of a steel 40 inch diameter buoy with recovery line and Nokalon 11 inch recovery float.
The ADCP buoyancy is a modified WOCE syntactic sphere , machined out to accommodate ADCPs and fitted with an in line stainless steel mooring frame .

Fitting of the Long Ranger ADCPs onboard Discovery was achieved using the mobile gantry crane in the hangar space. This mechanical lifting is essential when handling these instruments which require careful and yet heavy lifts on a moving platform such as a ship.

For future deployments, handling of these LongRanger ADCPs will require adequate planning as to how they are to be safely handled and fitted into buoys.

Rhys Roberts controlling the insertion of the LongRanger ADCP into the Syntactic buoy.Note removal of in line frame is required.

Mooring Wire

The wire used is all plastic jacket and of two types ;

4mm galvanised steel wire coated to 6mm dia. Polypropylene
Fitted with Crosby termination , heatshrink seal and bend restrictor.As deployed on 1 year moorings.

6mm galvanised steel wire coated to 8mm dia. Polypropylene
fitted galvanised steel hard eyes and copper talurits. The outer jacket being stripped back to allow correct 6mm terminations to be applied. This termination limiting endurance of the 2 year wire to around 6 months as the inner wire is now exposed to sea water at the termination.

Endeco clip on fairing is applied to the 4mm to 6mm wire below the upper sub surface buoy for a faired length of 200m. This fairing is clipped on by opening the fairing form such that the wire can br inserted within , this then springs back around the wire .

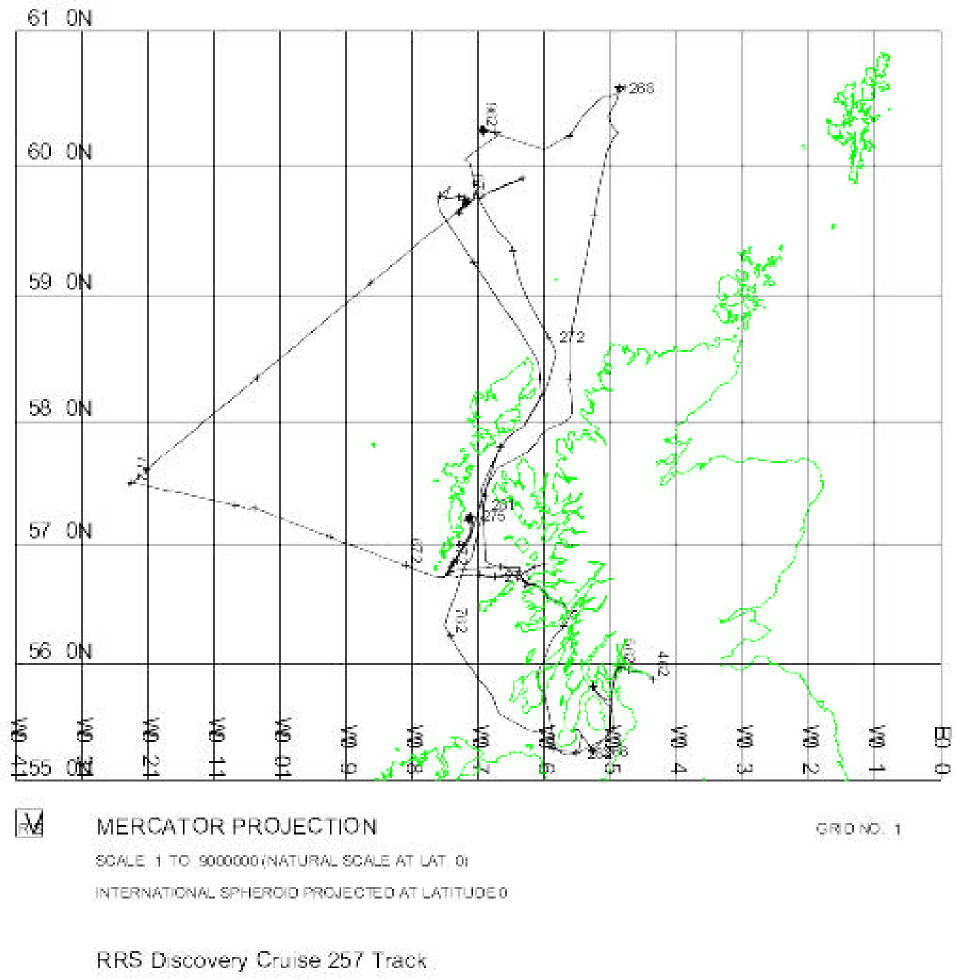
Mooring Hardware

All the mooring hardware such as shackles and links are as per SOC standard mooring equipment ,expected survival duration to be 6 months minimum .

Anchoring

The anchors are constructed as deadweight and are formed using railway wheels chained together .
Two sets of three railway wheels shown chained together with deployment line spliced into anchor mooring chain.

Railway Wheel anchor made up as two sections of three wheels chained together with ½" chain
Riser chain to release can be seen outboard, cut off line to crane being used to lower anchor.



Cruise Track for Discovery 257